

## AN INVENTORY OF MAMMALS OBSERVED AT PANGUANA BIOLOGICAL STATION, AMAZONIAN PERU

Rainer Hutterer<sup>1</sup>, Manfred Verhaagh<sup>2</sup>, Juliane Diller<sup>3</sup> & Richard Podloucky<sup>4</sup>

<sup>1</sup>Museum Alexander Koenig, Adenauerallee 160, D-53113 Bonn, Germany

<sup>2</sup>Staatliches Museum für Naturkunde, PF 6209, D-76042 Karlsruhe, Germany

<sup>3</sup>Zoologische Staatssammlung, Münchhausenstr. 21, D-81247 München, Germany

<sup>4</sup>Niedersächsisches Landesamt für Ökologie, Scharnhorststr. 1, D-30175 Hannover, Germany

*Abstract.* An inventory of mammalian species was compiled for Panguana, a biological station in Amazonian Peru, and its environs. It is based on four principal surveys conducted between 1968 and 1985. For an area of about 12 km<sup>2</sup> the occurrence of 8 families, 87 genera, and 111 species of mammals was documented. They represent a quarter of the mammal fauna of Peru. During the survey the first record of the bat *Micronycteris brachyotis* and a second record of *Micronycteris schmidtorum* from Peru were documented. Biological and distributional data are given for a number of species. A comparison with other mammal inventories suggests that 120 to 140 species may be a reasonable estimate for a local mammal fauna in primary forest of the Amazonian lowland. Accepted 9 February 1995.

*Key words:* Mammals, faunal inventory, ecology, species diversity, Amazonian Peru, Neotropics.

### INTRODUCTION

The Biological Station "Panguana" was founded by Maria and Hans-Wilhelm Koepcke in 1968 on the Río Yuyapichis in central Amazonian Peru (H.-W. Koepcke 1987). The station's two square kilometres of relatively undisturbed lowland forest and its environs have supported numerous field studies on animals and plants and their ecological relationships. Such studies exist for bird nests (M. Koepcke 1972), reptiles (Meede 1984, Podloucky 1987, Henzl 1991), amphibians (Toft & Duellman 1979, Toft 1980, Schlüter 1984, Aichinger 1985, 1987), carabid beetles (Hanagarth 1981, 1983), lepidopterans (Papageorgis 1975, J. Koepcke 1980), ants (Verhaagh 1990, 1991), oribatid mites (Wunderle 1985), lumbricids (Römbke & Verhaagh 1992), Rotatoria (Koste 1988) and plants of riparian and agricultural land (Seidenschwarz 1986a, b). As to mammals, only bats and terrestrial small mammals have been studied in detail (J. Koepcke 1984, 1987, J. Koepcke & Kraft 1984), although comparatively little has yet been published.

Between 1968 and 1985 numerous observations of mammals other than bats were made by various visitors to the station, and most of the small mammal inventories were done in a non-systematic way and on a smaller scale. Voucher specimens are now available for a considerable number of species. The authors critically checked all observations and identified all voucher specimens. The aim of this paper is, therefore, to document the mammal fauna of one part of the Selva Central del Perú, an area under high pressure because of conversion of forest into arable land and pasture, and to discuss its significance in the context of previous mammal inventories from the Neotropis.

Relatively few comparable mammal inventories exist for specific localities in the Neotropis despite the amount of field work carried out there over the last 20 years. There are a few complete or almost complete inventories available, such as for Montes Azules, Selva Lacandona, Chiapas, Mexico (Medellín 1994), La Selva, Costa Rica (Wilson 1990, Timm 1994), Barro Colorado Island, Panama (Eisenberg & Thorington

1973, Glanz 1990, Handley *et al.* 1991), Belem, Brazil (Pine 1973, and publications on bats listed in Medellín 1994), Río Alto Marañón and Río Curanja, Peru (Patton *et al.* 1982), Cocha Cashu, Manu Park, Peru (Terborgh *et al.* 1984, Janson & Emmons 1990, Ascorra *et al.* 1991, Pacheco *et al.* 1993), Cuzco Amazónico, Peru (Woodman *et al.* 1991), Pakitza, Manu Park, Peru (Pacheco *et al.* 1993), and Región de Santa Cruz de la Sierra, Bolivia (Anderson *et al.* 1993). Other localities were either surveyed less exhaustively or support a smaller number of species, e.g., Guatopo and Masaguaral, Venezuela (Eisenberg *et al.* 1979), Iguazú, Argentina (Crespo 1982), north of Manaus (Minimum Critical Size of Ecosystems Project), Brazil (Emmons 1984, Malcolm 1990), Chamela, Mexico (Ceballos & Miranda 1986), Estación Biológica del Beni, Bolivia (Cabor *et al.* 1986), or Parque Florestal Rio Doce, Brazil (Stallings *et al.* 1991).

## DESCRIPTION OF STUDY AREA

The study site is situated at 220-260 m a.s.l. on the left (southern) side of the Río Yuyapichis (=Río Llullapichis), tributary of the Río Pachitea, about 150 km south of Pucallpa, Provincia de Pachitea, Departamento Ucayali, eastern central part of Peru (9°37'S, 74°56'W). Originally Panguana consisted of an area of 2 km<sup>2</sup> of mostly little-disturbed or undisturbed primary forest (terra firme), an evergreen seasonal rain forest type of the preandine hylaea (Ellenberg 1959, Vareschi 1980) growing on dystric cambisol (Römbke & Verhaagh 1992). The site included some inundation forest and other riparian vegetation along the Río Yuyapichis and its oxbows, as well as a small clearing with a garden and some secondary vegetation around the station huts and on the northern side of the Yuyapichis. For more details of the study area see Hanagarth (1981), Seidenschwarz (1986a), H.-W. Koepcke (1987), J. Koepcke (1987), Verhaagh (1989), Römbke & Verhaagh (1992).

Since 1974 the valleys of the Río Pachitea and its tributaries belong to the agricultural development program of Pichis Palcazu. In it the government favours conversion of forest into agricultural land, especially pasture. Additionally, in 1983 the Carretera Marginal de la Selva on the west side of the Río Pachitea was opened for traffic. Panguana has never had a legal protection status, but since 1972 had been an official scientific study area (zona de estudio científico del Ministerio de Agricultura, Dirección forestal,

de caza y tierras). Meanwhile Panguana has the status of privately owned land.

When Panguana was founded in 1968, there were only the small plantations (chacras) of settlers and Ashaningka (= Campa) Indians along the Río Yuyapichis. During the following years more and more forest areas were converted into plantations (maize, manioc, bananas) and pasture, rendering the surroundings and the northern part of Panguana into a patchwork of primary and secondary forests and cultivated land (Seidenschwarz 1986a,b, Verhaagh 1989).

Published climatic data for Panguana are available for a few years only (Römbke & Verhaagh 1992). The mean annual temperature at the station was about 24,5°C, with an annual variance of  $\pm 1-2^\circ\text{C}$ . Mean maximum temperature was 27,9°C, mean minimum temperature 21,7°C. Absolute maxima and minima at the station were 33,5°C and 13°C respectively. Mean temperature in the forest was 1°C below that of the station, whereas mean temperature in the pastures was 27°C. In the pastures maxima often reached 40°C or more. For temperature differences in various habitats see Hanagarth (1981). The rainy season in Panguana lasts from the end of October to April, and is followed by a markedly dry season in which only about 20% of the whole annual precipitation falls. During the years of registration the annual rainfall averaged 2403 mm, with a variation between 1998 and 3007 mm. By application of the system developed by Reinke (1962), Panguana would exhibit an Afw''i climate type: no month with a precipitation below 60 mm, winter dry, two rain maxima.

