

Papéis Avulsos de Zoologia

MUSEU DE ZOOLOGIA DA UNIVERSIDADE DE SÃO PAULO

ISSN 0031-1049

Papéis Avulsos Zool., S. Paulo 36 (14): 147-164

(08-XI-1985)

ON A NEW SPECIES OF SQUIRREL MONKEY, GENUS *SAIMIRI*, FROM BRAZILIAN AMAZONIA (PRIMATES, CEBIDAE)

J.M. AYRES¹

RESUMO

Saimiri vanzolinii, sp. n., localidade tipo Lago Mimirauá, foz do Japurá, pertencente ao grupo boliviensis, é descrita com base em 13 exemplares. A distribuição das espécies de *Saimiri* na região que vai da foz do Japurá ao lago de Tefé é discutida com base em novas coletas.

INTRODUCTION

The two latest taxonomic reviews of *Saimiri* (Hershkovitz, 1984; Thorington, 1985) assign to it several forms distributed in the forested lowlands of southern Central America and northern South America. The two authors use different methodologies in assessing the taxonomy of the genus and differ considerably in their conclusions.

Hershkovitz (1984) assigns to the genus nine forms, belonging to four species. The main characters used in defining the two main species groups recognized are facial color pattern and degree of bushiness of the tail pencil. Karyotypes and behavioural data are also used in support of the taxonomic scheme, defined as follows:

1. The *boliviensis* species group is characterized by a "Roman arch" type of facial pattern, associated with a thin tail pencil. This group includes only *Saimiri boliviensis*, with two subspecies: *boliviensis* (d'Orbigny, 1834) and *peruviensis* Hershkovitz, 1984.

2. The *sciureus* species group is characterized by a "Gothic arch" facial pattern and bushier tail pencil. It contains three species: *sciureus* (L., 1758), with four subspecies (*sciureus*; *macrodon* Elliot, 1907; *cassiquiarensis* Lesson, 1840; *albigena* Pusch, 1941); *ustus* (I. Geoffroy, 1844), monotypic; and *oerstedii* (Reinhardt, 1872), with two subspecies (*oerstedii* and *citrinellus* Thomas, 1904).

Thorington (1985) bases his study on coat color and craniometric analyses. Five forms are assigned to the genus, partitioned into two species, *Saimiri sciureus*, with four subspecies (*sciureus*; *boliviensis*; *cassiquiarensis*; *oerstedii*) and *Saimiri madeirae* (Thomas, 1890). In his review, the *boliviensis* group is included as a subspecies of *S. sciureus*.

Both Hershkovitz and Thorington show the range of typical *boliviensis* as being bounded to the west by the Rio Juruá, and to the east by the Rios Purus and upper Madeira. In the south it inhabits the Amazonian lowlands of Bolivia. Northward the range is said to extend to the right bank of the Solimões, i.e., the Amazon between the Peruvian border and the mouth of the Rio Negro. They also extend the distribution of *Saimiri ustus* (= *S. madeirae*) to the west as far as the right bank of the Rio Purus and that of *Saimiri sciureus* ssp. to the left bank of the Rios Solimões and Japurá, and to the area west of the Rio Juruá.

In this paper a new species of the *boliviensis* species group is described, from the very complex area of the mouth of the Japurá and adjacent islands. The species was observed in its habitat and notes on its natural history are presented. It was possible to determine

1. Instituto Nacional de Pesquisas da Amazônia, INPA, Manaus, and Department of Anatomy, University of Cambridge.

its range with reasonable accuracy; it is areally restricted and ecologically peculiar, which leads to a discussion of the conservation status. The distributions of the forms of *Saimiri* occurring in the region are discussed based on new evidence.

MATERIALS

The present description is based on nine males and four females collected on four occasions, July 1983, February, July, and December 1984. These specimens are in the mammal collection of the Museu de Zoologia, Universidade de São Paulo (MZUSP). Over 130 skins of the other forms were examined (see Appendix 2), of which 20 recently collected around Tefé in order to refine the knowledge of distributions in this area. Field notes were taken from April 1983 to August 1984, during a socioecological study of the syntopic White Uakari, *Cacajao calvus calvus* (L. Geoffroy, 1847). Two specimens preserved in formalin (MZUSP 15475, 17560) are referred to the species with certainty but are not designated as paratypes.

In the discussion of localities two names are used for several islands, of which the first is that used locally and that between parentheses is that found on Brazilian official maps. The official names are indispensable in locating the islands on the chart, but are of no use in the field.

Saimiri vanzolinii, sp.n.

Holotype: MZUSP 15474, adult male, open skin and complete skeleton, left (north) bank of Lake Mamirauá, at the mouth of the Rio Japurá, state of Amazonas, Brasil (02°59'S, 64°55'W). Collected July 25, 1983, by J.M. Ayres and P.E. Vanzolini.

Paratypes: a) same data as the holotype: MZUSP 15471, 15473, 19016, 19017, males: 15472, 15476, females. b) Furo do Buá-buá (02°51'S, 64°59'W), Paraná do Jarauá, 17 km north of the type locality: MZUSP 17557 and 17558, male and female, collected on February 2, 1984, by J.M. Ayres and P.E. Vanzolini; c) Ilha do Tarará (= Pananim), Rio Solimões, upstream end (03°17'S, 64°36'W): MZUSP 18898, 18899, males, collected on July 6, 1984 by J.M. Ayres.

