

LEISHMANIASIS IN DIFFERENT ALTITUDES ON ANDEAN SLOPE OF ECUADOR

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Abstract: An epidemiological survey was performed in a leishmaniasis-endemic area along highway which was established about 15 years ago on the Andean slope of Ecuador; the area ranged from 300 m to 1,500 m above sea level. In general survey, 64 (14.3%) of the 446 subjects examined were positive for leishmanial signs. In order to know leishmanial infections in relation to the altitudes of dwelling sites of subjects, analysis was made on 224 children with 5 to 15 years of age. At 4 different sites with 500 m, 1,000 m, 1,300 m and 1,500 m above sea level, the infection rates of the subjects from the individual sites were 17.4, 18.8, 5.6 and 8.8%, respectively. A statistically significant difference was recognized between the altitudes, 500-1,000 m and 1,300-1,500 m ($0.01 < p < 0.05$, $\chi^2 = 5.314$), but not between 500 m and 1,000 m and between 1,300 m and 1,500 m. Leishmanial infections of the children who came from forest and highway areas were compared in each altitude. But no significant difference was found between forest and highway dwellers at any study sites.

INTRODUCTION

In Ecuador, transmission of American cutaneous and mucocutaneous leishmaniasis occurs in rural populations living in bilateral regions of the Andes mountains from the lowlands to highlands up to the elevation of 2,000 m. The disease is widely spread in most provinces and is a considerable public health problem in the country. In the endemic areas, however, little epidemiological study has been done on the community base, and no control measure has been applied to reduce or interrupt the transmission of the disease. For a future control, it would be necessary to clarify the epidemiological features in each endemic area of lowlands and highlands.

New World cutaneous or mucocutaneous leishmaniasis is more difficult to control than is those of Old World, since it is principally a disease of wild mammals in the dense forest, and numerous reservoir hosts are arboreal; thus, in most endemic areas, reservoir-vector control is almost impossible (Marinkelle, 1980). At present, the only alternative measure for the control

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in most parts of the neotropics seems to be evacuation of the entire human population from potentially dangerous areas, but such measure is inconceivable because of political, socioeconomic and logistic reasons (Marinkelle, 1980). Under such circumstance, it would be worthwhile to evaluate the effect of environmental changes in relation to the transmission of leishmaniasis.

The present paper deals with the result of an epidemiological survey performed in different altitudes of leishmaniasis-endemic areas with 300 m to 1,500 m above sea level. In the area, migration of inhabitants occurred from forest area to the vicinity of highway which was constructed on the Andean slope about 15 years ago. The leishmanial infections, therefore, were also compared between forest and highway dwellers, in order to know the effect of change in the life mode of the inhabitants on the transmission.

MATERIALS AND METHODS

Study area

The study site is located in the Department of Cañar on the south east of Ecuador, 2°30' West longitude, and located on the Pacific slope of the Andes, ranging from 300 m to 1,500 m above sea level. Two villages, Ocaña and Javin, in the above area are situated about 70 km from Guayaquil City and established as agricultural communities along highway to Cuenca City. A simplified sketch of the area is shown in Figure 1.

The paved highway with 10 meters in width was constructed about 15 years ago in the area and it changed a mode of villager's life, including agricultural systems. Before construction of the highway, bananas and yucas were the main agricultural products in densely forested areas, but they were replaced by sugar canes cultivated in largely deforested areas after the highway construction. The highway supported not only the movement of villagers but also transportation of their agricultural products to major cities, such as Cuenca and Guayaquil. Thus, the highway construction made a great environmental change of the endemic area of leishmaniasis.

Still, however, there were some surviving patches of natural dense forest which would provide the breeding sites for vector sandflies and reservoir hosts of leishmaniasis. Such limited patches are distributed in the one side of the highway, while on the other side there was a continuous undisturbed dense forest through lowlands to highlands along highway (Photos. 1, 2 and 3).

The majority of dwellings in the study area were built along highway, but the remainings were in forest areas. There was no livestock, but the people raised the dogs, cats, pigs, guinea pigs and domestic fowls. Wild mammals (sloths, armadillos, opossums, rats and mice) and 2 species of man-biting sandflies, *Lutzomyia trapidoi* and *Lu. hartmanni*, were found in the area (Hashiguchi *et al.*, 1985a, b, c).