## METHODS AND MATERIAL

The list of mammals presented herein (Table 1) is the result of mammal recordings by various researchers over 18 years (1968-1985). Most records are based on data of H.-W. and M. Koepcke (1968-1973), R. Podloucky (1973, 1982, 1983), J. Koepcke (now J. Diller) (1981-1983, 1984) and M. Verhaagh (1983-1985), with some additional records resulting from field work by U. Meede (1977, 1979, 1980), A. Schlüter (1977-1978, 1980), and an expedition by the American Museum of Natural History, New York (1969-1970). Two systematical surveys covered bats (J. Koepcke 1987) and terrestrial small mammals (Podloucky, unpubl.). Most records came from the 2 km<sup>2</sup> study area, with some additional records from within a radius of approximately 2 km

TABLE 1. List of 111 species of mammals recorded from the Panguana region between 1968 and 1985. - Abundance categories: A: abundant, C: common, U: uncommon, R: rare. - Habitat categories: PF: primary forest, SF: secondary forest and forest edges, P: pasture, PL: plantation, H: huts and surrounding garden at forest edge, RV: riparian vegetation, RI: river and oxbows. - Evidence: A: vocalization heard or tape record, V: visual record, T: tracks, R: dead animals or remains found, C: captured specimen, H: specimen obtained from local hunters.

Species	Abundance	Habitat	Evidence
Didelphimorphia			10 species
Didelphidae			
<i>Caluromys lanatus</i>	C	SF,H	V,R,C,H
<i>Chironectes minimus</i>	R	RI	T
<i>Didelphis marsupialis</i>	C	PF,SF,P,H	A,V,R,C,H
<i>Marmosa lepida</i>	R	P,H	C
<i>Marmosops noctivagus</i>	U	PF,SF, H	C
<i>Metachirus nudicaudatus</i>	U	P,H	C,H
<i>Micoureus regina</i>	R	H	C
<i>Micoureus phaea</i>	R	H	C
<i>Philander mcilhennyi</i>	C	PF,RV,H	V,R,C,H
<i>Philander opossum</i>	R	H	C
Xenarthra			9 species
Bradypodidae			
<i>Bradypus variegatus</i>	R	PF,RV	V,C,H
Dasyopodidae			
<i>Cabassous unicinctus</i>	R	?	H
<i>Dasyopus novemcinctus</i>	U	PF,P,H	R,C,H,V
<i>Dasyopus kappleri</i>	R	?	H
<i>Priodontes maximus</i>	R	PF	T
Megalonychidae			
<i>Choloepus hoffmanni</i>	R	PL	V
Myrmecophagidae			
<i>Cyclopes didactylus</i>	R	PF	C
<i>Myrmecophaga tridactyla</i>	R	PF	T
<i>Tamandua tetradactyla</i>	U	PF,SF,PL	T,V,H
Chiroptera			52 species
Emballonuridae			
<i>Cormura brevirostris</i>	R	PF	V,C
<i>Saccopteryx bilineata</i>	U	PF,SF	V,C
<i>Saccopteryx leptura</i>	R	PF,SF,RV,PL,H	V,C
<i>Rhynchonycteris naso</i>	C	RV,RI	V,C
Noctilionidae			
<i>Noctilio albiventris</i>	C	RV,RI,P,H	V,C
<i>Noctilio leporinus</i>	R	RV,RI	V,C
Phyllostomidae			
<i>Artibeus lituratus</i>	C	PF,SF,RV,PL,P	V,C
<i>Artibeus obscurus</i>	U	PF,SE,P	V,C
<i>Artibeus planirostris</i>	A	PF,SF,RV,PL,P	V,C
<i>Anoura caudifer</i>	R	PL	C
<i>Carollia castanea</i>	A	PF,SF,RV,PL	V,C
<i>Carollia perspicillata</i>	A	PF,SF,RV,PL,P,H	V,C
<i>Chiroderma trinitatum</i>	U	PF,PL	V,C
<i>Chiroderma villosum</i>	R	SF,RI,PL	C
<i>Choeronycteris intermedius</i>	R	PF,SF,RV,PL	V,C
<i>Dermanura anderseni</i>	U	PF,SF,RV,PL	C
<i>Desmodus rotundus</i>	U	PF,SF,RV,PL,P	V,C
<i>Diaemus youngi</i>	R	H	C
<i>Diphylla ecaudata</i>	R	H	C
<i>Enchisthenes hartii</i>	R	SF	C
<i>Glossophaga soricina</i>	U	PF,SF,RV,PL,H	V,C
<i>Lonchophylla thomasi</i>	U	PF,SF,RV,PL	V,C

Species	Abundance	Habitat	Evidence
<i>Micronycteris brachyotis</i>	R	SF	C
<i>Micronycteris daviesi</i>	R	PF	V,C
<i>Micronycteris megalotis</i>	U	PE,SF	V,C
<i>Micronycteris schmidtorum</i>	R	SF,PL	V,C
<i>Mimon crenulatum</i>	R	PE,SF,PL,H	C
<i>Phylloderma stenops</i>	R	PE,PL	C
<i>Phyllostomus elongatus</i>	R	PE,SF	C
<i>Phyllostomus discolor</i>	R	PF	C
<i>Phyllostomus hastatus</i>	U	SF,RV,RI,PL,P,H	V,C
<i>Platyrrhinus brachycephalus</i>	U	PE,SF,RV,PL,P	C
<i>Platyrrhinus helleri</i>	C	PE,SF,RV,PL	V,C
<i>Rhinophylla fischeri</i>	U	PE,SF,PL	C
<i>Rhinophylla pumilio</i>	A	PE,SF,RV,PL,H	V,C
<i>Sphaeronycteris toxophyllum</i>	R	SF	C
<i>Sturnira lilium</i>	A	PE,SF,RV,PL,P	V,C
<i>Sturnira tildae</i>	U	PE,SF,RV,PL	C
<i>Tonatia brasiliense</i>	R	SF,RV,PL	C
<i>Tonatia sylvicola</i>	R	PE,SF	V,C
<i>Trachops cirrhosus</i>	U	PF	V,C
<i>Uroderma bilobatum</i>	C	PE,SF,RV,PL,P	V,C
<i>Vampyressa bidens</i>	R	PE,SF,PL	C
<i>Vampyressa macconnelli</i>	U	PE,SF	V,C
Thyropteridae			
<i>Thyroptera tricolor</i>	R	PF	V,C
Vespertilionidae			
<i>Lasiurus ega</i>	U	RV,PL,P,H	V,C
<i>Myotis nigricans</i>	U	PE,RV,PL,H	V,C
<i>Myotis simus</i>	R	SF	C
<i>Eptesicus brasiliensis</i>	R	SF,RI,PL,H	V,C
Molossidae			
<i>Eumops bonariensis</i>	R	SF	C
<i>Molossops temminckii</i>	R	SF	C
<i>Molossus molossus</i>	U	RV,RI,PL,P,H	V,C
Primates			8 species
Callitrichidae			
<i>Saguinus fuscicollis</i>	C	PE,SF,RV,PL,H	A,V,H
Cebidae			
<i>Alouatta seniculus</i>	U	PF	A,R
<i>Aotus nigriceps</i>	C	PE,SF	A,V,C,H
<i>Callicebus cupreus</i>	C	PE,SF,H	A,V,H
<i>Cebus albifrons</i>	C	PE,SF	A,V,H
<i>Lagothrix lagothricha</i>	R	PF	H
<i>Pithecia monachus</i>	U	PF	A,V,H
<i>Saimiri sciureus</i>	C	PE,SF	A,V,H
Carnivora			11 species
Felidae			
<i>Herpailurus yagouaroundi</i>	R	PE,H	V,H
<i>Leopardus pardalis</i>	U	PE,SF	T,R,H
<i>Leopardus wiedii</i>	R	PF	H
<i>Panthera onca</i>	R	PF	T
<i>Puma concolor</i>	U	PE,SF,PL,P	T,H
Mustelidae			
<i>Eira barbara</i>	U	PE,SF,PL,P,H	T,H
<i>Lutra longicaudis</i>	R	PE,RV,RI	H
Procyonidae			
<i>Basaricyon gabbii</i>	R	PF	V
<i>Nasua nasua</i>	U	PF	A,V
<i>Potos flavus</i>	C	PE,SF,H	A,V,H
<i>Procyon cancrivorus</i>	R	RV	H