Diagnosis

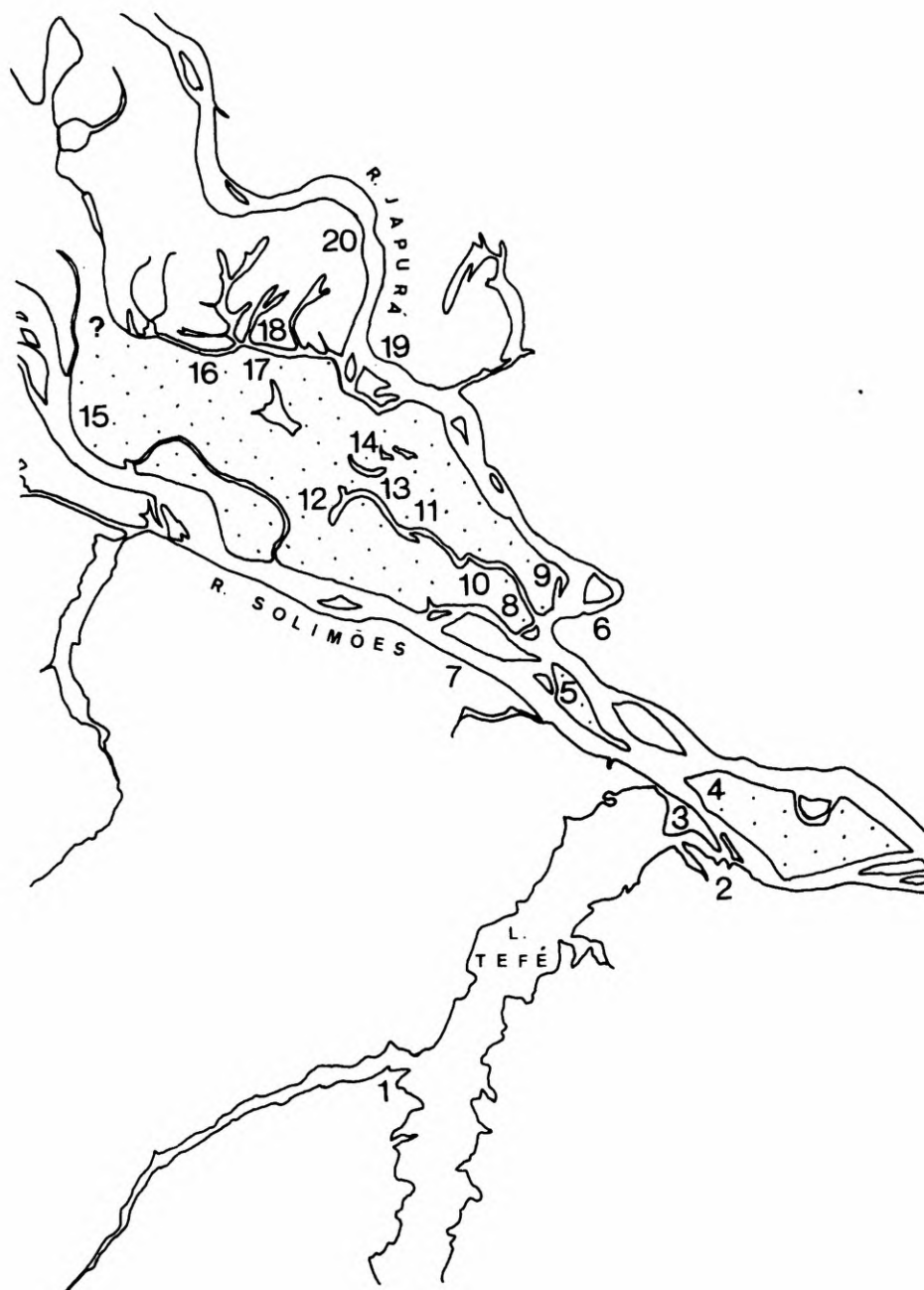
A *Saimiri* of the *boliviensis* species group, with the "Roman arch" type of facial pattern and a thin tail pencil. Differs from *boliviensis boliviensis* (*sensu* Hershkovitz, 1984), or *sciureus boliviensis* (*sensu* Thorington, 1985), the geographically closest form, in having: (i) dorsum very dark, black hairs predominating over agouti, forming a broad uninterrupted black band from the crown to the tip of the tail (as against dorsum much lighter, the longitudinal band frequently interrupted); (ii) dorsal aspect of hand and forearm, and of foot, light burnt yellow (darker reddish orange); (iii) dorsal fur denser, with shorter hairs resembling those of *Saimiri s. sciureus*. It differs further from *boliviensis peruviansis* in the coloration of the head of the male, which is grayish to dark gray agouti in the Peruvian form.

Description of the holotype

Forehead and crown black; face white, the white area oval in shape, transverse diameter longer ("Roman arch"). Browline black vibrissae present but not conspicuous. A continuous dorsal black band visible from the head to the tip of the tail. Sides of the neck white, contrasting with the dorsal aspect; sides of the trunk blackish agouti, not in strong contrast with the dorsal band. Chest and belly whitish to pale yellow. Ventral surface of tail pale yellow to orange-yellow on the proximal two thirds, black on the distal third. Hand and forearm dorsally burnt yellow, grading into the volar aspect, which is paler. Hind limb similarly patterned, but with the burnt yellow limited to the foot.



Saimiri vanzolinii. Upper photo: adult male in chavascal vegetation, at the type locality. Lower: eight months old male in captivity. Photographs by Luiz Claudio Marigo.



Map. 1. Localities cited in the text (see also Appendix 1).

Broad stippling, area of *S. vanzolinii*. 1, Ponta da Castanha, mouth of Rio Bauana. 2, Vila Vale. 3, Costa do Tefé. 4, Tarará Island (= Pananim). 5, Manixi, on Capucho Island (= Uanacá). 6, Caburini. 7, Parauari. 8, Vila Alencar. 9, Paraná do Maiana. 10, São Francisco, Lago Mamirauá. 11, Mouth of Lago Mamirauá. 12, Saracura, Lago Mamirauá. 13, Lago Mamirauá, in front of Lago Teiú. 14, Lago Teiú. 15, Porto Praia. 16, Lago Campininha. 17, Furo do Buá-Buá. 18, Igarapé Panema. 19, Paraná do Manacabi. 20, Across from Putiri.

Paratypes

The paratypes show little intra-sexual variation, the main differences relating to the width of the black dorsal pattern. The limb pattern is remarkably constant in the series at hand.

Derivation of the name

Named after Dr. P.E. Vanzolini, for his help in the conduction of this research.

Measurements

Table 1 and 2 show the measurements (in millimetres) and weight (in grams) of the materials at hand. Table 3 contains a comparison of *S. vanzolinii* with other relevant forms of *Saimiri*.

