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VIEWS AND REVIEWS

SOME ASPECTS OF GEOGRAPHIC PATHOLOGY IN PERU

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Peru is located in the Western Hemisphere between 0°02′-18°21′ of latitude South and 68°39′-81°19′ longitude West. Because of its geographic location, the whole Peruvian territory is situated in the tropical region of the New World and one therefore would expect to find a warm or tropical climate prevailing all over the country. However, this does not happen in a considerable proportion of the area, mainly due to the presence of the Andes Mountains, which change and diversify the climate to such an extent that a variety of climatic conditions can be found in different regions of the country.

Peruvians divide their country into three main but different geographic-climatic regions, which can be described as follows: (1) **Coast**—A narrow and mostly arid region on the western side of the Andes, with very little rain and a temperate climate; (2) **Sierra**—The region of high mountains with cold weather prevailing all the year round; and (3) **Jungle**—The region of tropical forest in the Amazon. As the climate changes gradually from one region of the country to the other, particular attention has been focused on the plants and wild animals that are present at different altitudes. In this way some climatic classifications have been attempted.

This report attempts to describe the natural conditions and the effect of altitudinal differences relating to the endemicity of some insect-born diseases. For this purpose the Peruvian territory will be divided as follows: a) Western side of the Andes, i.e., Pacific watershed, and b) Eastern side of the Andes, i. e., Amazon watershed.

In Peru the general pathological pattern is somewhat altered according to the climatic conditions of each geographic region or subregion. It is interesting to note in this connection the significance of altitude on the presence and incidence of most of the human diseases transmitted by insects that are endemic in certain regions. This phenomenon was clear some decades ago when the highly effective and long-lasting insecticides were not available. Today, because of the intensive use of such insecticides, some of these diseases have tended to disappear while others have been reduced considerably. However, since the natural conditions

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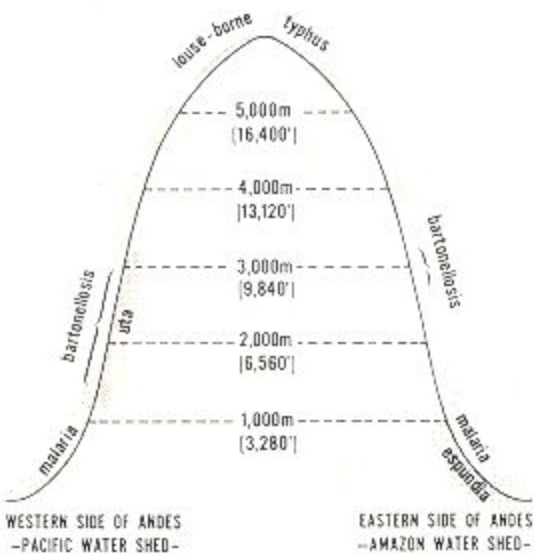
still remain the same and none of these diseases have yet been eradicated, it would be proper to mention how altitude affects the presence and incidence of some arthropod-born diseases around 12° of latitude South. For this purpose, previously gathered information is used as a basis for the preparation of the schema presented in *figure 1*.

I. WESTERN SIDE OF THE ANDES, i.e., PACIFIC WATERSHED

Rivers originating in the upper parts of the mountains descend directly to the Pacific ocean along narrow and deep valleys, where native population have lived for centuries. One of these valleys, the Rimac, lies around 12° latitude and extends from the ocean to the highlands. Lima, the capital of Peru, is found in this valley at approximately 150 meters above sea level. For many years several endemic insect-born diseases have been investigated in this area and important information concerning their epidemiology has been gathered. The presence and incidence of such diseases follow:

1. Malaria: From sea level to 1,800 m. This disease, which presently is almost eradicated from the Rimac valley due to the effectiveness of the Malaria Eradication Program, was of considerable economic importance before the use of modern insecticides. Only one species of *Anopheles* mosquito is important in the transmission of malaria in this valley. This insect is more abundant shortly after the rainy season in the highlands. During that time of the year small ponds which are found along the river constitute the principal breeding places for the mosquito. The low temperature found above 1,800 meters seems to be the main factor that limits the altitudinal distribution of the insect vector.

Fig. 1. **Schematic profile of Peruvian territory through 12° of latitude South, showing the altitudinal levels at which some insect-born diseases are endemic.**



2. Carrion's disease: 1,000 to 2,800 m. This disease, also called verruga Peruviana and human bartonellosis, is almost restricted to certain mountainous regions of Peru. For long time it was the most dangerous disease that affected particularly the foreigners. Written information on the disease has been available since 1630[1], less than a century after the first arrival of the Spaniards in Peru.