Species	Abundance	Habitat	Evidence
Perissodactyla			1 species
Tapiridae			
<i>Tapirus terrestris</i>	U	PF,RV	T,R,H
Artiodactyla			3 species
Cervidae			
<i>Mazama americana</i>	C	PF,PL,P	V,T,H
Tayassuidae			
<i>Tayassu pecari</i>	U	PF,RI,RV	V,H
<i>Pecari tajacu</i>	C	PF,RV	V,T,H
Rodentia			17 species
Agoutidae			
<i>Agouti paca</i>	C	PF,PL,H	A,V,H
Dasyproctidae			
<i>Dasyprocta fuliginosa</i>	C	PF,SE,PL,H	V,R,H
<i>Myoprocta pratti</i>	R	PF	C
Echimyidae			
<i>Isobryx bistrata</i>	R	PF	C
<i>Mesomys hispidus</i>	C	PF,SE,H	V,C
<i>Proechimys breviceauda</i>	C	PF,SE,H	C
<i>Proechimys simansi</i>	U	SE,H	C
Erethizontidae			
<i>Coendou bicolor</i>	U	PF	V,R
Hydrochaeridae			
<i>Hydrochaeris hydrochaeris</i>	C	RV,RI,PL,H	V,T,H
Muridae			
<i>Neacomys tenuipes</i>	U	PF,RV	C
<i>Nectomys squamipes</i>	C	PF,SE,RV,PL,PH	R,C
<i>Oecomys bicolor</i>	U	H	C
<i>Oryzomys capito</i>	C	PF,SE,PH	C
<i>Rattus rattus</i>	R	H	C
Sciuridae			
<i>Microsciurus flaviventer</i>	U	PF	V
<i>Sciurus igniventris</i>	U	PF,H	C
<i>Sciurus spadicus</i>	C	PF,SE,H	V,C

around the station huts (=12 km<sup>2</sup>). In a few cases additional specimens were obtained from as far as 3 km west of Panguana (Casa Módena, mouth of Río Yuyapichis), and 10 km to the east.

Bats were mostly netted and observed from September 1981 to January 1982, March 1982 to February 1983 and June to August 1984 (J. Koepcke 1984, 1987, J. Koepcke & Kraft 1984). Observations were made along the 15 km trail system of the Panguana forest, at the forest edge and borders of river and oxbows, around the station huts, and in plantations and cattle pastures in the vicinity of the station. Bats were captured with mist nets or by hand at roosting places, and some species were also shot. Thus the bat records are based on multiple observations, 1354 specimens netted (and mostly released) by J. Koepcke, and a few additional captures by other researchers.

Traplines set for terrestrial small mammals covered most of the transect shown in Fig. 1. Other mammal records are based on occasional captures with snap traps on the ground, specimens hunted by local people or their dogs, visual observations (often documented by photographs or on film), or acoustic records, some of which were taped. Unequivocal tracks, carcasses, or identifiable remains were also included.

Because of the different recording systems for bats and non-volant mammals, the same abundance categories for both mammal groups are based on different frequency records (sightings, vocalizations heard, tracks, remains or captured specimens). Bats: A = abundant: more than 100 records, C = common: 51-100 records, U = uncommon: 10-50 records, R = rare: less than 10 records. Abundance categories of other mammals are more subjective due to the nature of observation, capture, or hunting, and also because

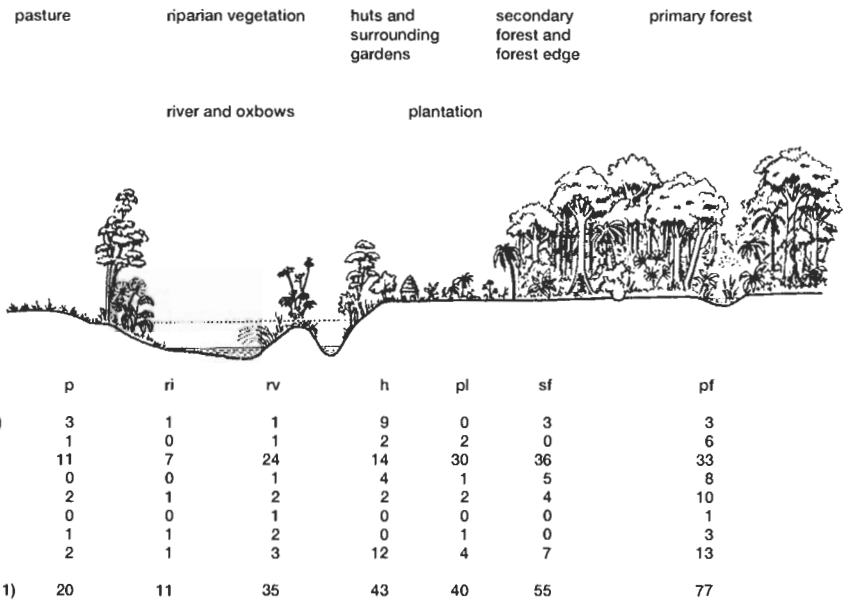


FIG. 1. A cross section of the Panguana area from the banks of Río Yuyapichis to the primary forest showing the seven principal habitat types: pasture (p), river and oxbows (ri), riparian vegetation (rv), huts and surrounding gardens (h), plantation (pl), secondary forest and forest edge (sf), and primary forest (pf). The numbers of mammal species observed in these habitats are given by orders.

of the long duration of our survey. The abundance of a number of species has certainly changed since 1968 as a consequence of high hunting pressure and habitat disturbance. We used a mixture of observation frequency, calls heard, tracks found by the various researchers, and the number of captured or hunted specimens or remains found. With this slightly arbitrary system we could not put any of the non-volant animals into the category "abundant". Species classified as "common" were regularly seen and recorded by 3-4 researchers or represented by 10-20 voucher specimens, "uncommon" if rarely seen and recorded by 2-3 researchers only or represented by 3-9 voucher specimens, and "rare" if recorded only once by 1 or 2 persons or represented by 1 or 2 voucher specimens only.

Voucher specimens have been deposited in the American Museum of Natural History, New York [AMNH], Museo de Historia Natural, Universidad Nacional Mayor de San Marcos, Lima [MUSM], Staatliches Museum für Naturkunde, Karlsruhe [SMNK], Staatliches Museum für Naturkunde Stuttgart [SMNS], Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn [ZFMK],

Zoologisches Institut und Museum der Universität, Hamburg [ZMUH], and Zoologische Staatssammlung, München [ZSM].

Calculation of species similarity between two localities was by the Soerensen index:  $S = 2j/(a+b) \times 100(\%)$ , where  $j$  is the number of species common (joint) to the two localities compared, and  $a$  and  $b$  are the total numbers of species at each one locality (Southwood 1978).

The taxonomy follows the relevant chapters of the mammal checklist edited by Wilson & Reeder (1993), except for the arrangement of the Phyllostomidae which follows Owen (1987), and for the species status of *Philander mcilhennyi* which follows Reis *et al.* (1994).

## RESULTS

*Mammal species recorded from Panguana.* We have evidence for the occurrence of 111 species of mammals in Panguana and its close environs. 8 families and 87 genera are represented. Our checklist (Table 1) includes all data collected between 1968 and 1985. One

bat, *Micronycteris brachyotis*, had not been recorded from Peru before. Comments on other noteworthy species are given in the Appendix.