Epidemiological examinations

In the inhabitants, the survey was performed by house visit, while it was done in children with 5 to 15 years of age by visiting 4 study sites (schools), La Delicia (A, 500 m above sea level), Ocaña (B, 1,000 m), Las Copas (C, 1,300 m) and Javin (D, 1,500 m). All the subjects were interviewed about their life history, such as occupation, cultivation, migration and contact history with sandflies, then examined clinically by well-experienced physician (E.A.G.L. and V.V.C.) to find ulcers (active lesions) and scars (cured lesions) of leishmaniasis. When they had active lesions, tissue samples were taken from the margin of ulcers for microscopic examina-

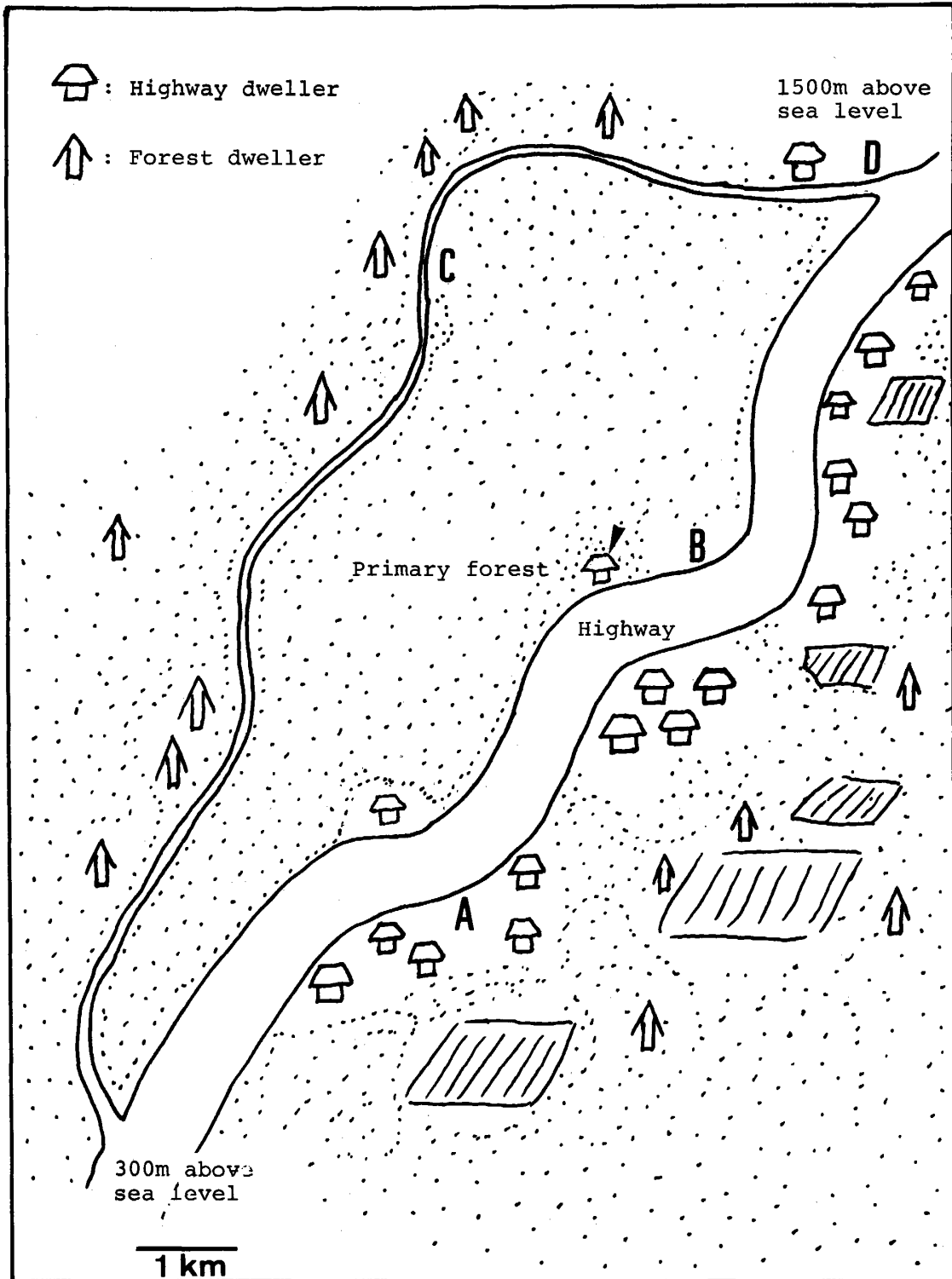


Figure 1 A simplified sketch of the study sites in the Department of Cañar, Ecuador. A, La Delicia (500 m above sea level); B, Ocaña (1,000 m); C, Las Copas (1,300 m); D, Javín (1,500 m).

