



Andean cutaneous leishmaniasis (Andean-CL, uta) in Peru and Ecuador: the vector *Lutzomyia* sand flies and reservoir mammals

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ABSTRACT

The vector *Lutzomyia* sand flies and reservoir host mammals of the *Leishmania* parasites, causing the Andean cutaneous leishmaniasis (Andean-CL, uta) in Peru and Ecuador were thoroughly reviewed, performing a survey of literatures including our unpublished data. The Peruvian *L. (V.) peruviana*, a principal *Leishmania* species causing Andean-CL in Peru, possessed three *Lutzomyia* species, *Lu. peruensis*, *Lu. verrucarum* and *Lu. ayacuchensis* as vectors, while the Ecuadorian *L. (L.) mexicana* parasite possessed only one species *Lu. ayacuchensis* as the vector. Among these, the Ecuadorian showed a markedly higher rate of natural *Leishmania* infections. However, the monthly and diurnal biting activities were mostly similar among these vector species was in both countries, and the higher rates of infection (transmission) reported, corresponded to sand fly's higher monthly-activity season (rainy season). The *Lu. tejadai* sand fly participated as a vector of a hybrid parasite of *L. (V.) braziliensis/L. (V.) peruviana* in the Peruvian Andes. Dogs were considered to be principal reservoir hosts of the *L. (V.) peruviana* and *L. (L.) mexicana* parasites in both countries, followed by other sylvatic mammals such as *Phyllotis andium*, *Didelphis albiventris* and *Akodon* sp. in Peru, and *Rattus rattus* in Ecuador, but information on the reservoir hosts/mammals was extremely poor in both countries. Thus, the Peruvian disease form demonstrated more complicated transmission dynamics than the Ecuadorian. A brief review was also given to the control of vector and reservoirs in the Andes areas. Such information is crucial for future development of the control strategies of the disease.

1. Introduction

The leishmaniasis is one of the most important emerging and re-emerging infectious vector-borne diseases. It is caused by the infection with about 20 species of the genus *Leishmania* parasites, and transmitted by the bite of an infected female sand fly belonging to the subfamily Phlebotominae, *Phlebotomus* spp., transmitting parasites of the subgenus *Leishmania* (*Leishmania*) in the Old World, and *Lutzomyia* spp. transmitting those of two subgenera *L. (Leishmania)* and *L. (Viannia)* in the New World. Clinically, the disease is divided into three

principal forms, cutaneous (CL), mucocutaneous (MCL), and visceral (VL) known as kala-azar and often fatal if left untreated. It is prevalent in tropical and subtropical geographic zones of the world, affecting at least 12 million people in 98 countries and regions (Desjeux, 2001; WHO, 2010; Alvar et al., 2012).

In the New World, the disease is prevalent in a wide range of distribution from the southern US to the northern Uruguay (Hashiguchi et al., 2017; Satragno et al., 2017). Among the *Leishmania*-endemic countries of South America, there exist so-called Andean types of CL (Andean-CL, uta) in Peru and Ecuador. In the Peruvian Andes, it has

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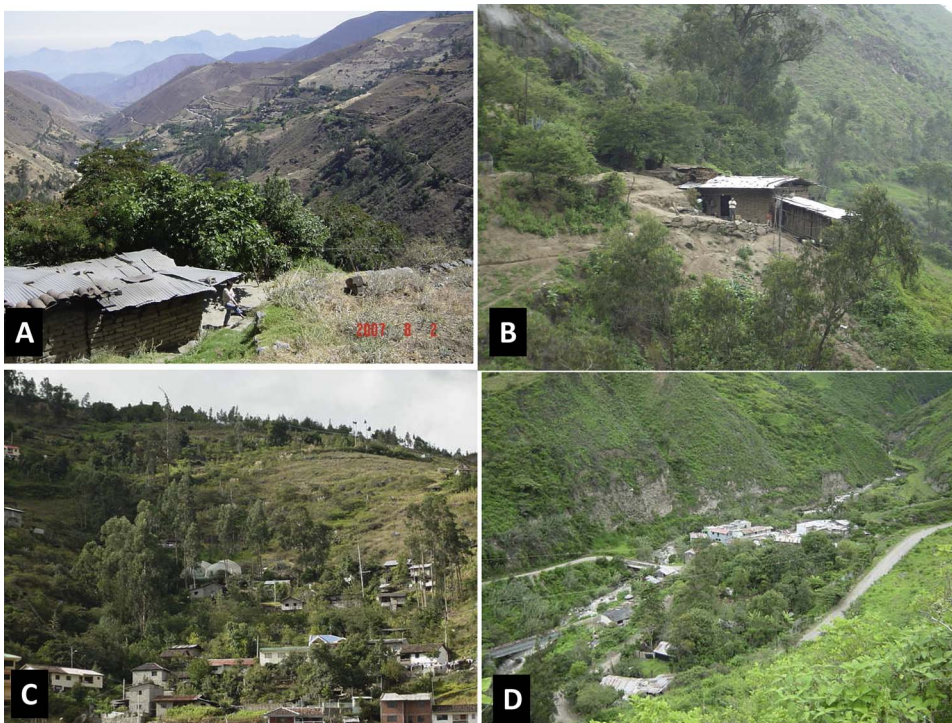