In modern times human bartonellosis constituted an important public health problem when non-immune persons remained, even for a few days, in endemic localities. But at present, due to the long-lasting effect of modern insecticides, this disease has been almost completely controlled. Carrion's disease is transmitted in nature through the bite of a few species of Phlebotomus sandflies, which are very sensitive to DDT and other similar insecticides. The epidemiology of this disease suggests the existence of non-human reservoirs, but these are unknown at present.

There is a close relationship between the presence of *Phlebotomus* sandflies, particularly *P. verrucarum*, and the prevalence of Carrion's disease, at least in the Rimac valley and other valleys on the western side of the Andes.[2] Its incidence in relation to altitude was demonstrated in a valley 200 kilometers north of the Rimac valley.[3]

3. Cutaneous leishmaniasis: 1,200 to 3,000 m. A benign form of cutaneous leish-

maniasis called uta prevails endemically in many mountainous localities on the western side of the Andes, together with Carrion's disease. Uta seems to be a very old disease and some investigators believe that it has been present in Peru since the time of the Incas. It is epidemiologically related to Carrion's disease, since both are usually present in the same localities, are transmitted by *Phlebotomus* sandflies, and seem to have non-human reservoirs.

The direct effect of altitude on the incidence of uta was clearly demonstrated about 20 years ago[4] in the province of Huarochiri, in which the Rimac valley is located. At that time both uta and Carrion's disease were highly prevalent in Peru. A survey on uta infection among school children, grouped according to altitude, revealed the following:

Altitude in meters	*Incidence of the disease (%)*
900 - 1,199	0.0
1,200 - 1,499	19.8
1,500 - 1,799	48.0
1,800 - 2,099	90.3
2,100 - 2,399	71.6
2,400 - 2,699	37.8
2,700 - 2,999	14.3
3,000 - 3,299	0.7

Some years later a similar epidemiological investigation on uta and Carrion's disease was carried out in another valley of the Pacific watershed.[3] The results concerning the effect of altitude on the incidence of uta were comparable to those obtained in the previous Rimac valley study.

4. Epidemic typhus fever: About 3,000 m. and above. The actual effect of altitude on the incidence of this disease at 12° latitude South or in other areas in Peru is not well known due to the lack of adequate studies. However, at higher altitudes the ecological conditions frequently determine the occurrence of this disease. Cold climate, low economical status, and lack of adequate education of most of the native people are factors that frequently create conditions favorable to infestation by the insect vector and to the presence of the disease itself.

II. EASTERN SIDE OF THE ANDES OR AMAZON WATERSHED

The eastern side of the Peruvian Andes is very different from the western one, at least in relation to the climate, course and importance of rivers, fauna, flora, and other aspects which effect the ecology of disease. Unfortunately, in relation to the epidemiology of the diseases considered in this paper (except malaria), the knowledge available at present is almost nil.

1. Cutaneous leishmaniasis: 300 to about 1,000 m. In this region, as in the rest of the Peruvian jungle and in other South American countries, a clinical form of cutaneous leishmaniasis, called espundia, is present. This form is much more pathogenic than uta since, in addition to the skin lesions, the mucosa of the nose and mouth are frequently involved; in these cases the infection tends to be chronic. Aside from its greater pathogenecity, espundia is also considered different from uta geographically and epidemiologically.[5] The incidence of espundia in relation to altitude, potential reservoirs, and the insect vector (supposedly *Phlebotomus* sandflies), are completely unknown at present.

2. Malaria: 300 to about 1,800 m. Malaria was highly endemic in this area before the Malaria Eradication Program was initiated. The main vector is the same species of *Anopheles* found in the Rimac valley. Few secondary vectors exist but only at lower altitudes.

3. Carrion's disease: About 2,800 to 3,000 m. Human bartonellosis is rare in the eastern side of the Andes and most of the information available concerning this disease still needs to be checked. Nevertheless, during the first months of 1959 an epidemic occurred around 12° of latitude. In that outbreak the disease was demonstrated only in a narrow zone of 2,800-3,000 meters above sea level.[6] *Phlebotomus verrucarum*, the well known insect vector of Carrion's

disease, was not found; instead, two other species of *Phlebotomus* sandflies were abundant. From epidemiological correlations one of these species was incriminated as the possible vector. In addition, some other peculiarities of the epidemiology of the disease, such as high mortality and the absence of cutaneous eruptions, were observed.

4. Epidemic typhus fever: About 3,000 meters and above. Also in the eastern side or Amazon watershed, there is lack of information concerning the role of altitude on the incidence of this disease. However, in this zone the natural factors which determine either directly or indirectly the infestation by the insect vector and certain customs of the native population are certainly important.

SUMMARY

Information concerning the role of altitude on the presence and incidence of some insect-born diseases in Peru are presented. The important effects of altitude have been clearly demonstrated in the Rimac valley, which is found on the western side of the Andes or Pacific watershed at 12° of latitude South. The principal diseases involved are: malaraia, Carrion's disease, cutaneous leishmaniasis, and epidemic typhus fever.

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