A comparison of field measurements of four Amazonian *Saimiri* shows that *S. ustus* and the two subspecies of *S. boliviensis* are slightly larger than *S. sciureus* and *S. vanzolinii* (Table 3). Body weights of *S.b. peruviansis* and *S. vanzolinii* cannot be compared since most of the sample of *S. vanzolinii* was collected during the mating season, the specimens being in the "fat" condition.

Comparison of cranial and dental measurements of *S.b. peruviansis* (Hershkovitz, 1984) and *S. vanzolinii* (Table 2) confirms the tendency, seen in external characters, of

TABLE 1. *Saimiri vanzolinii*, external measurements

		Head- -body	Tail	Foot	Ear	Weight
♂						
15475		295	355	83	27	1050
15473	Paratype	284	398	81	29	1100
15474	Holotype	282	366	84	28	980
17557	Paratype	276	375	81	27	620
15471	Paratype	270	360	79	28	1030
18898	Paratype	262	384	84	30	890
18899	Paratype	262	384	75	30	880
M		276	375	81	28	950
♀						
15476	Paratype	258	410	79	25	750
17558	Paratype	258	369	80	24	540
15472	Paratype	257	410	83	25	680
17560		224	-	79	28	630
M		249	396	80	26	650
♂/♀		1,11	0,95	1,01	1,08	1,46

TABLE 2. *Saimiri vanzolinii*, type series, skull measurements

	Head- -body	SL	ZW	BW	PW	BL	BW	CH	ML	AM	CL	CH
♂												
15473	284	64,2	40,1	34,9	30,0	50,5	33,8	9,9	35,0	18,3	46,4	17,9
15474*	282	62,4	39,2	34,0	28,8	51,2	33,8	8,6	32,5	17,7	44,2	16,0
17557	276	65,1	42,2	34,0	31,1	53,8	35,4	9,7	34,6	18,5	44,7	19,3
15471	270	62,5	40,0	33,3	30,1	51,6	34,4	8,9	33,9	18,1	43,8	16,1
18898	262	62,7	37,6	32,7	28,9	49,3	34,2	9,0	32,0	17,1	44,6	16,6
18899	262	62,1	36,3	32,9	30,1	49,2	34,4	9,0	31,6	18,1	44,5	15,1
M		63,2	39,2	33,6	29,8	50,9	34,3	9,2	33,3	18,0	44,7	16,8
♀												
15476	258	60,7	36,4	32,3	29,1	50,9	36,5	4,7	29,9	18,5	41,1	-
17558	258	58,9	33,9	30,9	28,2	48,5	33,3	4,6	30,5	17,5	41,1	15,5
15472	257	62,5	35,6	32,4	29,8	50,7	35,4	4,5	29,6	17,8	40,8	15,3
M		60,7	35,3	31,9	29,0	50,0	35,1	4,6	30,0	17,9	41,0	15,4
♂/♀		1,04	1,11	1,05	1,03	1,02	0,98	2,00	1,11	1,01	1,09	1,09

* Holotype

SL greatest skull length ZW zygomatic width BW biorbital width PW postorbital width
 BL braincase length BW braincase width CH height of canine ML length of mandible
 AM across first molars CL condylar length CH condylar height

S.b. peruviansis to be larger than *S. vanzolinii*. Of the ten cranial and dental parameters compared, only post-orbital width seems not to differ.

Sex dimorphism

As in other *Saimiri* (Table 3), males are heavier (on the average 46%) than females. The upper canine of males is on the average 100% larger than that of females (Table 2). Females have relatively longer tails (average 5%), but the size of the sample is too small for a firm conclusion.

Females are generally of a darker colour than males, in particular having more black on the sides of the neck, which is useful in sexing free ranging monkeys.

Cytogenetic data

Dr. Yatiyo Yonenaga Yassuda, Department of General Biology, University of São Paulo, has studied the chromosomes of one male and one female *S. vanzolinii* from the type locality. She found the 44 chromosomes characteristic of *Saimiri*, but also some features peculiar to the species, especially the presence of heterochromatin blocks in the long arm of chromosomes 13, 15 (submetacentric), 17 and 19 (acrocentric) and the lack of an interstitial C-band in the short arm of chromosome 6 (submetacentric).

It should be noticed that the karyotype of *S. vanzolinii* is closer to that of *S. sciureus macrodon* from Leticia, as described by Jones & Ma (1975) than to that of the morphologically closer *S. boliviensis peruviansis* from Iquitos (described by Jones & Ma, 1975, under the name *S. sciureus*).

A report by Drs. Yonenaga-Yassuda and Chu constitutes the next article in this journal.

Geographic distribution

The distribution of *S. vanzolinii* as determined at present is limited to three adjacent areas separated by short stretches of river. The first area is part of lowlands in the process of being built at the mouth of the Rio Japurá, the limits to the north and to the east being the Japurá proper; to the south, the boundary is the Rio Solimões; to the west it is almost certain that the Paran  do Jarau  constitutes a definite boundary. There is still some doubt about the western limit, but it is very probable that in this region the existence of an ecologically unfavourable area (i.e., low, scrubby, almost permanently flooded back-swamp "chavascais": see below) bounds the species.

Within this area *S. vanzolinii* is exceedingly common, but no other form of *Saimiri* was seen in over 2,500 hours of field observation. Beyond the boundaries described above, *S. sciureus* was just as abundant, and no black-headed squirrel monkeys were to be seen (a fact spontaneously remarked upon by the local people).

The other two areas where the species has been found are the islands of Tarar  (= Pananim) and Capucho (= Uanac ). Both are low swampy islands in the Rio Solim es in front of the "Costa de Tef ". The distance between Tarar  and Capucho is 4.2 km and between Capucho and the right bank of the Japur  2.3 km.

The total area presently known to be occupied by the species does not exceed 950 km². This is probably the smallest range for a Neotropical primate. Before this, the pied tamarin, *Saguinus bicolor*, with a distribution of approximately 73,000 km² (Ayres, 1983) was regarded as having one of the smallest distributions among South American mammals (Hershkovitz, 1977: 744).