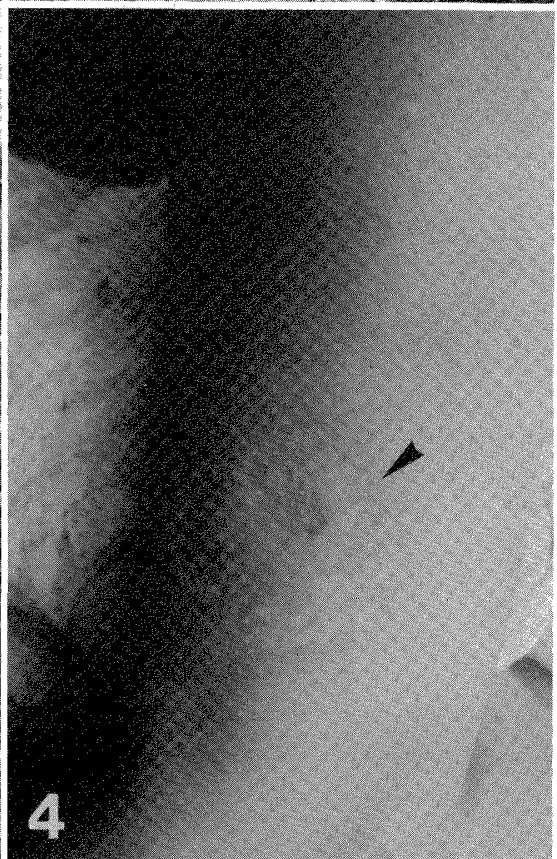
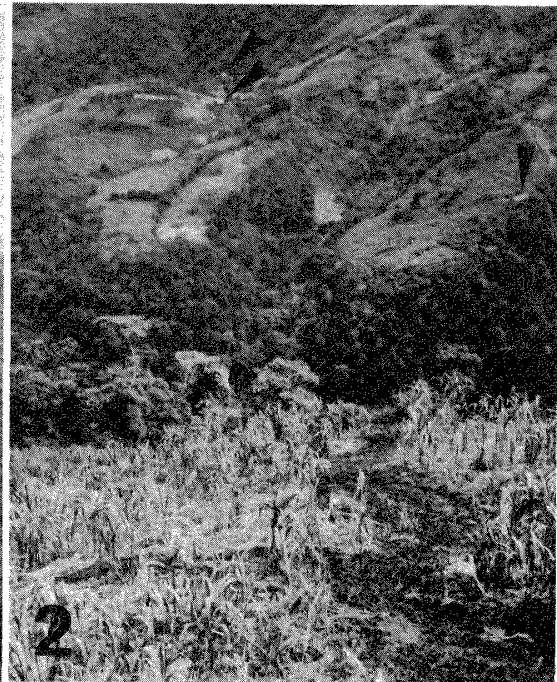
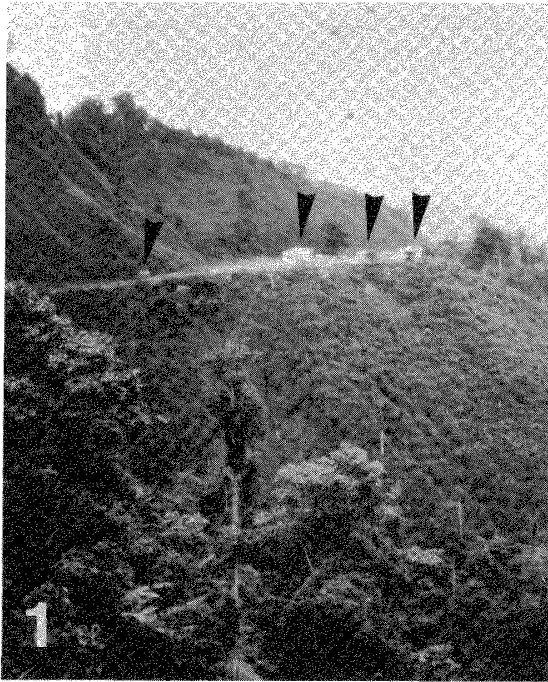


Photo. 1 Showing 4 houses (arrows) along highway in the study site (highway dwellers).

Photo. 2 Showing fields of sugar cane cultivation and remaining patches of natural (primary) forest. Arrows on the above side show 3 houses in forest area (forest dwellers).

tions. The location, size, onset and duration of lesions were recorded.

With regard to the subjects with scars, the diagnosis was determined only clinically, i.e., mainly based on the type and localization of the scars, duration of the lesions and contact history with sandflies; the chronic leishmanial ulcers resulted in a thin, depigmented scar (Photo. 4). The villagers have been calling leishmaniasis as *llaga de montaña* and sandflies, *manta blanca* in Spanish, respectively.