*Ecological Aspects.* Looking at the species frequencies (Tables 1-3), as well as the body mass distributions (Table 4), the composition of the mammal fauna of Panguana is typical of an Amazonian rainforest (Eisenberg 1990). Bats are most diverse and form 47% of the total number of species, followed by rodents (15%), carnivores (10%), marsupials (9%), xenarthrans (8%), primates (7%), artiodactyles (3%) and perissodactyles (1%). So far there is no record of a rabbit. 58 species, or 52.3% of the fauna, are of small size (body mass <100 g) and include 52 bats, 5 rodents and 1 mouse opossum; 20 species (18.0%) are of medium size (0.1 – <1 kg) and include most marsupials, some monkeys and rodents, and the silky anteater; 23 species (20.7%) are large (1 – <10 kg) and include one opossum, most of the xenarthrans and carnivores, half of the primates and four rodents; 10 species (9.0%), the giant armadillo, giant anteater, three cats, all ungulates and the capybara, are very large (> 10 kg).

In Panguana, mammals occur in all available habitats (Table 1, Fig. 1). Most species were found in primary rain forest (77), or forest edge and secondary forest (55), resulting in a total of 90 species collected from or observed in forest or forest edges. 19 species were only recorded from non-forest areas, including several marsupials such as *Chironectes minimus*, *Marmosa lepida*, *Metachirus nudicaudatus*, *Micoureus regina*, *M. phaea*, *Philander opossum*, the bats *Rhynchonycteris naso*, *Noctilio albiventris*, *N. leporinus*, *Anoura caudifer*, *Diaemus youngi*, *Diphylla ecaudata*, *Lasiurus ega*, *Molossus molossus*, the sloth *Choelopus hoffmanni*, the racoon *Procyon cancrivorus*, the capybara *Hydrochaeris hydrochaeris*, the murids *Oecomys bicolor* and the black rat *Rattus rattus*, which was only observed around the huts. Most of these species were either exclusively encountered near the huts and in the surrounding gardens, or close to the river and in riparian vegetation. The majority of the species found outside the forest were bats. In fact only 5 bat species were exclusively recorded from the primary forest, and an additional 11 species only from primary and secondary forests or forest edges, but 36 bat species were netted or observed in non-forested areas. 42 species were recorded only from one habitat (24 only from primary forest), 24 species from two, and 44 from at least three different habitats. No habitat infor-

mation is available for two armadillo species which are documented only by skulls obtained from local hunters.

In a transect from the river to the undisturbed primary forest (Fig. 1), the number of mammal species increases in that direction.

## DISCUSSION

*Faunal composition.* A comparison with other Peruvian mammal faunas (Table 2, Fig. 2) demonstrates that our list of 111 mammals of Panguana is not fully complete. The rich faunas of the Manu Park, or of Cuzco Amazónico, comprise 136 and 135 species respectively. However, both faunas are based on a much larger area, and the latter fauna also includes species the occurrence of which was only "presumed", a category which we on principal excluded from our list. There are a number of reasons for the incompleteness of the Panguana survey:

1. Most samples and observations, except for bats and some terrestrial small mammals, were not obtained in a systematic way but rather randomly. Moreover, the accumulation of raw data happened in four main steps over a timespan of 18 years. Species numbers recorded were approximately 48 by 1974, 55 by 1982, 101 by 1984, and 111 by 1985.

2. Not all habitats were sampled or surveyed to the same extent. The surroundings of the field station received most attention, while the interior of the rain forest received less, and the canopy region was neglected entirely.

3. The total number of trap nights for small terrestrial mammals was comparatively low, and traps were never set in trees.

We therefore believe that the mammal fauna of Panguana may include a further ten or more species of rodents, a few more bats and marsupials, and possibly one or two canids. Therefore a total number of 120 to 140 species may be realistic.

However, we found no evidence for the existence of canids (although JD was told that a small, dark-brown canid, possibly *Speothos venaticus*, was observed in the hinterland of Panguana) and also not for the existence of rabbits, an element present in most other faunas examined (Table 2). We also do not know whether more than the eight species of primates (Table 1) occur or may have occurred previously. Strong hunting pressure on larger mammals in and around Panguana suggests that some species such as *Ateles* may have already disappeared from the study

TABLE 2. Comparison of mammal faunas in Amazonian Peru. Sources: (1) Panguana, 220 m, this study; (2) Cocha Cashu, Manu N.P., 380 m, Janson & Emmons 1990, Pacheco *et al.* 1993, figures in parentheses include data from Ascorra *et al.* 1991; (3) Pakitza, Manu N.P., 350 m, Pacheco *et al.* 1993; (2+3) Manu, localities Cocha Cashu and Pakitza combined; (4) Cuzco Amazónico, 200 m, Woodman *et al.* 1991, figures in parentheses include species listed as "probably present"; (5) Río Alto Maraón, 170-790 m, Patton *et al.* 1982; (6) Río Curanja, 300 m, Patton *et al.* 1982. "small" = less and "large" = more than 100 km<sup>2</sup>.

	Localities						
	1 Panguana	2 Cocha	3 Pakitza small	2+3 Manu small	4 Cuzco +100 200	5 Maraón large 170-790	6 Curanja ?
Area (km <sup>2</sup> )	12	10	small	small	+100	large	?
Altitude (m)	220	380	350	-	200	170-790	300
Taxa							
Didelphimorphia	10	8	9	12	9(10)	10	9
Xenarthra	9	7	2	7	5(9)	9	6
Chiroptera	52	28(44)	54	59	42(54)	38	57
Primates	8	13	9	13	7(13)	6	9
Carnivora	11	13	8	13	9(15)	14	12
Perissodactyla	1	1	1	1	1(1)	1	1
Artiodactyla	3	4	3	4	2(5)	4	3
Rodentia	17	23	21	26	24(27)	26	24
Lagomorpha	0	1	1	1	1(1)	1	1
Totals	111	98(114)	108	136	100(135)	109	122
Non-volants	59	70(70)	54	77	58(81)	71	65

area. (This is supported by a neighbour living downriver who told the Koepckes that *Ateles* had occurred in his area but was exterminated by hunting.) On the other hand it is also possible that one or two small and rare primate species exist in Panguana which may have been overlooked in the past. For example *Callimico goeldii* may have been the "small and dark primate" once observed by Maria Koepcke, though her observation could not be supported on later visits. *Abundance and ecological aspects.* The estimation of relative abundance is always a subject of heavy bias. The only group in which abundance figures in Panguana are more than just a subjective impression are bats, but even in this group records depend mainly on adequately positioned nets. 25 species were classified as rare (less than 10 records), 17 as uncommon (10-50 records), and only 10 as common or abundant, with 50-100 or >100 records respectively. Thus 10 species represent more captured specimens than the remaining 42 species. Eight of these 10 species are also common or abundant in Cuzco Amazónico (Woodman *et al.* 1991). These data probably reflect real aspects of the faunal composition. Comparable

figures with high numbers of rare species and only a few abundant species are known for other tropical bat communities (LaVal & Fitch 1977) as well as for other tropical animal communities, including birds (Bierregaard 1990), beetles (Morse *et al.* 1988), and parasitic wasps (Stork 1988).

Most non-volant mammals in Panguana must be classified as rare or uncommon, with the following exceptions: *Caluromys lanatus*, *Didelphis marsupialis*, *Philander mcilhennyi*, *Potos flavus*, *Saguinus fuscicollis*, *Aotus nigriceps*, *Callicebus cupreus*, *Saimiri sciureus*, *Cebus albifrons*, *Mazama americana*, *Pecari tajacu*, *Agouti paca*, *Dasyprocta fuliginosa*, *Mesomys hispidus*, *Proechimys brevicauda*, *Hydrochaeris hydrochaeris*, *Nectomys squamipes*, *Oryzomys capito*, *Sciurus spadicus*. Most of these species are commonly found in other Amazonian localities as well, or are replaced by similar species (Pine 1973, Malcolm 1990, Woodman *et al.* 1991, Pacheco *et al.* 1993). However, we have no figures of absolute population size for these species, and it is therefore difficult to judge whether our classification of the relative abundance of the Panguana mammals reflects absolute abundance.



