

PLAGUE IN THE AMERICAS: AN HISTORICAL AND QUASI-EPIDEMIOLOGICAL SURVEY*

(Continued)

VI. ECUADOR

Ecuador, the last of the Pacific Coast countries to be invaded by plague, has an area of some 173,000 square miles, and a population estimated at around 2,000,000. It lies between 2° N. and 5° S. Lat. and 75° and 81° W. Long., being traversed by the Equator for which it is named. The country is crossed by two parallel cordilleras of the Andes which are joined by eight transverse ranges of hills divided by river valleys. Between the mountains and the Pacific lies a narrow coastal plain, with two small chains of hills not over 2,600 ft. high, characterized by meadows, forests, and even swamps in the neighborhood of rivers, and more arid savannas near the sea.¹ East of the Andes stretches the large plain known as Oriente. The different altitudes afford many varieties of climate: the lowlands are hot, with an average temperature of 82-84 F in the Littoral; regions from 6,000 to 9,000 feet are mild (Loja, 7,300 ft., average annual temperature 60.8 F; Ambato, 8,440 ft., average temperature 57.2 F); those above this level, including the Quito plateau, are cold, and the highest peaks are snow-capped. The dry season runs from June to November; the rainy, December to May. The annual rainfall in Guayaquil is around 40 or 50 inches, and precipitation increases as one goes toward the mountains.

The area in which plague has appeared includes the Pacific littoral and some parts of the inter-Andean region. The disease has not been reported from the Eastern plain (Oriente). Some instances of the infection (Province of Loja) appear to be more closely related to Peruvian plague than to that in other parts of Ecuador.²

Of Ecuador's 17 provinces and one territory, the three seacoast provinces (Manabí, 1913-1924 and 1936-37; Guayas, 1908-1930; 1935-1939; El Oro, 1911-1918 and, 1939, Zaruma, inland); and six of those inland (León, 1926-29; Tungurahua, 1926-1929; Los Ríos, 1909-1923; 1936; Chimborazo, 1909-1940; Loja, 1921-1940; and Cañar, 1933) have been invaded by plague. It has apparently been eradicated from the ports and lowland towns, but persists stubbornly in certain mountain areas. About 11,458 cases have been reported from 1909-1939, of which about 8,000 belong to Guayaquil. How many cases have actually occurred it is impossible to determine, but certainly far more than the number given.

Ecuador became alarmed at the invasion of Peru by plague in 1903, and the government, through the Guayaquil Board of Health, took

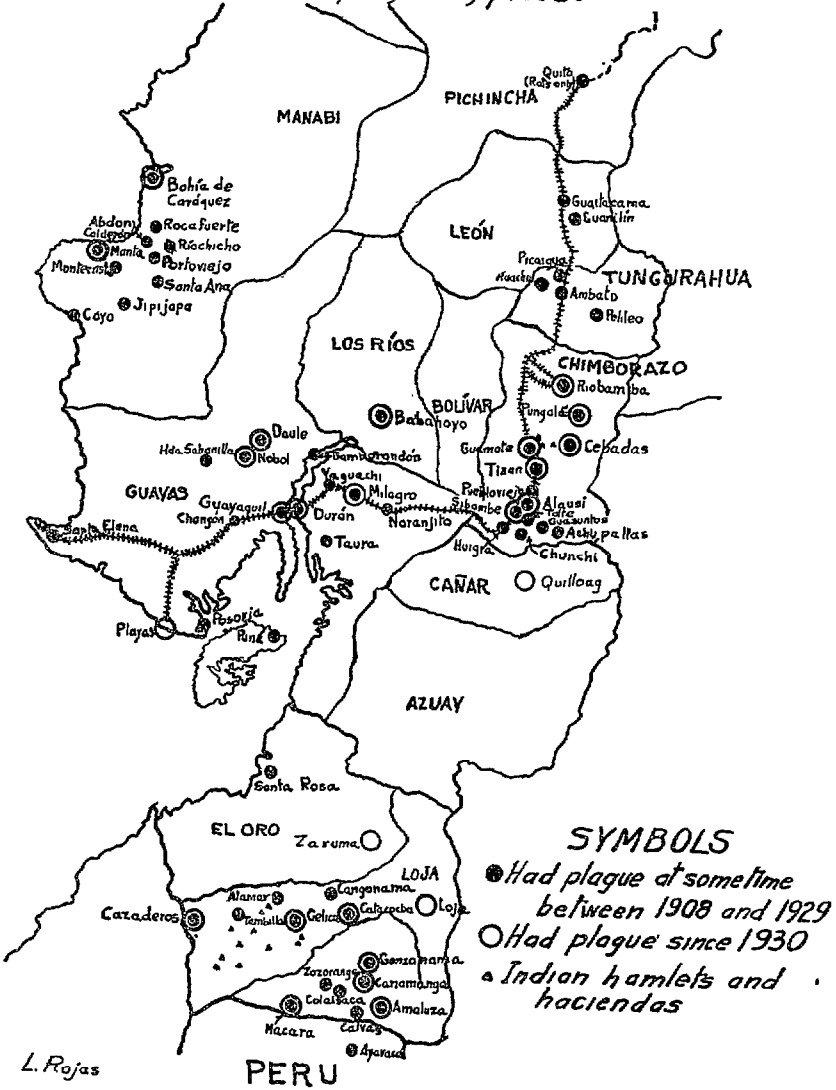
* See General Review.