Both Hershkovitz (1984) and Thorington (1985) confine the range of *ustus* (= *madeirae*) to the right bank of the Rio Purus, at approximately 61°30'W. Three individuals of this species have now been collected on the right bank of Lake Tef , at ca. 64°45'W; this would seem to be the actual western boundary of the species.

TABLE 3. *Saimiri*, measurements and ratios

	Head-body length				Tail length				Tail: total	Weight			σ/ϕ
	N	R	M	σ/ϕ	N	R	M	σ/ϕ		N	R	M	
<i>vanzolinii</i>	σ	7	262-295	276	1,11	7	355-398	375	0,58	7	720-1100	950	1,46
	ϕ	4	224-258	249		3	355-410	396	0,95	4	630-750	650	
<i>boliviensis</i>	σ	6	280-315	293	1,07	7	380-430	409	0,58				
	ϕ	4	265-285	275		4	395-410	404	0,59				
<i>peruviansis</i>	σ	10	273-320	300	1,11	10	374-435	407	0,57	2	930-950	940	
	ϕ	4	265-277	270		4	377-404	393	0,59				
<i>sciureus</i>	σ	5	250-305	279	1,02	4	360-400	390	0,59				
	ϕ	8	250-302	273		8	360-477	402	0,60	2	685	685	
<i>ustus</i>	σ	13	250-350	300	0,96	13	402-450	426	0,59				
	ϕ	7	230-420	311		7	310-420	385	0,55				

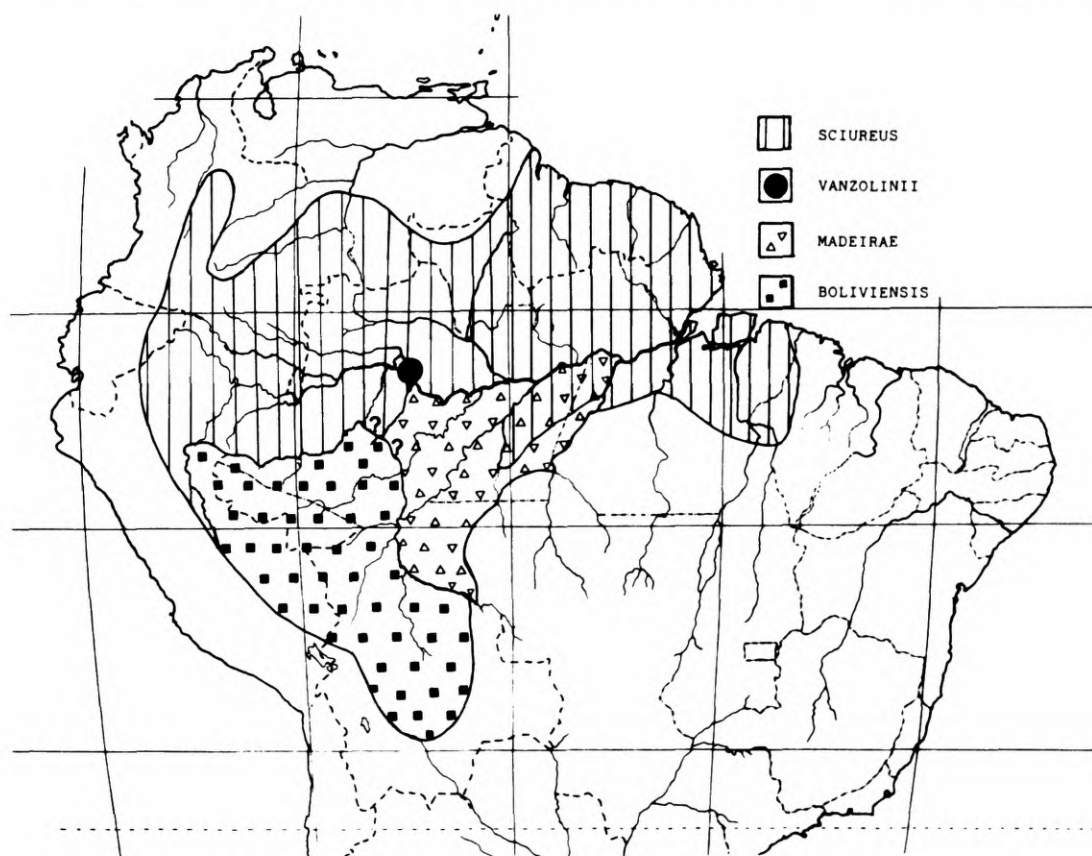
In three localities of the left bank of Lake Tefé, south of the Solimões, was found a form of *Saimiri sciureus* whose females correspond to the description of *S. nigrivittata* Wagner, 1846, showing a black band in front of and above the ear. These features are not present in the two males we have collected with the females, which might to be reason why Wagner (1848), not finding the pattern in all individuals of his sample, regarded the lack of the black band as a juvenile character. It is probable that these animals should be referred to *S.s. sciureus*.

S.s. cassiquiarensis has also been found on the left and right banks of the lower Rio Japurá, west of the Paraná do Jarauá. These specimens do not have the "nigrivittata" black band found west of Lake Tefé.

Habitat

The area where *S. vanzolinii* occurs is subject to an yearly flood of 11 to 12 meters. This "várzea", young and low, has its soils flooded for six months every year, contrary to higher várzea ground, outside the area, that goes under water only in extreme years (such as were 1953 and 1982).

Within the low várzeas two main types of vegetation exist "chavascal" and "restinga", i.e., back-swamp and low levees. The chavascal, which is in the process of being silted over, occupies the lower ground, between very low levees, both active and abandoned. The vegetation, growing on poorly aerated soils is, as said, low, shrubby,



Map 2. Distribution of *S. vanzolinii* in the context of Thorington's (1985) scheme, modified. The modifications include: a) extension of the range of *S. madeirae* to the right bank of the Tefé river; b) extension of the range of *S. sciureus* to the left bank of the Tefé river; c) retraction of the range of *S.s. boliviensis* to the south of the Tefé area; d) the other forms of *S. sciureus* are not individualized in this map.