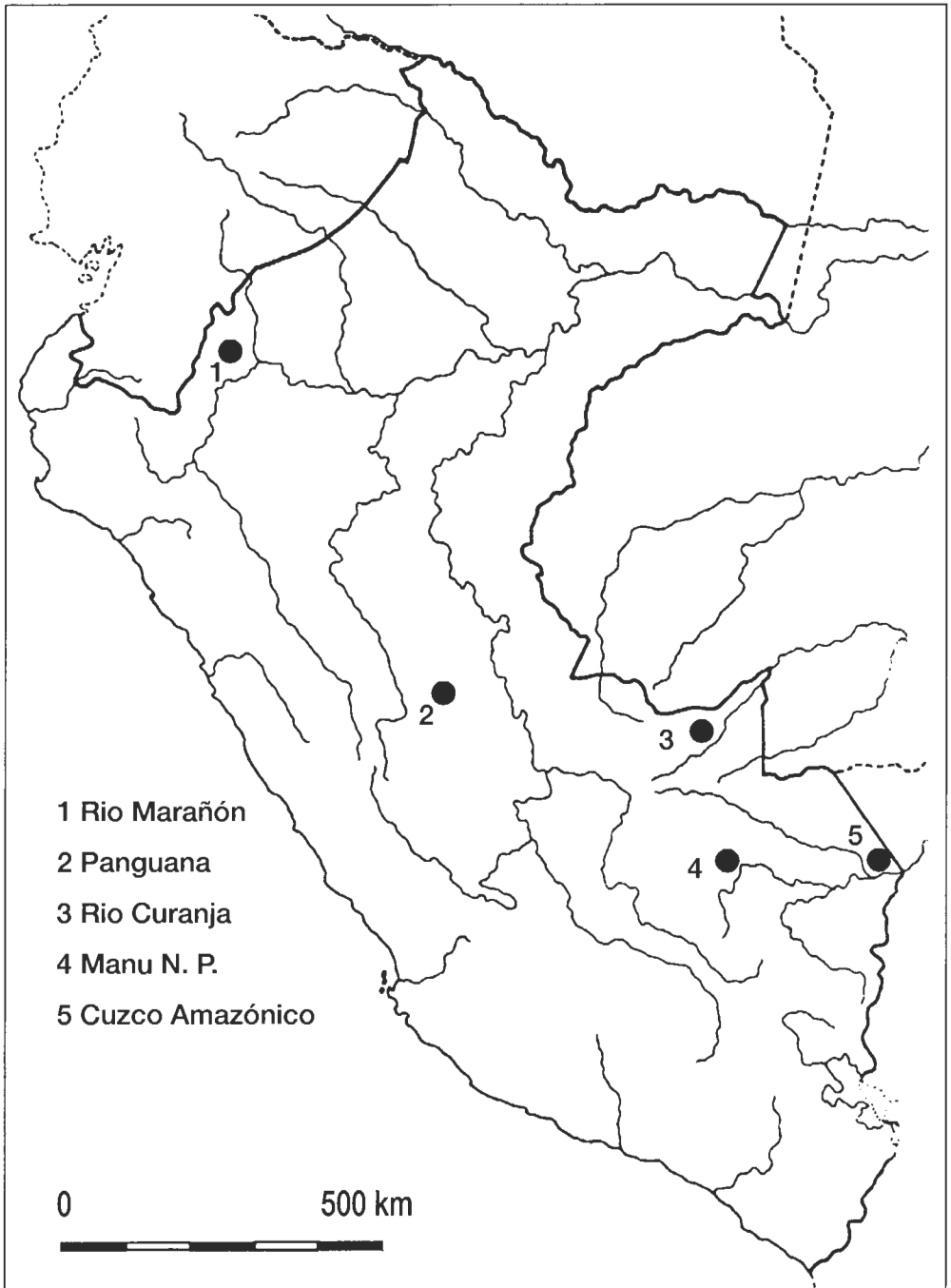


FIG. 2. Locations of mammal surveys in the Amazonian rainforest of Peru; 1 Río Alto Marañón (Patton *et al.* 1982), 2 Panguana (this study), 3 Manu National Park: Cocha Cashu (Janson & Emmons 1990, Pacheco *et al.* 1993) and Pakitza (Pacheco *et al.* 1993), 4 Río Curanja (Patton *et al.* 1982), 5 Cuzco Amazónico (Woodman *et al.* 1991).

Obviously, small rodents and marsupials are underrepresented in our survey, not only in species number but also in their abundance due to inadequate sampling.

A factor with a strong impact on the mammal fauna of Panguana is hunting for food by local people. Originally this was forbidden by decree of the Ministry of Forest and Fauna but not renewed in 1973 when H.-W. Koepcke left Peru. Outside the 2 km<sup>2</sup> of Panguana the hunting pressure has always been high, and larger primates and cats, wild pigs, tapir, and other mammals have become notably scarce and shy during the last decades, as also related by the local people. This made it sometimes difficult to place a species in our abundance system (e.g., *Alouatta seniculus*, *Pecari tajacu*). At the end of the seventies the region around Panguana became part of an agricultural developmental program that caused a lot of disturbance for the forest fauna and a remarkable reduction of forest habitat. On the other hand, additional anthropogenic habitats may have supported some species by offering new or more abundant food resources or roosting places (huts), and even may have attracted new species introduced by man or native to open habitats. So far the only immigrant in Panguana has been the black rat, which was occasionally observed near the river and around the huts. It is not known whether the species is fully established in the region. Black rats were also reported from the surroundings of the huts in Cuzco Amazónico (Woodman *et al.* 1991) and from the Alto Marañón (Patton *et al.* 1982), but not from Cocha Cashu or Pakitza, Manu N.P. (Pacheco *et al.* 1993).

The remaining 110 species are typical of Amazonian lowland rainforest areas. The fact that we found several marsupials and bats, the two-toed sloth and the mouse *Oecomys bicolor* only outside the forest is probably due to limited sampling. All these species may be expected in the forest as well. Some other species are strongly associated with natural habitats like river, oxbows and riparian vegetation: *Chironectes minimus*, *Rhynchonycteris naso*, *Noctilio albiventris*, *N. leporinus*, *Molossus molossus* (partly), *Procyon cancrivorus*, *Lutra longicaudis*, and *Hydrochaeris hydrochaeris*. Because the anthropogenic habitat within the study area of 12 km<sup>2</sup> was small until 1985, and interspersed with different forest types, these cleared areas could be used by a number of species in addition to their natural habitat. This is especially true for the bats, most of which use more than just one habitat (J. Koepcke 1987). Several species roost in the roofs of huts and

houses thatched with palm leaves (*Saccopteryx leptura*, *Lasiurus ega*, *Myotis nigricans*, *Eptesicus brasiliensis*, *Molossus molossus*, *Phyllostomus hastatus*, *Carollia perspicillata*, *Rhinophylla pumilio*), while vampire bats (*Desmodus rotundus*, *Diaemus youngi*, *Diphylla ecaudata*) are attracted by cattle and chicken-coops. Some frugivorous and nectarivorous species (*Artibeus lituratus*, *A. planirostris*, *Carollia castanea*, *C. perspicillata*, *Glossophaga soricina*, *Phyllostomus hastatus*, *Rhinophylla pumilio*, *Sturnira lilium*, *Lonchophylla thomasi*, *Anoura candifer*) exploit the seasonally increased supply of flowers and fruits of plants like *Cecropia*, *Ochroma*, *Piper*, *Solanum*, *Passiflora*, and cultivated plants like banana or mango. The number of insects in open habitats and their edges can also be attractive to bats (*Saccopteryx bilineata*, *Lasiurus ega*, *Myotis nigricans*, *M. simus*, *Eptesicus brasiliensis*, *Molossus molossus*, *Molossops temminckii*, *Eumops bonariensis*, *Noctilio albiventris*, *M. schmidtorum*, *Tonatia brasiliense*). Most bats which regularly forage in cultivated land belong to species which normally prefer thin forest, forest edges, or river sides (J. Koepcke 1987).