The causative agent of these cutaneous and mucocutaneous leishmaniasis in Ecuador has been considered *Leishmania braziliensis* s.l., based mainly on the clinical manifestations, behavior and localization of the organisms in sandfly vectors and growth in cultures.

RESULTS

In the inhabitants from whole area, the positive rates with leishmanial signs were arranged by age and sex in Table 1. In a total of 446 subjects examined, 64 (14.3%) were found to be positive for leishmanial signs. No marked difference was recognized between both sexes in the positive rates.

In Table 2, leishmanial infections of 224 children with age 5 to 15 years in the total examinees were arranged by the altitudes of their dwelling sites. The data revealed a statistically significant difference between altitudes, 500–1,000 m and 1,300–1,500 m above sea level ($0.01 < p < 0.05$, $\chi^2 = 5.314$), but not between 500 m and 1,000 m and between 1,300 m and 1,500 m. The result, therefore, suggested that the intensity of transmission was markedly influenced by the altitudes of dwelling sites in the endemic area.

To evaluate the intensity of transmission, the above 224 children were reanalyzed between forest and highway areas (Table 3). They were divided into the following two groups; 1) forest dwellers who have or had experience living in forest area, that is, those who settled down or

Table 1 Leishmanial infections among 446 inhabitants arranged by age and sex in the Department of Cañar, Ecuador

Age	Male			Female			Total		
	No. examined	+*	%	No. examined	+	%	No. examined	+	%
-10	110	12(4)	10.9	109	12(3)	11.0	219	24(7)	11.0
11-20	77	14(3)	18.2	70	12(1)	17.1	147	26(4)	17.7
21-30	16	4(1)	25.0	19	3	15.8	35	7(1)	20.0
31-	19	2	10.5	26	5	19.2	45	7	15.6
Total	222	32(8)	14.4	224	32(4)	14.3	446	64(12)	14.3

* Positives with leishmanial scars or ulcers; the number in parentheses shows positives with active lesions (ulcers).

Photo. 3 A house constructed in the vicinity of highway (1,000 m above sea level), but surrounded by dense forest (arrow in Figure 1). A considerable number of sandfly was collected around the house. All the persons of this family, 8 in total, had already suffered from leishmaniasis, showing the typical scars.

Photo. 4 A typical leishmanial scar (arrow) found on the forearm of a 34-year-old female who lives in the house shown in Photo. 3.

Table 2 Leishmanial infections of 224 children, 5-15 years old, arranged by altitude of dwelling sites in the Department of Cañar, Ecuador

Altitude* (in meters)	Schools**	No. examined	Positives with leish-*** manial signs (%)
500	A	46	8 (17.4)
1,000	B	85	16 (18.8)
1,300	C	36	2 (5.6)
1,500	D	57	5 (8.8)

* Altitude above sea level.

** A, La Delicia; B, Ocaña; C, Las Copas; D, Javin.

*** Statistically significant difference between the altitudes, 500-1,000 m and 1,300-1,500 m ($0.01 < p < 0.05$, $\chi^2 = 5.314$), but not between 500 m and 1,000 m and between 1,300 m and 1,500 m.

Table 3 Leishmanial infections of 224 children, 5-15 years old, arranged by their dwelling sites in forest and highway areas in the Department of Cañar, Ecuador

Children from	Schools*	No. examined	Positives with leish- manial signs (%)
Forest	A	27	6 (22.2)
	B	34	5 (14.7)
	C	36	2 (5.6)
	D	11	1 (9.1)
	Total	108	14 (13.0)
Highway	A	19	6 (31.6)
	B	51	11 (21.6)
	C	0	-
	D	46	4 (8.7)
	Total	116	21 (18.1)
Total		224	31 (13.8)

* A, La Delicia; B, Ocaña; C, Las Copas; D, Javin.

lived in the past in forest area, 2) highway dwellers who were born at or immigrated from non-endemic area to highway area. No statistically significant difference was recognized between forest and highway dwellers in each study site of A, B, C and D.

The localization and number of lesions were examined in 52 subjects with leishmanial scars. Of 110 scars found, 40.9% were in the face, 30.0% in the upper extremities, 26.4% in the lower extremities and 2.7% in the trunk. The majority of scars measured less than 15 mm in diameter. Only 12 persons (2.7% of the total examinees), 8 males and 4 females, had 1 to 8 ulcers in the cheek, ear and upper or lower extremities. In interviews, the duration of ulcer ranged from 1 month to 2 years; the lesions measured between 4 mm and 32 mm in diameter.