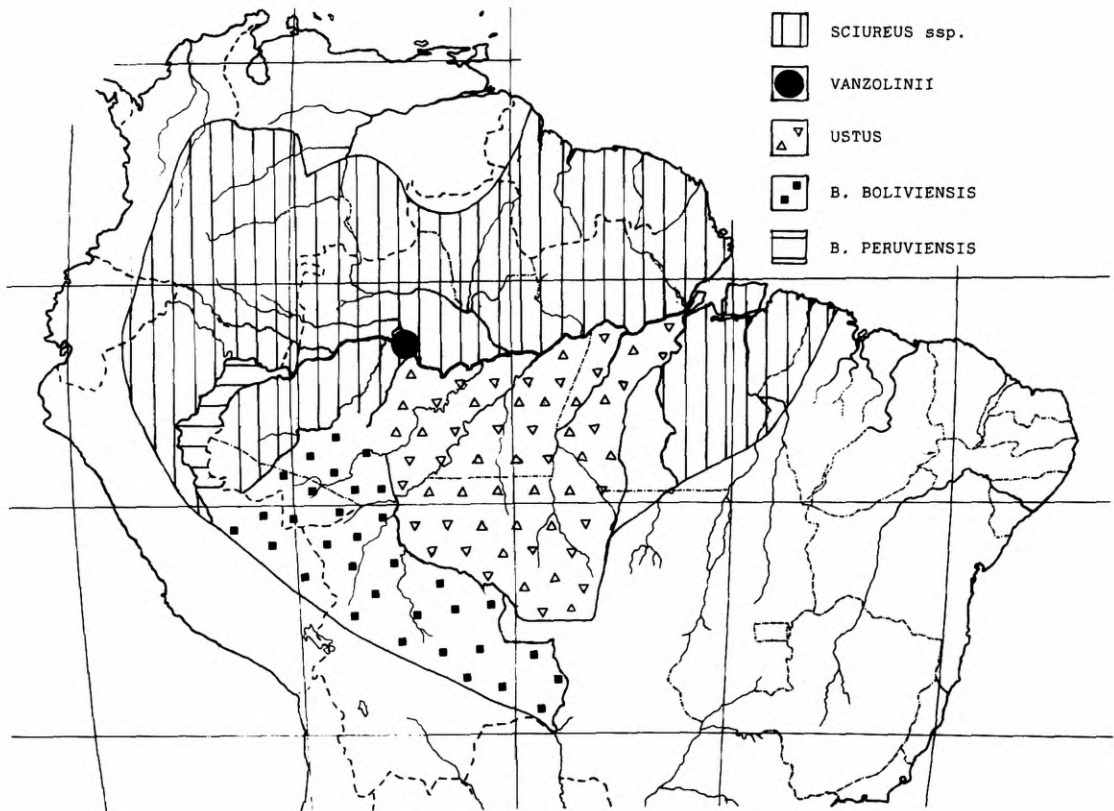
intricate and hard to negotiate. The characteristic trees include *Cecropia* sp. (embaúba, Moraceae), *Bambusa* sp. (tabocas, Bambuseae), *Ficus* sp. (apuís, Moraceae), *Bombax munguba* (munguba, Bombacaceae), *Piranhea trifoliata* (piranheira, Euphorbiaceae), *Astrocaruym jauari* (jauari, Palmae), *Myrcia* sp. (gumorana, Myrtaceae).

Restingas are the levees proper, of diverse height, either live or abandoned. They are flooded for three to six months in normal years, but their soils are coarser and better aerated than those of back swamps. The characteristic trees include *Brosimum lactescens* (manixi, Moraceae), *Franchetella* sp. (maparajubas, Sapotaceae), *Eschweilera turbinata* (matá-matá, Lecythidaceae), *Euterpe* sp. (açai, Palmae), *Lecointea amazonica* (paracuuba, Caesalpinoideae), *Ceiba pentandra* (samaúma, Bombacaceae), *Hevea spruceana* (seringueira barriguda, Euphorbiaceae), *Hura crepitans* (assacu, Euphorbiaceae), *Malouetia* cf. *tamaquarina* (molongó, Apocynaceae).

S. vanzolinii frequents both types of environment, but the core areas of its home ranges are on the restingas, from which it never gets very far. The use of chavascal areas corresponds to less than 10% of the activity budget.

Sympatric primate species

It has already been said that no other species of *Saimiri* is syntopic with *vanzolinii* in the Japurá and Mamirauá areas; the Black-capped Capuchin (*Cebus apella*), the Red Howler (*Alouatta seniculus*) and the White Uakari (*Cacajao calvus calvus*) are common



Map. 3. Distribution of *S. vanzolinii* in the context of Hershkovitz's (1984) scheme, modified. The modifications include: a) extension of *S. ustus*'s range to the right bank of the Tefé river; b) extension of the range of *S. sciureus* to the left bank of the Tefé river; c) retraction of the range of *S.s. boliviensis* to the south of the Tefé area; d) the subspecies of *S. sciureus* are not individualized in this map.

there, but *S. vanzolinii* is by far the most numerous primate in the area. Reliable informants assert that at Tarará and Capucho *Alouatta seniculus* and *Cebus apella* are the only cohabitants.

Habits

S. vanzolinii lives in large multi-male troops, which may reach 50 individuals. Good estimates of two troops indicated that they had 47 and 49 individuals; other groups in the area had at least 20 to 30 individuals. Group size is similar to that of *Cacajao calvus calvus* in the same area and much larger than those of *Alouatta seniculus* and *Cebus apella*. In the study site the population density of *Saimiri* was between 0.96 and 1.34 individuals per hectare, considering only the restingas. Home ranges of two troops observed at Lake Teiú may exceed 50 hectares. One troop followed for seven days used an area of 34 ha with a core area of 14 ha (L.D. Brandão, pers. com.). Overlap between neighbouring troops has not been accurately measured, but may well exceed 10% of their home ranges.

Reproduction

There is no direct information on the mating season of *S. vanzolinii*: however, adult males collected late in July 1983 were in the "fat condition", an indication of sexual activity. The gestation period has also not been directly observed, but infants were seen in February and March, one per female.