¹ Sheppard, G.: "El clima y la fisiografía en la región suroeste de la república del Ecuador," Observatorio de Quito, 1934; and other sources.

² Eskey, C. R.: *Pub. Health Rep.*, U. S., Sept. 5, 1930, p. 2077.

MAP SHOWING PLAGUE PREVALENCE IN ECUADOR

*Based on the map by Miña and Eskey, Pub. Health Rep.,
Sept. 5, 1930, p.2080*



from the beginning precautionary measures.³ The danger became more pressing with the appearance of the disease in Paita, Peru, in 1905, because both Santa Rosa (El Oro Province) and Guayaquil carried on commerce with that port. Despite quarantine of passengers from Peru, deratization of steamers, and similar measures, the disease finally made its entrance.⁴ A rat epizootic in Guayaquil in February, 1908, was diagnosed as plague by Dr. B. J. Lloyd of the U. S. Public Health Service. He predicted that human cases would soon follow, and they did: 63 in February, 225 in March.⁵ It was also said that similar human cases had occurred during January among individuals working on the wharves.⁶ Many early cases were also traced to the river market of Guayaquil.

The history of Ecuadorian plague has been ably written both in Spanish and in English, and the works of Suárez, Miño, Sáenz Vera, Pareja, Martínez-Vinueza, and others, the detailed and comprehensive epidemiological studies of Eskey in 1929-30,⁷ and the reports of the Traveling Representatives of the Pan American Sanitary Bureau, Drs. John D. Long, Anthony Donovan, Henry Hanson, and John R. Murdock, have been heavily drawn on in the following pages.

Once invaded, Guayaquil itself offered a peculiarly favorable atmosphere for the continued presence of plague. The climate (average temperature 75.4-80.1 F; mean high temperature 79.9-85.1 F; mean low temperature 70.9-75.6; hottest months January-April, the rainy season) is favorable to *X. cheopis* except during the rainy season. The city, lying at sea level, with a population of some 150,000, has a great

³ In April, 1904, Dr. B. J. Lloyd reported finding plague in rats which were dying in the hold of the steamer *Limari* en route to Callao and apparently on a round trip voyage from Chile. The vessel had been refused entry at Guayaquil, and Dr. Lloyd had boarded her in quarantine at Puna. He suggested that the infection had been obtained somewhere between Valparaíso, Chile (infected in 1903) and Paita, Peru (infected in 1905); some of the intervening Peruvian ports had plague. About a year before the *Limari* incident, rats had died on the steamer *Loa*, a sister ship of the *Limari*, the epizootic lasting a month. The circumstance serves as an indication that Ecuadorian fears were well-founded. (*Pub. Health Rep.*, U. S., May 20, pp. 1008-9, and Jul. 8, p. 1388, 1904.)