DISCUSSION

In our previous study in the Pacific slope of the Andes in Ecuador, 15.8% of the examinees were positive for active leishmanial lesions and 60%, for leishmanial scars (Hashiguchi *et al.*, 1984). The present study showed rather low intensity of the transmission, in the Department of Cañar, Ecuador.

In the examination at 4 sites with different altitudes, the prevalences were higher at 500 m (17.4%) and 1,000 m (18.8%) above sea level than 1,300 m (5.6%) and 1,500 m (8.8%). The fact is quite noticeable in connection with the infection of sandfly vectors with leishmanial promastigotes. In this area, Hashiguchi *et al.* (1985c) examined natural infections with the parasites in man-biting species of sandflies, and reported that the infection rate of *Lu. hartmanni* was 5.9% at 350–600 m, 3.8% at 950 m, 2.3% at 1,200–1,500 m and 0% at 2,000 m, while the other sandfly, *Lu. trapidoi*, was positive for the parasites at only one site of 350–600 m (8.1%), showing a markedly reduced number of fly catches at higher sites. These results indicated that leishmanial transmission in the Andean slope was greatly influenced by the altitudes of dwelling sites, and also that the intensity of transmission would be very low at higher lands of 1,300 m or over.

By the data analysis of 224 children, the prevalence of leishmaniasis was compared between forest and highway dwellers revealed no marked difference between two groups. The result, therefore, suggested that there might be no remarkable difference between forest and highway areas, in terms of the intensity of leishmaniasis transmission in the present endemic area. This might be due to the existence of primary forest along highway or the remaining patches of natural forest around dwellings, which would play a role as the breeding sites for the vector and reservoir of the disease. In Panama, an insular effect resulting from clearance of primary forest which surrounded a settlement, guarded properly the community against leishmanial infection prevalent in the nearby forest (Herrer *et al.*, 1976). To reduce the transmission in the present area, a further clearance of the forested areas would be necessary.

The localization of lesions in the subjects examined mostly agreed with that reported by Rodriguez and Aviles (1953) and Hashiguchi *et al.* (1984) from Pacific coastal regions of Ecuador, but greatly differed from that in Amazon regions of the country, where 60% of the lesions observed were in lower extremities (Amunarriz, 1982). This discrepancy might be caused by the difference of biting behavior of sandflies or clothing habits of inhabitants between the two regions.

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エクアドル国アンデス斜面の高度差による リーシュマニア症浸淫

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エクアドル国のアンデス斜面低地から高地（海拔 300 m–1,500 m）にかけて居住する住民について、リーシュマニア症の罹患状況を調べた。この流行地には約15年前にハイウェイ（道幅約 10 m）が建設され、住民の居住環境ならびに生活様式に大きな変化が認められた。

一般住民446名について検査したところ、64名（14.3%）は本症によると考えられる治療病変、または皮膚潰瘍を保有していた。

居住地の高度差による住民のリーシュマニア症罹患状況を知るため、被検者のうち5–15歳の学童224名を対象に、4地点（A, 海拔 500 m; B, 1,000 m; C, 1,300 m; D, 1,500 m）において、居住地区別の罹患を比較した。その結果、学童のリーシュマニア症罹患率は、海拔 500 m 地点で17.4%、1,000 m で18.8%、1,300 m で5.6%、1,500 m で8.8%となり、500 m–1,000 m の地域と 1,300 m–1,500 m の地域との間には、統計学的に有意の差を認めた ($0.01 < p < 0.05$, $\chi^2 = 5.314$)。このことは、アンデス斜面のリーシュマニア症流行地の比較的低い地域（1,000 m 以下）では、本症の罹患率が高くなるが、より高い地域では罹患率は低くなることを示唆している。

一方、ハイウェイ沿いと山間部との間で、本症罹患率の差異を検討するため、上記224名の学童を、その居住地の状況によって次の2群に分類した。1) 山間部に定住または過去に一時期居住した者、2) ハイウェイ沿いで出生または非流行地から移住した者。上記2群間での学童の罹患率を見る上で、高度差による影響を除去するため、各地区ごとの山間部住民とハイウェイ住民との比較を行った。その結果、4地点のいずれにおいても両群間に有意な差を認めなかった。したがって、本調査地においては、ハイウェイが建設され、環境変化や住民の移動がみられたものの、道路沿いの原生林や人家、および農耕地周辺に原生林の一部が残存し、これがサシチョウバエや保虫宿主の供給源の役割を果たしているものと判断された。

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