Contrary to *A. seniculus* and *C. apella*, that seem to have two birth seasons per year, February-March and September-October, *S. vanzolinii* has been seen to breed only once a year, in the former period, which is during the peak of the rainy season. Like *S. vanzolinii*, *Cacajao c. calvus* breeds only once a year, but in the second half of the year, between September and early November. Up to eleven newborn *S. vanzolinii* were seen on the backs of their respective mothers, within a single troop. Several other groups in the study site and neighbourhood were observed during the breeding season with at least five newborn each.

Diet

S. vanzolinii, as all *Saimiri*, is both an insectivore and a frugivore. It feeds on the mesocarp of several ripe fruits of the restinga, such as *Ficus* cf. *pertusa* (apuí, Moraceae), *Xylopia frutescens* (envira vassourinha, Annonaceae), *Brosimum lactescens* (manixi, Moraceae), *Inga* spp. (ingás, Leguminosae), *Franchetella* spp., *Chrysophyllum auratum* (maparajubas and abioranas, Sapotaceae), *Gustavia hexapetala* (matarana, Lecythidaceae), *Paullinia pinnata* (liana, Sapindaceae). Like *Cacajao c. calvus*, they feed considerably on flowers (nectar) of *Eschweilera turbinata* (matá-matá, Lecythidaceae) in October, near the peak of flowering of the várzea forest. Mesocarp feeding seems to be more intense during the first half of the year, when ripe fruits are most common. Considerable amounts of insect matter were found in stomach contents, mixed with fruit pulp; these stomach contents have yet to be studied in detail.

As Thorington (1968) has observed at Monte Seco, in the llanos of Colombia, during the first part of the day they feed mostly on fruits and in the afternoon spend most of their time foraging for insects. This is probably why group splitting into two or three subunits is more common in the first part of the day. The várzeas of the lower Japurá, despite having a lower tree diversity than the "terra firme" (forests which do not get flooded), have probably a lower degree of clumping, with smaller food sources. It is possible that this structure of the first trophic level is responsible for subgrouping in this species, as it is in *Cacajao c. calvus* (pers. obs.). In the later hours of the day they descend to the lower forest levels (or, during the dry season, venture onto the ground) foraging for insects as single units, which should increase the capture rate.

Polyspecific associations

Mixed troops of squirrel monkeys with other primates, especially *Cebus apella*, have been repeatedly reported in the literature. Such associations are not rare in the general Mamirauá and Jarauá areas. *S. vanzolinii* frequently feeds in association with *Cacajao c. calvus* on trees such as *Ficus* cf. *pertusa* and *Brosimum* sp. Associations between *S. vanzolinii*, *Cacajao c. calvus* and *C. apella* were not frequent, but were observed mostly during the peak of the rainy season.

A peculiar association of *S. vanzolinii* is with a bird, the greater ani, *Chrotophaga major* (Cuculidae). During the months of July to August, *S. vanzolinii* may be seen travelling above bands of *C. major*, which may contain over 150 birds. As with other associations of this type, the present one is probably related to the flushing of insect prey. This association has been also observed in *Saimiri sciureus* in the flooded areas of the region. This behaviour can be useful in detecting *Saimiri* troops, since the anis are noisier than the monkeys.

CONSERVATION STATUS

As stated above, *S. vanzolinii* has probably the smallest geographical range of any South American primate. On the basis of the geographical range and ecological preferences described above, the population of the species may be estimated at approximately 50,000 individuals.

Although people from varzea do not usually hunt *Saimiri* for food, the rate of habitat disturbance is increasing, if slowly, in the area of *S. vanzolinii*.

The main form of habitat disturbance is selective logging of several restinga tree species such as *Ceiba pentandra*, *Virola* sp., *Piranhea trifoliata*, *Ocotea* sp. and of other endemic várzea species. The trees usually logged are not potential food for *Saimiri vanzolinii*, but logging may cause longer-term changes in the habitat, related to the effects of erosion, which could change the water courses and lead to the disappearance of restinga.

Therefore, although not at present endangered, *S. vanzolinii* should be regarded as vulnerable, on account of its very small geographical range.

DISCUSSION AND CONCLUSIONS

Although the distribution of most Amazonian primates is not known in detail, due to lack of collections from critical areas, it is frequently asserted in the literature that the major Amazonian tributaries limit the ranges of many primate taxa (e.g. Hershkovitz, 1977). The only monkey genera for which rivers would not constitute barriers within Amazonia are *Alouatta*, *Cebus* and *Saimiri*. These primates are also the only to be found both in "terra firme" and young varzeas along the banks and on islands of the major tributaries. This ability to live in diversified forested areas is probably related to the generalist feeding habits of these genera (e.g. Milton, 1980; Baldwin & Baldwin, 1972; Freese & Oppenheimer, 1981).

The dynamics of the white water rivers, alternating deposition and erosion of sediments, with the consequent building and destruction of islands and shorelines, leads to a marked instability of varzea ecosystems. In the process, isolation of populations of the primate genera mentioned should not be infrequent. Otherwise, the distribution of these monkeys is certainly not limited by major rivers, as it seems to be the case with other primate taxa endemic to "terra firme". At the mouth of the Rio Japurá there are several islands of diverse ages, as attested by reliable local informants; these islands differ also in primate colonization. The island of Juruamã is approximately 25 years old and has no monkey. Jacaré Island, of about the same age, has already been colonized by *A. seniculus*. Icé (= Japurá) Island is over one hundred years old and has no primates. Capucho (= Uanacá) and Tarárá (= Pananim) Islands, of unknown age but probably much

more than a few hundred years old, are inhabited by the three varzea species, *A. seniculus*, *C. apella*, and *S. vanzolinii*. This suggests that there have been different colonization opportunities.

S. vanzolinii is morphologically closest to nominal *boliviensis*, whose distribution suggests the following hypothesis: a) *boliviensis*'s former range reached the south bank of the Solimões; b) some time in the past this range contracted, leaving an area to be occupied by the expansion of *S. ustus*, coming from the east; c) *S.s. sciureus*, probably from the west, occupied the area west of the Rio Tefé; d) the populations of *boliviensis* which were able to cross the Solimões in the course of sedimentation-erosion episodes became isolated and differentiated.

