

## ABO BLOOD GROUPS IN SQUIREL MONKEYS (*Saimiri boliviensis boliviensis*)

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### ABSTRACT

Blood and saliva samples were collected from 76 *Saimiri boliviensis boliviensis* from Bolivia. Saliva samples were tested for human ABH antigens by the conventional hemagglutination inhibition method. Fifty-nine samples were classified as A group and 17 as AB group. The phenotypic distribution fits well the expected one, assuming Hardy-Weinberg equilibrium in a two-allele model with the following frequencies  $I^A - 0.89$  e  $I^B - 0.11$ . These results are not significantly different from those found for *S. b. peruviansis* (Schneider *et al.*, unpublished data). Natural agglutinins were investigated in 71 serum samples with a standard hemagglutination test and disagreement was observed in 34% of the comparisons between saliva and serum phenotypes.

### INTRODUCTION

Recently the utilization of New World monkeys as experimental models in biomedical research has considerably increased, specially those studies involving the genera *Aotus* and *Saimiri*, and consequently a genetic characterization of these species is mandatory.

Several reports on ABO blood groups of man and non-human primates have been published. However, probably due to capturing difficulties, New World monkeys species have been scarcely studied.

Our group is involved in a long term project whose main objective is the evaluation of the genetic variability of New World monkeys. An important aspect of this

work is the description of the ABH substances in natural populations of these primates. In this paper we present, for the first time, a qualitative and semi-quantitative description of the ABH antigens distribution in a natural population of *Saimiri boliviensis boliviensis* from Santa Cruz de la Sierra (Bolivia).

## MATERIAL AND METHODS

Hershkovitz (1984) considered the genus *Saimiri* to be comprised of two groups, the Roman and Gothic types both distinguished by external characters, behavior and geographic distribution. The species *S. boliviensis*, with two subspecies (*S. b. boliviensis* and *S. b. peruviansis*), corresponding to the Roman type and *S. sciureus*, *S. ustus* and *S. oerstedii* to the Gothic type. *S. b. boliviensis* occurs in the upper Amazonian region to the south of the Solimões-esAmazon river; between the Purús and Juruá rivers in the states of Amazonas and Acre (Brazil); in the upper Madeira river basin of Bolivia; and in Peru north to the Ucayali river basin.

Seventy-six *S. b. boliviensis* animals were captured in Santa Cruz de la Sierra (Bolivia) and kept at the "Centro Argentino de Primatologia" (CAPRIM) in Corrientes, Argentina. Saliva samples were used for detection of fluid antigens in order to allow the identification of the ABO phenotypes in this species using human and lectin reagents. Agglutinins were tested in only 71 sera, due to the small volume of some samples. Our methods of samples collection as well as the blood typing techniques were described previously (Schneider *et al.*, 1987; Harada-Hamel *et al.*, 1988). Gene frequencies were calculated by maximum likelihood method using the MAXLIK program of Reed and Schull (1968). Descriptive statistics (means, minimum and maximum titer and standard deviation) of the ABH substances and comparisons among the titer means (t-test) were determined with the SPSS program (Statistical Package for Social Sciences).

## RESULTS AND DISCUSSION

As can be seen in Table I, only two phenotypes (A and AB) were detected in *S. b. boliviensis*. Allelic frequencies were estimated assuming the hypothesis of two and three alleles. In both cases, the observed and expected distributions fit well, suggesting Hardy-Weinberg equilibrium (two-allele model:  $\chi^2 = 1.21$ ;  $df = 1$ ,  $P = 0.27$ ; three-allele model:  $\chi^2 = 0.27$ ,  $df = 1$ ,  $P = 0.60$ ). However in the three-allele model the presumed  $I^0$  allele acquired a negative value ( $I^0 = -0.58$ ). So, the two-allele model ( $I^A = 0.89$  and  $I^B = 0.11$ ) seems to be the most probable for the population studied here.

Table I - Observed and expected phenotypic distributions assuming a two allele model.

Class	Observed	Expected	$\chi^2$	Allele	Freq $\pm$ Sd
A	59	59.95	.015	I <sup>A</sup>	.89 $\pm$ .03
AB	17	15.10	.240	I <sup>B</sup>	.11 $\pm$ .03
B	0	.95	.950		
Total	76	76.00	1.205		1.00

Sd - Standard deviation.

Table II shows the mean titer of ABH substances estimated by the log conversion of the inhibition titer. The mean level of A substance was higher in the A group than in the AB group (t-test = 7.45; df = 74; P < 0.0001). Similarly, the average amount of H substance was significantly higher in the saliva of A group (t-test = 2.97; df = 74; P = 0.004).

Table II - ABH antigen titers in *Saimiri boliviensis boliviensis*.

Phenotypes	N	Antigens	Titer*		
			Mean $\pm$ Sd	Minimum	Maximum
A	59	A	9.4 $\pm$ 1.3	6.0	12.0
		H	4.3 $\pm$ 1.6	1.0	7.0
AB	17	A	5.1 $\pm$ 3.7	1.0	11.0
		B	3.9 $\pm$ 2.4	1.0	9.0
		H	5.6 $\pm$ 1.6	2.0	8.0

\* The antigen inhibition titers were recorded according to the logarithmic method reported by Dunsford and Bowley (1967).

Table III reviews data available for New World monkeys. In spite of Schneider *et al.* (unpublished data) had found three phenotypes in *S. b. peruviansis* (A, B and AB), the allelic frequencies are comparable to those estimated in the present work. Besides, our results are similar to those obtained for one population of *S. boliviensis* (Terao *et al.*, 1988) but differs from two other groups of this species studied by the same authors. I<sup>A</sup> is the most frequent allele (0.89) in the species investigated in the present work. Interestingly, it seems also to be the most frequent in the genus *Saimiri*, with frequencies ranging from 0.46 to 0.89.

