

# Short Communication: Epidemiological Evidence That Simian T-Lymphotropic Virus Type 1 in *Macaca fuscata* Has an Alternative Transmission Route to Maternal Infection

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## Abstract

Serological inspection of Simian T-lymphotropic Virus Type 1 was conducted for a wild colony of *Macaca fuscata*, which was captured in the middle Honshu, Japan. The increase of positive rate after the juvenile stage with the positive rate reaching 100% (or 35/35) in youngster and adult stages, was observed. This finding suggests that, in contrast with human T-lymphotropic Virus Type 1, horizontal transmission play an important role in increasing prevalence of STLTV-1 with age among *M. fuscata*.

**P**RIMATE T-LYMPHOTROPIC VIRUS TYPE 1 (PTLV-1) has so far been detected in Old World primates only. Lineages of which the natural host is human are referred to as Human T-Lymphotropic Virus Type 1 (HTLV-1), whereas those of nonhuman primates as Simian T-Lymphotropic Virus Type 1 (STLV-1). The aggregations of the HTLV-1 carriers are seen in Western Africa, Papua New Guinea, South America, and Japan.<sup>1</sup> On the other hand, among Old World monkeys, a high prevalence of STLTV-1 has been reported in green monkey (*Cercopithecus sabaues*), rhesus monkey (*Macaca mulatta*), Formosan monkey (*Macaca cyclopis*), red-faced macaque (*Macaca arctoides*), pig-tailed macaque (*Macaca nemestrina*), bonnet monkey (*Macaca radiata*), crab-eating monkey (*Macaca fascicularis*), and Japanese monkey (*Macaca fuscata*).<sup>2</sup> All of the host species listed above, except *C. sabaues*, belong to the *Macaca* genus. Among the nonhuman apes, chimpanzee, orangutan, and siamang have been known as natural hosts of STLTV-1.<sup>2,3</sup> Multiple infections with STLTV-1-like viruses are observed among bushmeat hunters in central Africa<sup>4-6</sup> and, thus, PTLV-1 diversity might have resulted from multiple cross-species transmissions of STLTV-1. Soon after the discovery of a high prevalence of HTLV-1 in southwestern Japan,<sup>7</sup> *M. fuscata* was suspected to be a reservoir of HTLV-1. Hayami *et al.*<sup>2</sup> conducted a nationwide serological survey of natural colonies of *M. fuscata*, and showed that sero-positive rates of STLTV-1 were 35% (110/314) in male adults and 43% (311/719) in females. They then claimed that sero-prevalence of STLTV-1 in *M. fuscata* was much higher than that of HTLV-1 in Japanese people. The geographical distribution patterns of STLTV-1 and

HTLV-1 were also different in Japan. Since then, virological and epidemiological studies of STLTV-1 of *M. fuscata* have not been published.

In the course of our long-term study on evolution of PTLV-1 and epidemiology of HTLV-1, we are now revealing epidemiological schema of STLTV-1 of *M. fuscata* which can be comparative to that of HTLV-1. In this short communication, we provide epidemiological evidence that Simian T-lymphotropic Virus Type 1 in *Macaca fuscata* has an alternative transmission route to maternal infection, which is the main transmission route of HTLV-1 in human.

We conducted an epidemiological survey for "M-colony" of *M. fuscata* which are now reared in an enclosed farm of the Primate Research Institute, Kyoto University, for observing social interactions. However, monkeys were captured from a single colony in the middle Honshu, Japan, and kept separately in individual cages during a quarantine period; each infant was reared with its mother in the same cage. Inspection for STLTV-1 was conducted in the quarantine period with the SERODIA-HTLV-I (Fujirebio Inc., Tokyo, Japan), according to the manufacturer's instructions.

The results are shown in Table 1. Development of *M. fuscata* females can be divided into four stages: infant (0 years old), juvenile (1-4 years old), youngster (5-6 years old), and adult (7 years or older).

The society of *Macaca fuscata* is based on the maternal line where male monkeys leave the colony as they grow up and migrate into another one. The number of male monkeys in a colony is smaller than that of female ones. Our data on males

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TABLE 1. STLV-1 PREFERENCE IN AGE AND SEX GROUPS OF THE MINOH COLONY OF *MACACA FUSCATA*

Age	Sex	STLV-1 Status		
		Positive	Negative	Inconclusive
Infant				
0	F	6/10 (60)	2/10 (20)	2/10 (20)
Juvenile				
1	F	0/5 (0)	5/5 (100)	0/5 (0)
2	F	1/4 (25)	3/4 (75)	0/4 (0)
3	F	1/3 (33.3)	1/3 (33.3)	1/3 (33.3)
4	F	1/1 (100)	0/1 (0)	0/1 (0)
1–4	F	3/13 (23.1)	9/13 (69.2)	1/13 (7.7)
Youngster				
5	F	4/4 (100)	0/4 (0)	0/4 (0)
6	F	4/4 (100)	0/4 (0)	0/4 (0)
5–6	F	8/8 (100)	0/8 (0)	0/8 (0)
Adult				
7<	F	27/27 (100)	0/27 (0)	0/27 (0)
	F	44/58 (75.9)	11/58 (19.0)	3/58 (5.2)
0	M	5/6 (83.3)	0/6 (0)	1/6 (16.7)

Percentages are given in parenthesis. F, female; M, male.

(6 male infants), thus, are insufficient to discuss statistically the difference of STLV-1 prevalence between male and female. We hereafter examine data on females only (a total of 58 females from 0 to over 7 years old).

The high sero-positive rate (60.0% or 6/10) in the infant stage, in contrast with the much lower positive rate (23.1% or 3/13) in the juvenile stage, seems due to maternal antibodies. The increase of positive rate after the juvenile stage, with the positive rate reaching 100% (or 35/35) in youngster and adult stages combined, was observed. Hayami *et al.*<sup>2</sup> also reported that the sero-prevalence of STLV-1 in *M. fuscata* increased gradually with age, reaching a maximum (about 50%) at 10–14 years of age.

In a typical colony of *M. fuscata*, most females are at a youngster stage when they first give birth. Whereas HTLV-1 is transmitted mainly from mother to child through breastfeeding,<sup>8</sup> our epidemiological data show that, in contrast with HTLV-1, horizontal transmission play an important role in increasing prevalence of STLV-1 with age among *Macaca fuscata*, and support an experiment<sup>9</sup> where a sero-negative female enclosed in a cage with a sero-positive male seroconverted after 8 weeks. The transmission route might change as host species change in several ways. If so, what are the clinical manifestations?

HTLV-1 was first discovered as an agent of Adult T-Cell Leukemia (ATL) and later was also described as an etiological agent of HTLV-1-associated myelopathy/tropical spastic paraparesis (HAM/TSP). At the same time, it is interesting that previous studies show that few or no HTLV-1 carriers horizontally infected developed ATL in their lifetime,<sup>10</sup> whereas HAM/TSP is developed through both vertical and horizontal transmission.<sup>11–13</sup> The questions arose as to whether the same virus could induce different diseases thorough different pathways, or as to whether different transmission route could induce different diseases.

The clinical manifestations of STLV-1 are still unknown. There have so far been no leukemia cases reported in the M colony. There might be a possibility that a disease caused by

STLV-1 is quite different from that of HTLV-1. Such study may bring further insight into mechanisms of disease development being caused by cross-species transmission and thus changing the transmission route.

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### Author Disclosure Statement

Dr. Yamamoto has full access to all the data in the study and had final responsibility for the decision to submit for publication. All authors declare that they have no conflict of interest.

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