Shelter and regular food resources available in huts, gardens and plantations also seem to attract many marsupials and rodents. The arboreal *Caluromys lanatus*, rarely found in Cocha Cashu (Terborgh *et al.* 1984) and Cuzco Amazónico (Woodman *et al.* 1991), was regularly seen in and around the station huts by several observers throughout the study period, often feeding on stored bananas. The same was true for *Mesomys hispidus* and *Sciurus spadicus*. Bananas also regularly attracted a troop of *Saguinus fuscicollis*, and some members of the group could be fed by hand near the huts. *Didelphis marsupialis* regularly invaded chicken-coops and were then killed by settlers.

*Comparisons with other Neotropical faunas.* Comparisons between different faunas are always a matter of ambiguity. Localities in the Neotropis for which larger faunal lists exist differ remarkably in annual rainfall, altitude, altitudinal gradient, vegetation cover, sampled area and sampling time. Thus, in Table 2 and 3 small study areas of a few square kilometers like Panguana, Cocha Cashu, Pakitza, La Selva or Barro Colorado Island stand next to large areas like Mts. Azules, Belem, Cuzco Amazónico, Alto Marañón or St. Cruz, with hundreds or thousands of square kilometers. Nevertheless, the faunal composition at the level of mammal orders is remarkably similar between Peruvian faunas (Table 2) as well as between other Neotropical faunas from Mexico to Bolivia, when forested areas are considered (Table 3). This led

TABLE 3. Comparison of Panguana with some other Neotropical forest mammal faunas. Sources: (1) Mts Azules, Chiapas, Mexico, Medellín 1994; (2) La Selva, Costa Rica, Wilson 1990, Timm 1994; (3) BCI, Panama, Glanz 1990, Handley *et al.* 1991, figures in parentheses include species listed as possibly and probably extinct; (4) Guatopo, Venezuela, Eisenberg *et al.* 1979, and *pers. comm.* 1994; (5) 80 km N of Manaus, Brazil, Malcolm 1990, figures in parentheses include species listed by Emmons 1984 as "likely to be found"; (6) Parque Florestal Rio Doce, Brazil, Stallings *et al.* 1991; (7) Belem, Brazil, Pine 1973 (includes many taxa now extinct in the region) and various publications on bats listed in Medellín 1994; (8) Panguana, Peru, this study; (9) Estación Biol. del Beni, Bolivia, Cabot *et al.* 1986; (10) Santa Cruz de la Sierra, Bolivia, Anderson *et al.* 1993. n.d. = not determined; "small" = less and "large" = more than 100 km<sup>2</sup>.

	Localities									
	1	2	3	4	5	6	7	8	9	10
	Mts Azul	La Selva	BCI Panama	Guatopo	Manaus	Rio Doce	Belem	Panguana	Beni	St Cruz
Area (km <sup>2</sup> )	+3310	15	15	-20	-270	350	large	12	1200	large
Altitude (m)	300	85	100	700	100	?	50	220	100	?
Taxa										
Didelphimorphia	7	5	6	7	9(9)	8	9	10	4	15
Xenarthra	4	7	6	5	8(8)	4	10	9	6	10
Chiroptera	64	65	56	29	n.d.	14	46	52	31	43
Primates	2	4	5	3	6(8)	4	6	8	7	8
Carnivora	12	14	6(12)	8	7(14)	8	17	11	15	17
Perissodactyla	1	1	1	1	1(1)	1	1	1	1	1
Artiodactyla	4	4	3(4)	2	4(4)	1	4	3	5	5
Rodentia	17	16	12(17)	13	16(22)	17	21	17	n.d.	30
Lagomorpha	1	1	1	1	0(1)	1	1	0	1	1
Totals	112	117	96(108)	69	-	58	115	111	70	130
Non-volants	48	52	40(52)	40	51(68)	44	69	59	39	87

Medellín (1994) to the conclusion that "the size of the area seems not to be an important factor in species richness." However, there certainly is a size effect. 114 species of mammals are known from Cocha Cashu to date (Janson & Emmons 1990, Ascorra *et al.* 1991), and 108 from the nearby Pakitza (Pacheco *et al.* 1993), resulting in 136 species for both combined areas. By adding more localities from the whole Manu Park, the species number increases to 190 (Pacheco *et al.* 1993). The comparison of La Selva in Costa Rica (15 km<sup>2</sup>) with the much larger (320 km<sup>2</sup>) La Selva-Braulio Carrillo Complex shows a similar result: 117 versus 142 species (Timm *et al.* 1989). It is evident that a large area with a considerable altitudinal gradient and a higher habitat diversity supports more mammal species than a rather homogeneous piece of lowland rainforest.

120 to 140 mammalian species seem to be a reasonable number for a given rainforest area of 10 to 50 km<sup>2</sup> in the Neotropics with a slight altitudinal gradi-

ent. This number is equivalent to about a quarter of the total mammal fauna of such countries as Mexico and Peru (452 and 460 species respectively, Medellín 1994, Pacheco 1994). At the species level it is not surprising that the fauna of Panguana is more similar to the fauna of Cocha Cashu and Pakitza in Peru than to that of Mts Azules in Mexico. Thus, the Sorensen similarity index for the faunas of Panguana (111 species) and Cocha Cashu plus Pakitza (136 species, Pacheco *et al.* 1993) is 66.4% (82 species common to both localities; when records from sites other than Cocha Cashu and Pakitza are added, the number of shared species is even larger) versus 39.5% (44 species in common) for Panguana and Mts Azules (112 species, Medellín 1994). The low similarity index between Panguana and Mts Azules is mainly caused by the different rodent faunas: both localities share only one species (*Agouti paca*) while Panguana and Manu (Cocha Cashu and Pakitza combined) share 11 species (S=5.9% versus 51.2%).

TABLE 4. Comparison of body mass classes (as defined by Medellín 1994) in several terrestrial Neotropical mammal faunas. Data in percentages, absolute numbers in parentheses. Body mass data were taken or derived from Eisenberg *et al.* 1979, Janson & Emmons 1990, and Medellín 1994. Sources of faunal data: 1 Mts Azules, Chiapas, Mexico, Medellín 1994; 2 La Selva, Costa Rica, Wilson 1990, Timm 1994; 3 BCI, Panama, Glanz 1990, Handley *et al.* 1991; 4 Belem, Brazil, Pine 1973 and various publications on bats listed in Medellín 1994; 5 Panguana, Peru, this study; 6 Manu, Peru, combined data from Cocha Cashu, Janson & Emmons 1990, Pacheco *et al.* 1993, and Pakitza, Pacheco *et al.* 1993; 7 Cuzco Amazónico, Woodman *et al.* 1991.