There is no indication that in the area there is interbreeding between *S.s. cassiquiarensis*, or *S.s. sciureus*, or *S. ustus* (= *madeirae*), and *S. vanzolinii*, and this is obviously the reason why I describe this animal as a full species and not a subspecies of *boliviensis*.

Another area of particular importance for the taxonomy of *Saimiri* is the upper Rio Tefé, where *S. boliviensis*, *sciureus* and *ustus* will probably be found without the allopatric conditions imposed by the river banks. Further research in the area could probably clarify definitively the taxonomic status of these three forms of *Saimiri*.

ACKNOWLEDGMENTS

Field research in the Tefé area was mostly supported by the Instituto Nacional de Pesquisas da Amazonia (INPA) and Conselho Nacional de Pesquisas e Desenvolvimento Tecnológico (CNPq). I wish to thank Dra. Maria de Nazaré G. Ribeiro, head of the Department of Ecology, and the former directors of INPA, Drs. H. Bergamin Filho and R. Vieira, for their continuous support during the research. The Academia Brasileira de Ciências provided financial help for museum work at the Universidade de São Paulo. I am particularly grateful to Dr. Paulo E. Vanzolini for permission to examine specimens of *Saimiri* in the Museu (MZUSP) and for his support throughout the study, both in the field and the laboratory.

Plants were identified by Dr. J. Murça Pires (Museu Paraense Emilio Goeldi), to whom special thanks are due, by Dr. W. Rodrigues (INPA) and by Drs. R. Secco and N.A. Rosas (Museu Goeldi). L.C. Marigo has kindly provided photographs in the wild and in captivity. The maps were drawn by my wife D.M. Lima. Preparation of karyotypes as well as the comments on this matter by Dr. Yatiyo Y. Yassuda of the Universidade de São Paulo are gratefully acknowledged. Dr. Richard W. Thorington, jr., of the National Museum of Natural History, Smithsonian Institution, was extremely generous in communicating his work still in proof and in criticizing this manuscript. Of course he should not be held responsible for its shortcomings. I also wish to thank to Dr. D.J. Chivers of the University of Cambridge for his help during one of the surveys and for discussions during this work. Dr. A. Johns provided assistance during field work and Dr. E. Barrett helped with editorial comments. Several other people, locals and field assistants, have helped in many ways with their knowledge of the area.

The author is supported in Cambridge by a doctoral scholarship of CNPq, Conselho Nacional de Desenvolvimento Científico e Tecnológico of Brasil, and an Overseas Research Student Award from the United Kingdom.

REFERENCES

- Ayres, J.M., 1983. Conservation of Primates in Brazilian Amazonia: Problems and Strategies, p. 2-33, in D. Harper, ed., Proceedings of the Symposium on the Conservation of Primates and their Habitats. Department of Adult Education, University of Leicester.
- Baldwin, J.D. & J.I. Baldwin, 1972. The ecology and behaviour of squirrel monkeys (*Saimiri oerstedii*) in a natural forest in western Panama. *Fol. Primat.* 18: 161-194.

- Freese, C.N. & J.R. Oppenheimer, 1981. The Capuchin monkeys, genus *Cebus*, p. 331-390 in A.F. Coimbra-Filho & R.A. Mittermeier, eds., Ecology and behaviour of Neotropical primates. Rio de Janeiro: Academia Brasileira de Ciências.
- Hershkovitz, P., 1977. Living New World monkeys (Platyrrhini). Vol. 1. Chicago: University of Chicago Press. xiii + 1117 p.
- Hershkovitz, P., 1984. Taxonomy of squirrel monkeys, genus *Saimiri* (Cebidae, Platyrrhini): a preliminary report with the description of a hitherto unnamed form. Amer. J. Primat. 7: 155-210.
- Jones, T.C. & N.S.F. Ma, 1975. Cytogenetics of the squirrel monkey (*Saimiri sciureus*). Fed. Proc. 34 (8): 1646-1650.
- Milton, K., 1980. The foraging strategies of howler monkeys - a study in primate economics. New York: Columbia University Press. xiv + 165 p.
- Thorington, R.W., jr., 1968. Observations on squirrel monkeys in a Colombia forest, p. 69-85 in L.A. Rosenblum & R.W. Cooper, eds., The squirrel monkeys. New York: Academic Press.
- Thorington, R.W., jr., 1985. The taxonomy and distribution of squirrel monkeys (*Saimiri*), p. 1-33 in L.A. Rosenblum & C.L. Coe, eds., Handbook of Squirrel Monkey Research. New York and London: Plenum.

APPENDIX 1

Collecting and observation localities, 1983 and 1984, of *Saimiri* in the general Tefé area (numbers within parantheses refer to Map 3).

S. sciureus sciureus ("nigrivittata" pattern).

- (1) Ponta da Castanha, mouth of Rio Bauana, MZUSP 19019 ♂.
- (3) Lago de Tefé, left bank, across from town, MZUSP 19012 ♀.
- (7) Parauari, MZUSP 19010 ♂, 19009, 19011 ♀♀.

S. sciureus cassiquiarensis

- (6) Caburini, MZUSP 19008, 19024 ♀♀.
- (18) Igarapé Panema, Paraná do Jarauá, MZUSP 17556, 17561♂♂, 17554 ♀♀ :
- (19) Paraná do Manacabi, MZUSP 17546 ♂, 17548 ♀.
- (20) Right bank of Rio Japurá, across from Putiri, MZUSP 17547, 17549 ♂♂.

S. ustus

- (2) Vila Vale, MZUSP 19013 ♂, 19014, 19015 ♀♀.

S. vanzolinii

- (4) Tará island (= Pananim), MZUSP 18898, 18899 ♂♂.
- (5) Manixi, Capucho island (= Uanacá), MZUSP 19020, 19022 ♂, 19021 ♀♀.
- (8) Vila Alencar, 3 groups observed.
- (9) Paraná do Maiana, 4 groups observed.
- (10) São Francisco, Lago Mamirauá, 1 group observed.
- (12) Saracura, Lago Mamirauá, 3 groups observed.
- (13) Lago Mamirauá, across from Lago Teiú, MZUSP 15471, 15473, 15474, 19016, 19017 ♂♂, 15472, 15476 ♀♀.
- (14) Lago Teiú, 11 groups observed.
- (15) Porto Praia, 1 group observed.
- (16) Lago Campininha, 1 group observed.
- (17) Furo do Buá-Buá, MZUSP 17557 ♂, 17558 ♀.