⁴ Eskey states: "There is little doubt that plague was carried from Peru to Guayaquil, Ecuador, but the particular vessel that brought the disease is unknown." (*Pub. Health Rep.*, Sept. 5, 1930, p. 2077.) According to a member of the local board of health, rats had been dying in Machala, a port near the Peruvian border, for about two months, and coasting vessels plied between Machala and Guayaquil without supervision. (Lloyd, *Pub. Health Rep.*, U. S., Mar. 6, 1908, pp. 284-5.)

⁵ Eskey, *supra*; and *Pub. Health Rep.*, Feb. 21, p. 219, Mar. 6, p. 284, 1908. The first dying rats were reported February 6, in river front warehouses. Lloyd made a provisional diagnosis of plague on the macroscopic and microscopic findings, and began the bacteriological examination. On Feb. 9 a clinical diagnosis of plague was made, in consultation with a local physician, in a human case, which died and presented at autopsy findings which were accepted by the majority of Guayaquil physicians as conclusive, and on February 13 they reported that plague was present. The local board of health reserved official announcement until the bacteriological examinations could be completed, but before that was taking steps to combat the disease. The complete bacteriological report was submitted March 7. On March 24 by Executive Decree a special Commission was created to combat plague, yellow fever and small-pox, with Dr. Lloyd as Director and Dr. F. Martínez S. and Sr. Emilio Estrada as the other members. There was some opposition from the press and prominent persons to the acceptance of the original diagnosis, but the completion of the bacteriological examinations seemed to silence it, and afterwards the entire press began to cooperate. In his 1909 report Lloyd mentioned that one of the daily newspapers had constantly aided in educating the public in sanitary work, and he attributed the favorable attitude of the public toward plague vaccination to the influence of *El Grito del Pueblo*. (*Pub. Health Rep.*, Mar. 6, 1908, p. 284; An. Rep. Surg. Gen. Pub. Health & Marine Hosp. Serv., 1909, p. 141.)

⁶ Mifo, C. A.: "La Peste bubónica en el Ecuador," Quito, 1933, pp. 5, 6.

⁷ Eskey, C. R.: Chief etiological factors of plague in Ecuador and the antiplague campaigns, *Pub. Health Rep.*, U. S., Sept. 5, 1930, p. 2077, and Sept. 12, p. 2163.

deal of wooden construction offering excellent rat harborage.⁸ Garbage disposal has been another problem.⁹ The situation has been slowly improving in the last ten or fifteen years.

Plague persisted in Guayaquil until March 1930, when it disappeared following a vigorous anti-rat campaign. It reappeared in 1935 (case, April 10, in a man employed in unloading freight at Durán and in loading Guayaquil ferries; and other cases in August, followed by an epidemic) and was again extinguished in 1939 (last case April 14; last infected rat, March 19). The reinfection was the result of carelessness in the fumigation of freight cars coming from the interior, a considerable number having passed Bucay without fumigation from April to July.¹⁰ Guayaquil was again declared a Clean Port, Class A, in May, 1940.¹¹

Following Miño's classification¹² of Ecuadorian plague into water-borne (sea and river), land-carried (radiating from Guayaquil) and "Southern" (also following land routes, but related to Peruvian plague), the spread of the disease in Ecuador may be briefly described:

Babahoyo, capital of Los Ríos, carrying on daily commerce with Guayaquil by water, was invaded by plague in 1909 and suffered outbreaks year after year until 1918. It was again infected in 1936 after the reappearance of the disease in Guayaquil. No cases have been reported since 1937. Samborondón, Guayas province, midway between Guayaquil and Babahoyo, was infected in 1914. Other villages in this province infected by the maritime traffic were Daule, 1916; Posorja, 1916-1924 (on the bay); Nobol, 1923; Playas 1937; Puná, 1924 (an island. See also General Review); and Colimes, 1929. Various haciendas and hamlets were infected from these foci, including Hacienda Sabamilla, 1923, Chongón, 1923, and the cantón Santa Elena (Dept. Ancón), 1929.