Localities	Body mass classes			
	Small <0.1kg	Medium 0.1<1kg	Large 1<10 kg	Very Large >10 kg
1 Mt. Azules, Mexico (n=112)	66.1 (74)	9.8 (11)	17.0 (19)	7.1 (8)
2 La Selva, Costa Rica (n=117)	61.5 (72)	12.8 (15)	17.9 (21)	7.7 (9)
3 BCI, Panama (n=108)	62.0 (67)	10.2 (11)	19.4 (21)	8.3 (9)
4 Belem, Brazil (n=115)	53.0 (61)	13.9 (16)	24.3 (28)	8.7 (10)
5 Panguana, Peru (n=111)	52.3 (58)	18.0 (20)	20.7 (23)	9.0 (10)
6 Manu, Peru (n=136)	55.1 (75)	18.4 (25)	18.4 (25)	8.1 (11)
7 Cuzco Amaz., Peru (n=135)	53.3 (72)	17.8 (24)	20.7 (28)	8.1 (11)

There is not only a difference in species composition between Amazonian and Mesoamerican faunas but also a slight shift to higher proportions of small mammals in the composition of the Mesoamerican faunas (Table 4). In the faunas of Mts Azules, La Selva and Barro Colorado Island the size guild of small mammals constitutes more than 61 to 66% (compared to 50 to 55% in the Amazonian faunas) of the whole fauna and reflects the higher proportion of bats in these faunas, despite the fact that the whole bat fauna of these sites is still not known (Wilson 1990). Accordingly, the size guilds of medium and large mammals combined are about 10 % smaller in Mesoamerican faunas than in Amazonian ones. The size guild of very large mammals (> 10 kg) is similar in its composition in all faunas considered, reflecting the wide geographical distribution of large animals such as *Panthera onca*, *Puma concolor*, *Mazama americana* or *Pecari tajacu*.

These comparisons, however, are hampered by the fact that the sizes of the study areas, altitudes and sampling efforts are often not comparable (Table 3). Also, some areas are imbedded in larger forested areas (La Selva and Barro Colorado) which increase the total catchment area for highly mobile forms such as bats (Eisenberg, pers. comm.). Others, such as Rio Doce National Park in Brazil, are true islands because forest no longer exists around them; totals for these species may be lower.

## APPENDIX

*Remarks on selected species.* Local names are only provided if not already given in Emmons & Feer (1990).

*Caluromys lanatus.* The species was seen to eat the fruits of *Urena caracasana* (Fam. Urticaceae). Stomachs and intestines of 2 specimens hunted by a dog contained fruit pulp and some insect remains. Insects were identified as one big Lepidoptera larva, 2 Orthoptera and some ants (3 *Camponotus femoratus*, 3 *Crematogaster* sp. and one *Ectatomma tuberculatum*). For some time one individual of *C. lanatus* lived in the roof of the station hut, feeding on ripe bananas every night. The species is called "zorillo plátano" or "zarigueya" by local settlers. Larvae and nymphs of the tick *Amblyomma* sp. were found on one specimen (Walter 1990). A female collected on November 2 carried one juvenile in its pouch.

*Didelphis marsupialis.* The stomachs and intestines of 4 individuals were checked. One contained a ball of hairs and feathers with chewed parts of Orthoptera, Blattodea, and ants (*Azteca*); some hairs belonged to a spiny rat (Echimyidae). The other stomach was firmly filled with remains of fruits and seeds, a small mammal, a frog, and many arthropods: beetles, termites, larvae of Diptera, a wingless fly, a cicada and specimens of the ant genera and species *Brachymyrmex*, *Camponotus*, *Crematogaster*, *Dolichoderus bidens*,

*Gnamptogenys*, *Labidus coecus*, *Pachycondyla harpax* and *P. pergandei*, *Pheidole*, *Proceratium*, *Solenopsis geminata*, and *Solenopsis (Diplorophtrum)* sp. Surprisingly, a lot of ant specimens were small to tiny (1-2 mm), e.g., *Brachymyrmex*, *Diplorophtrum*. The stomach also contained some sand, indicating together with the ant species spectrum that the opossum mainly fed on the ground, although some of the ants may have been ingested with the frog. The third stomach was filled with papaya, a fourth with fly larvae, fragments of beetles, a frog and papaya. A female killed on July 23 in a snap trap at a chicken hut carried five young in its pouch; another one collected on November 28 carried nine young. Several specimens of the common opossum hosted ticks of the species *Ixodes luciae* and larvae and nymphs of *Amblyomma* sp. (Walter 1990).

*Marmosa lepida*. This is a rare species normally found in rain forests (Emmons & Feer 1990). A specimen was found under the bark of a felled tree in a recently cleared forest. The stomach was filled with finely-chewed insect remains. Some could be identified as *Crematogaster* ants. Another animal caught in a hut had Lepidoptera larvae and Orthoptera in its stomach.

*Marmosops noctivagus*. Two stomachs were examined; they contained fruit flesh and seeds of an unidentified plant and insect remains, of which only Orthoptera and the ant *Pachycondyla harpax* could be identified.

*Metachirus nudicaudatus*. One specimen was killed by a settler in a banana plantation on January 20. It was a female with six young in a spherical nest built of dry leaves and stems on a tree trunk covered by dense undergrowth. The interior of the nest was upholstered with leaves, the nest entrance was at the side. Stomach and intestine of the adult specimen contained finely-chewed parts of arthropods among which beetles, larvae of Diptera, termites, a cockroach, a spider, and the ants *Eciton* sp., *Pachycondyla* sp., *Pachycondyla harpax*, and *Pheidole* sp. were identified.

*Micoureus phaea*. Besides the very large *Micoureus regina*, which is represented by one specimen (ZMUH), two smaller mouse opossums were collected in Panguana (SMNK) which we tentatively assign to *M. phaea*. The latter form is listed as a synonym of *regina* in Wilson & Reeder (1993).

*Philander mcilhennyi*. This little-known species had been synonymized with *P. andersoni* by Terborgh *et al.* (1984) and Emmons & Feer (1990). However, recent cytochrome b gene studies by Reis *et al.* (1994)

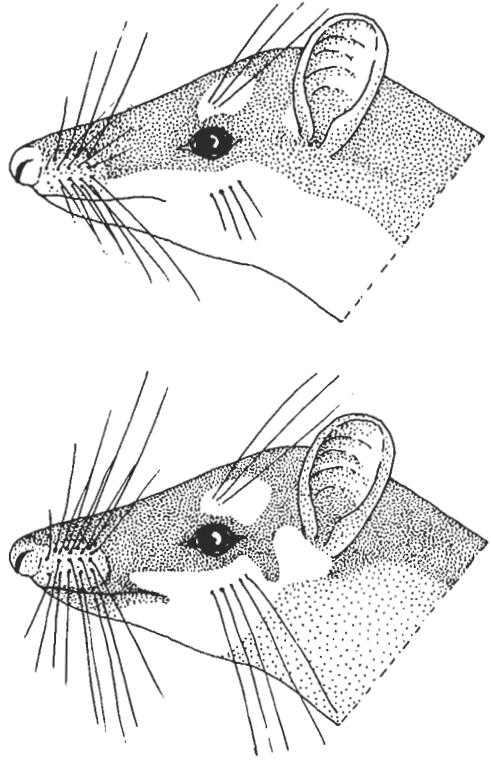


FIG. 3. *Philander opossum* (top) differs from *P. mcilhennyi* (bottom) in the pattern of the head mask and in the development of facial vibrissae. Sketches based on specimens from Panguana.

show that both *Philander* represent distinct taxonomic units which are probably separately confined to the western and eastern cordillera of the Andes. The animals observed at Panguana match very well the original description of *P. mcilhennyi* by Gardner & Patton (1972). From the sympatric *P. opossum* the species differs by larger size, darker coloration, a broad blackish dorsal band, and a thicker and hairier tail with larger scales; also the facial vibrissae are more pronounced (Fig. 3). The stomach of a female taken by a hunter contained remnants of a frog, one beetle and 22 ants (19 *Crematogaster* sp., 2 *Wasmannia auropunctata* and an unidentified ant male). The frog was heavily digested but the ants not; it is therefore likely that the *Philander* consumed the ants directly. Another captured specimen was infested with several nymphs of the tick *Amblyomma* sp. (Walter 1990, as *P. andersoni*).