APPENDIX 2

Skins examined at the Museu de Zoologia da Universidade de São Paulo (MZUSP).

Saimiri boliviensis boliviensis

AMAZONAS: Lago Grande, Rio Juruá, ♂, 4804; ♀, 4800. Rio Juruá, sex?, 749, 754, 753. Santa Cruz. Rio Eiru, ♂♂, 5447, 5498, 5499, 5500, 5501, 5503, 5504, 5506, 5507,

5510, 5512, 5513, 5515, 5516, 5518; ♀♀ , 5505, 5508, 5509, 5511, 5522; sex ? , 5514. Santo Antonio, Rio Juruá, ♂ , 4153; sex ? 4154, 4155.

Saimiri o. oesterdii

PANAMÁ: Bogaba, ♂ , 10130.

Saimiri sciureus ssp.

RORAIMA: Água Boa, Rio Mucajaí, ♀ , 18997. Rio Mucajaí, ♀ ; 9673.

AMAZONAS: Boca do Rio Purus, ♂♂ , 18888, 18889, Igarapé do Garotão, Rio Juruá, ♂ , 4807. Iracema, Rio Amazonas, ♀ , 18896. Eirunepé, Rio Juruá, ♀ , 4813. Lago do Jacaré, Rio Amazonas, ♀ , 19131. Lago Miuá, sex ? 18887, 18892, 18893. Lago dos Reis, ♂ , 19132; ♀♀ , 19133, 19134. Manacapuru, sex ? , 4250. Paissandú, Paraná do Bom Jardim, ♂ , 8955. Paraná do Aiupia, Auati-paraná, ♂ , 18894; ♀ , 18895. Paraná do Bom Jardim, ♂ , 8953. Pauini, ♂ , 19136. Rio Juruá, ♂ , 750. São Sebastião do Uatumã, ♂ , 18890; sex ? , 18891.

PARÁ: Belém, ♀♀ , 6795, 19137, 19138, 19139, 19140. Boca do Igarapé Piaba, sex ? 4375. Cametá, Rio Tocantins, ♂ , 5531. Curral Grande, ♀ , 3620. Igarapé Taperebá, Ilha de Marajó, ♂ , 8678; ♀ , 8677. Oriximiná, ♂ , 19141; ♀ , 19135. Rio Capim, ♀ , 8922. Santo Antonio, Rio Tocantins, sex ? 13473. Jaquara, Lago Grande de Monte Alegre, ♂♂ , 8899, 8902; ♀ , 8901; sex ? 8900.

Saimiri ustus

AMAZONAS: Lago do Batista, ♂♂ , 5206, 5209, 5213; ♀♀ , 5204, 5205, 5208, 5210, 5211, 5212, 5215, 5217; sex ? 5207, 5216, 5218.

PARÁ: Bom Jardim, Rio Amazonas, ♂♂ , 5517, 5520, 5521; ♀ , 5519. Caxiricatuba, Rio Tapajós, ♂♂ , 5228, 5229, 5523, 5525; ♀♀ , 5527, 5530; sex ? 5526, 5528. Fazenda Monte Cristo, Rio Tapajós, ♂♂ , 3613, 3614. Fordlândia, Rio Tapajós, ♂♂ , 19142, 19143, 19144, 19146, 19147, 19148, 19149, 19150; ♀♀ , 19145, 19151, 19152; sex ? 19153. Itapoama, Rio Tapajós, ♂ . 10100. Piquiatuba, Rio Tapajós, ♂ , 5524. Taperinha, ♀ , 3615.

APPENDIX 3

External measurements of the specimens used for comparison

MZUSP	Total length	Head + body	Tail	Hind foot	Weight
<i>ustus</i> ♂♂					
935	700	250	450	95	
1820	740	295	445	85	
1846	720	310	410	80	
1962	700	270	430	95	
1963	760	350	410	95	
2016	750	321	429	95	
2017	740	310	430	92	
5209	730	280	450	80	
5229	690	288	402	94	
5523	708	298	410	90	
5524	690	288	402	94	
5525	724	304	420	85	
10100	790	340	450	80	
Range	690-760	250-350	402-450	80-95	
Mean	726	300	426	89	
<i>ustus</i> ♀♀					
1820	680	370	310	80	
2018	666	271	395	80	
2196	820	420	400	80	
5025	660	290	370	60	
5211	615	230	385	80	
5212	735	318	417	-	
5527	688	-	-	-	
10102	700	280	420	80	
Range	615-820	230-420	310-420	60-80	
Mean	696	311	385	77	

APPENDIX 3, continued

b. boliviensis ♂♂

4153	705	285	420	90
4804	690	280	410	90
5447	730	305	425	85
5498	630	-	-	-
5499	680	280	400	90
5501	680	-	-	-
5503	795	-	-	-
5504	745	315	430	90
5510	660	-	-	-
5512	-	-	380	80
5513	690	295	395	90
5515	700	-	-	90
Range	630-795	280-315	380-430	80-90
Mean	701	293	409	88

b. boliviensis ♀♀

4800	675	265	410	85
5505	680	280	400	90
5508	680	270	410	85
5516	680	285	395	80
Range	675-680	265-285	395-410	80-90
Mean	679	275	404	85

sciureus ♂♂

8899	650	250	400	75	
8920	690	290	400	82	
19010	-	291	-	92	1050
19019	665	305	360	90	1050
	660	260	400	80	
Range	650-690	250-305	360-400	75-92	1050
Mean	663	280	390	84	1050

APPENDIX 3, continued

<i>sciureus</i> ♀♀					
83	650	270	380	75	
17548	610	250	360	74	620
17554	627	252	375	76	690
18896	637	255	380	80	
18897	693	270	423	90	
19009	777	300	477	82	1050*
19011	739	302	437	89	1050*
19012	664	281	383	84	710
Range	610-777	250-302	360-477	74-92	620-710
Mean	675	273	402	81	673

* pregnant, not included in range and mean