Table III - ABO genes frequencies in New World monkeys.

Species	N	Gene frequencies			Ref.
		I <sup>A</sup>	I <sup>B</sup>	I <sup>O</sup>	
Genus <i>Alouatta</i>					
<i>A. palliata</i>	52		1.00		1
<i>A. belzebul</i>	44		1.00		2
Genus <i>Aotus</i>					
<i>A. nancymai</i>	93		.12	.88	3
<i>A. vociferans</i>	20		.29	.71	3
Genus <i>Cebus</i>					
<i>C. apella apella</i>	19	.36	.21	.41	4
<i>C. a. apella</i>	95	.50	.22	.28	5
<i>C. a. paraguayanus</i>	55	1.00			6
Genus <i>Chiropotes</i>					
<i>C. satanas</i>	72	1.00			7
Genus <i>Saimiri</i>					
<i>Saimiri sp.</i>	11	.53	.14	.33	8
<i>S. s. macrodon</i>	8	.62	.38		9
<i>S. boliviensis peruviansis</i>	44	.85	.15		9
<i>S. boliviensis</i> 1980*	17	.46	.28	.26	10
<i>S. boliviensis</i> 1981*	18	.52	.28	.20	10
<i>S. boliviensis</i> 1982*	22	.86	.14		10
<i>S. b. boliviensis</i>	76	.89	.11		**
Genus <i>Saguinus</i>					
<i>S. midas niger</i>	81	.26	.66	.08	11
<i>S. fuscicollis</i>	18	1.00			12
<i>S. f. weddelli</i>	88	1.00			13
<i>S. nigricollis</i>	8	1.00			14
Genus <i>Callithrix</i>					
<i>C. emiliae</i>	47	1.00			13
<i>C. jacchus</i>	35	1.00			13

\* First called *Saimiri sciureus* by Terao *et al.* (1988), the species was renamed by the authors as *Saimiri boliviensis* based on HersHKovitz (1984).

\*\* Present paper.

(1) Froehlich *et al.*, 1977; (2) Corvelo *et al.*, 1985; (3) Harada Hamel *et al.*, 1990b; (4) Schneider *et al.*, 1985; (5) Corvelo *et al.*, 1987; (6) Harada-Hamel *et al.*, 1988; (7) Harada-Hamel *et al.*, 1990a; (8) Socha and Ruffici, 1983; (9) Schneider *et al.*, unpublished data; (10) Terao *et al.*, 1988; (11) Schneider *et al.*, 1987; (12) Wiener *et al.*, 1967; (13) Rocha *et al.*, 1990; (14) Gengozian, 1964.

As can be observed from the literature, the *Cebus* and *Saimiri* genera, considered by Ford (1986) as related groups, share  $I^A$  as the most common allele. On the other hand, the genus *Aotus* is the only one among those studied, that possesses the  $I^0$  allele as the most prevalent form (Harada-Hamel *et al.*, 1990b). Conversely, two *Alouatta* species were monomorphic for the  $I^B$  allele (Froehlich *et al.*, 1977; Corvelo *et al.*, 1985), while *Chiropotes satanas*, which belongs to the Pitheciinae group, is monomorphic for the  $I^A$  allele (Harada-Hamel *et al.*, 1990a). On the other hand, among the Callitrichidae, *Saguinus fuscicollis*, *Saguinus fuscicollis weddelli*, *Callithrix emiliae*, *Callithrix jacchus* and *S. nigricollis* exhibit the  $I^A$  allele exclusively while the other species (*S. midas niger*) presents the  $I^B$  as the most usual allele.

The agglutinins detected in the 71 sera revealed high frequencies of anomalous antibodies. Among 54 individuals from the A group, 41 presented only anti-B antibodies, one had both anti-A and anti-B and 12 had no agglutinins. On the other hand, among AB phenotypes, eight showed only anti-A, three only anti-B and six did not show agglutinins. However, no additional tests were performed due to the small quantity of serum. Similar findings describing anomalous antibodies have been reported before in Old World monkeys (Moor-Jankowski *et al.*, 1964; Socha *et al.*, 1981; Dracopoli and Jolly, 1983) and in New World monkeys (Wiener *et al.*, 1967; Froehlich *et al.*, 1977; Schneider *et al.*, 1985). However, at the moment, no definitive explanation exists for this phenomenon.

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## RESUMO

Amostras de sangue e saliva foram coletadas de 76 animais da espécie *Saimiri boliviensis boliviensis* da Bolívia. As amostras de saliva foram testadas para a presença de antígenos ABH humanos, pelo método convencional de inibição da hemaglutinação. Cinquenta e nove animais foram classificados como sendo do grupo sanguíneo A e 17 como sendo do grupo AB. A distribuição fenotípica ajusta-se ao esperado, assumindo-se o equilíbrio de Hardy-Weinberg, em um modelo com dois alelos, com as seguintes frequências:  $I^A = 0.89$  e  $I^B = 0.11$ . Esses resultados não mostraram diferenças estatisticamente significantes, quando comparados com

aqueles descritos por Schneider *et al.* (unpublished data) em *S. b. peruviansis*. Amostras de soro de 71 animais foram utilizadas na investigação de aglutininas naturais, pelo teste de hemaglutinação direta e foi observado 34% de discordância entre os fenótipos salivar e sérico.

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