*Philander opossum*. A single adult female was captured near a hut on December 1, 1970 (ZMH). Its coloration - clear white chin sharply contrasted against dark upper labia, whitish belly, uniformly grey dorsum, whitish feet, tail with small scales and short and soft hairs - identifies it as *P. opossum* (Fig. 3). No other specimen has ever been seen in the Panguana area.

*Cabassous unicinctus*. Only known from the Panguana region by a single skull obtained from a local hunter. The species is rarely found in rainforest.

*Dasylops kappleri*. Known from the study area by a single skull (ZSM) obtained from local farmers on the Río Yuyapichis, about 2 km from Panguana, in 1983.

*Dasylops novemcinctus*. A young specimen hunted by a dog in a pasture was examined for ingested food. The stomach was firmly filled, contained a lot of sand and the following arthropods: 3 centipedes, 20 millipedes, 19 earthworms, 12 beetles, 38 beetle larvae, 3680 termites, 4 bugs, 2 mole crickets, 2 cockroaches, 6 Diptera larvae, 1 cicada larva, 1 scale insect, 1 spider, 6 mites, and the following ants: 434 *Brachymyrmex* sp. (workers and winged sexuals), 1 *Cheliomyrmex megalonyx*, 249 *Crematogaster* sp., 3 *Ectatomma tuberculatum*, 200 *Iridomyrmex* sp., 69 *Erebomyrma* sp., 13 *Pachycondyla harpax* (and some brood), 10 *Pheidole* sp., 711 *Solenopsis (Diploropthrum)* sp., and numerous unidentified ant brood. The stomach of a second young specimen contained only 5 ants (*Odontomachus haematodus*), 8 ant pupae and some ant fragments, and the intestines remains of millipedes, beetles and ants (*Crematogaster* sp., *Pachycondyla harpax*, *Pachycondyla obscuricornis*, *Pachycondyla* sp. and 2 species of *Pheidole*).

*Priodontes maximus*. No voucher specimens exist, but large burrows sometimes observed in the forest were taken as testimony of the giant armadillo. Local people also spoke about its presence in the north of Panguana.

*Tamandua tetradactyla*. Known as "shihui" by the local people. Occurs around Panguana also in the melanistic morph (Wetzel 1982). The stomach of a specimen taken by a hunter while sleeping in a maize field contained some termites and a lot of ants: 2 species of *Crematogaster*, *Dolichoderus bispinosus*, *Pachycondyla harpax*, *Pheidole cephalica*, *Solenopsis geminata* and unidentified winged Formicidae. The species composition indicates that the animal foraged in forest and open habitat.

*Cyclopes didactylus*. Settlers call this animal "serafin" or "inti pejejo". The almost empty stomach

and intestines of one captured specimen contained fragments of termites and ants of the following, mostly arboreal taxa: *Atta*, *Azteca*, *Camponotus (Myrmosphincta)*, *Crematogaster*, *Dolichoderus (=Hypoclinea)*, *Pheidole*, *Pseudomyrmex*, *Solenopsis (Diploropthrum)* and *Wasmannia auropunctata*, thus enlarging the known ant prey spectrum of the species (Best & Harada 1985).

*Artibeus planirostris*. Handley (1991) includes this taxon as a subspecies in *A. jamaicensis*.

*Micronycteris schmidtorum*. A group of 6 individuals of this rare bat was observed at the forest edge (J. Koepecke 1987). At that time the species had not yet been recorded from Peru (voucher in ZSM). Recently, Ascorra et al. (1993) netted a single specimen in Amazonian Peru, 140 km SSW of Iquitos, Loreto, which constitutes the first published record.

*Micronycteris brachyotis*. A single female (ZSM) was netted at the forest edge. This species had not been recorded from Peru before. According to Medellín et al. (1985) the southernmost records of this bat are known from Pará, Brazil.

?*Callimico goeldii*. Small and uniformly-colored primates which probably represented this species were occasionally observed by Maria Koepecke; however, no voucher specimen exists and no other observer saw such an animal. The species was therefore not included in the checklist.

*Aotus nigriceps*. The only specimen examined (SMNK) was shot at 10:00 h by a local hunter out of a group of *Saimiri sciureus*; its bright reddish belly is characteristic of *nigriceps* (Hershkovitz 1983). The stomach was empty but the colon contained some fruit pulp with many undigested seeds, some remains of Orthoptera and a single *Crematogaster* ant.

*Callicebus cupreus*. We follow Hershkovitz (1990) in recognizing *cupreus* as a species; a voucher specimen (SMNK) from Panguana fits the description of the subspecies *discolor* rather well. However, the ears of this animal are clearly white. Hershkovitz (1990) mapped "Panguana" in his Fig. 2 but did not list any specimen from that locality.

*Cebus albifrons*. The "mono blanco" was sometimes seen in small numbers within a large resident group of squirrel monkeys.

*Lagothrix lagotricha*. This is the only species of which we have no sighting or voucher specimen from Panguana or the close vicinity. Two skulls were obtained about 10 km to the east and hunters were seen with dead animals outside the station boundaries. Possibly it was exterminated in Panguana by hunting.

*Leopardus pardalis*. An old, dying ocelot was found on a trail at the forest edge. The animal was meagre, its fur gray and shabby, and two large warble fly larvae were in the skin.

*Eira barbara*. The stomach of a specimen collected by a settler was full of unidentified chewed plant material. The typical orange scats after a papaya meal were sometimes found in the plantations.

*Bassaricyon gabbii*. Occurs around Panguana and has possibly been observed in the study area by Maria Koepcke (H.-W. Koepcke, *in litt.*).

*Lutra longicaudis*. A specimen was killed by a dog when crossing a small clearing between forest and river. Its stomach and intestine contained remnants of fish, of a crayfish and a crab.

*Procyon cancrivorus*. A skull of an adult male (ZMUH) was obtained from local hunters in 1971, and occasionally tracks were seen along the Río Yuyapichis. The animal had a body mass of 9 kg, total length was 980 mm and tail length 370 mm. Stomach and intestine contained a greenish-white pulp of plant fiber, some large insect larvae, and remains of a small fish (H.-W. Koepcke, *in litt.*). Records of crab-eating racoons from Peru are not common; Grimwood (1969) and Gardner (1976) listed observations from Río Tumbes in northwestern Peru, and from Río Curanja, Río Apurímac and Río Manú, all in Amazonian Peru.

*Tayassu pecari*. Once, H.-W. Koepcke (*in litt.*) observed a herd of about 400 animals crossing the Yuyapichis downriver of Panguana. The species has become quite rare in subsequent years with no further reports since the nineteen eighties.

*Nectomys squamipes*. Three specimens (a female and two young) were captured in a pasture where they had a nest of dry grass in dense vegetation on the ground. Their stomachs were full of plant pulp (possibly maize) and some arthropod parts: cockroaches, myriapods, Lepidoptera and Diptera larvae, one spider.

*Isothrix bistrriata*. A male sitting 8 meters up in a tree in the primary forest of Panguana was shot on 28 December 1968 (voucher specimen in MUSM); the species was never observed again.

*Meromys hispidus*. These rodents, known as "rata espinosa" or "cachaocucho" in Panguana (Meede 1978), were regularly found in the station hut and kitchen, sometimes gnawing on cardboard boxes and books. One stomach examined contained only plant pulp.

*Neacomys tenuipes*. Four of these tiny spiny rats (ZFMK) were trapped in primary forest and in river

vegetation; because of their small dimensions (hind-foot 17 mm) we allocated them tentatively to *N. tenuipes*.

*Rattus rattus*. Black rats first appeared in Panguana in July 1971. Another specimen was obtained in the station in 1985 (SMNS).

*Microsciurus flaviventer*. A small squirrel was observed but not collected; its characters point to *M. flaviventer* which is known to occur in that part of the Amazon (Emmons & Feer 1990).

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