Fig. 1. Representative pictures (land scape) of the areas endemic for the Andean-CL (uta) in Peru (A, B) and Ecuador (C, D); in the areas examinations of vector sand flies and reservoirs (dogs) were conducted in and around the houses/villages (Hashiguchi et al., 2007a,b,c and our unpublished data). A. Nambuque (2500 m, a.s.l.), La Libertad Department; B. La Cuesta (2200 m a.s.l.), La Libertad Department; C. Paute (2500 m, a.s.l.), Azuay Province; D. Chanchan (1500 m, a.s.l.), Chimborazo Province.

long been known that there exists a unique clinical form of CL known as ‘uta’, caused by *L. (V.) peruviana* parasites (Lainson et al., 1979; Kreutzer et al., 1983; Lainson, 1983, 1996; Lucas et al., 1998; Arevalo et al., 2007). The disease name ‘uta’ has been used synonymously for the vector and the disease in certain endemic areas of the Peruvian Andes, and it was believed to have been present for a long time, probably long before the discovery of the Americas (Hertig, 1942; Weiss, 1943; Herrer and Christensen, 1975). In Ecuador, on the other hand, autochthonous Andean-CL cases, very similar to “classical” Peruvian uta were reported for the first time in 1987 from a small Andean town Paute, Azuay Province, located in the country’s mid-southwestern region (Hashiguchi et al., 1987, 1991). Since the first report of the cases from Ecuador, it has been considered that the Andean-CL would be mostly similar to the Peruvian uta.

In the previous study, we focused on the causative *Leishmania* parasites and the patho- and clinico-epidemiology of the Andean-CL (uta) in Peru and Ecuador, and the results suggested that the diseases in the two countries seemed to be changing gradually, especially in the clinico-epidemiological features, the Peruvian form being more severe than the Ecuadorian affecting higher age groups, besides the Ecuadorian form being more rural than before (Hashiguchi et al., 2018). The current study was designed to review the disease, mainly focusing on the vector sand flies and reservoir host mammals of the *Leishmania* parasites circulating in the Andean-CL endemic areas of the two countries. For this purpose, a survey of the relevant literatures including our unpublished data was conducted thoroughly. Such information is crucial for the future development of intervention and control strategies of the disease, not only for the Andes regions but also for other *Leishmania*-endemic areas.

2. Materials and methods

2.1. Data/information collection

A bibliographic survey was conducted, thoroughly performing a review of the articles reported, using Medline, Global Health and others, with keywords: Peru; Ecuador; phlebotomine sand flies; *Lutzomyia*; vectors; reservoirs; *Leishmania*; Andean cutaneous

leishmaniasis; uta; and other related-terms/words. Countrywide up-to-date epidemiological data were also collected from the official reports of the Ministries of Public Health of Peru (Centro Nacional de Epidemiología; Prevención y Control de Enfermedades-MINSA) and Ecuador (EPI-2; Epidemiología-MSP). The leishmaniasis are prevalent in 19 of the 24 Departments in Peru (Lucas et al., 1998) and in 21 of the 24 Provinces of Ecuador (Hashiguchi et al., 2017, 2018). The current study however mainly focused on the Andean-CL (uta); thus, information or data collections were mostly limited to those concerning on the Andean highland areas of both countries; Peru and Ecuador; mainly dealing with the vector sand flies and reservoir mammals of *L. (V.) peruviana* in Peru; and those of *L. (L.) mexicana* and *L. (L.) major*-like in Ecuador.

2.2. Study areas (Fig. 1)

Global situation of Peru and Ecuador was described previously (Hashiguchi et al., 2017). Therefore, in this text a brief sketch of topographical and ecological features of the study areas endemic for the Andean-CL (uta) was given. The topography, climate, fauna and flora of the Andes in Ecuador and Peru are mostly similar and unique areas endemic for the Andean-CL even though the ecological features are quite different from those of tropical and subtropical lowlands where most cases of other types of clinical forms, CL and MCL are prevalent in the two countries (Hashiguchi et al., 2017). The altitude above sea level (a.s.l.) decides the natural barriers of high mountain ranges, and the variations in temperature, humidity, rainfall, frost-line, types of soil, which affect the availability of suitable mammalian hosts (reservoirs) and *Lutzomyia* species (vectors) at each Andean-CL endemic area (Herrer, 1951a,b, 1957; Gomez and Hashiguchi, 1987, 1991; Hashiguchi and Gomez, 1987, 1989, 1991; Hashiguchi et al., 1991; Perez et al., 1994; Villaseca et al., 1993). Climatically, there are two well-defined seasons in the Andes areas: a dry season from March/April to November/December with few clouds, higher evaporation rates and the round completely dry, and a rainy season from January to March with abundant rains and permanently cloudy skies (Gomez and Hashiguchi 1991; Gomez et al., 1992, 1994; Perez et al., 1994). In the Andean-CL endemic areas, the climate is generally temperate

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