Santa Rosa, in El Oro province, was invaded in 1911 and had plague until 1918; the disease was again reported in the province in 1939,¹³ in Zaruma, near the Loja border.

⁸ The central part of the city was built mostly of wooden buildings, in solid blocks without openings except doors and windows, the enclosed space of party walls permitting rat harborage. Double floors and walls were prohibited by law in new buildings and their removal in old ones required since before 1930, but the good effect of this measure has been undermined by the custom of boxing in all rough joists and beams, often with a larger boxing than necessary. Uprights supporting overhanging second stories are also boxed in, largely and ornately, and there are usually openings in the bottom of the columns through which rats may enter and travel up the column to the boxed-in horizontal beams. Other rat harbors and passages are the spaces beneath floors (raised, for ventilation), and tile roofs. This section of the city suffered most from plague. More ramshackle in appearance but less of a plague problem were the bamboo shacks found particularly on the outskirts of the city. Since they were usually constructed with single walls and floors and unenclosed ceilings, and were generally isolated from each other, they did not offer so much shelter as the wooden buildings, except under the floors, and then not during the rainy season. There is a certain amount of concrete construction in the city. The large central market and the river market were both persistent plague foci. (Eskey, *Pub. Health Rep.*, Sept. 12, 1930, p. 2163.) Yards and patios are often littered with collections of wood, chips, tin cans, sacks, rags, bones, and so on, and animals (chickens, pigs) are sometimes kept there. (Report of John R. Murdock.)

⁹ Garbage is thrown in the street and collected at night. This was apparently a measure designed to prevent accumulation of garbage in kitchens overnight and consequent attraction of rats to the interior of houses. (Dirección de Sanidad Pública: "Cartilla Sanitaria No. 1, La peste bubónica," Guayaquil, 1923, p. 12.) The night collection offers difficulties in the way of thoroughness (darkness, scattering of garbage by dogs) so that rats may find nourishment both in the street and at the garbage dump itself.

¹⁰ Report of Ecuador to the X Pan American Sanitary Conference, Bogotá, 1938 ("Actas," p. 813. J. A. Montalván).

¹¹ *Bol. Of. San. Pan.*, May 1940, p. 439.

¹² *Op. cit.*, p. 6.

¹³ Miño (*op. cit.*, p. 15) observed that the disease seems never to have appeared in Puerto Bolívar, a port between Santa Rosa and Guayaquil. However, Puerto Bolívar would appear to be the port for Machala (4 miles distant), and a suspicious epizootic seems to have occurred in that area. There was apparently no confirmation of the epizootic or of its nature, however.

In the Province of Manabí, the ports of Manta 1913-1916, 1936-1937; Bahía de Caráquez, 1913-1914, 1936-37; and Cayo, 1918-19 were infected, and the disease spread from Manta by rail to the capital, Portoviejo,¹⁴ 1916-18, and then to Rocafuerte, 1916-18, Montecristi, 1918-19, Jipijapa, 1918-1923, Santa Ana, 1918-23, Río Chico, 1918-19, and Abdon-Calderón, 1915-17.

From Guayaquil, plague spread inland via the Guayaquil and Quito Railroad, and from its stations to other points. The railway terminus is at Durán, across the river from Guayaquil, reached by ferry, and it is interesting to note that the disease did not appear in Durán until 1912, although it had reached towns further inland along the railroad. Yaguachi, Milagro, and Huigra were invaded in 1909, the first cases appearing among persons living near the station. Yaguachi and Milagro and other lowland towns have a climate similar to that of Guayaquil, although both rainfall and temperature are higher. Sugar cane is raised in the Yaguachi area. Huigra, first of the mountain towns to be invaded, is in the Province of Chimborazo, in the foothills (altitude about 3,900 ft., average temperature about 68 F, with fairly warm days and cool nights) and is drier than Guayaquil. Epizootics have consistently been noted in connection with outbreaks, especially in the vicinity of the railway station, where merchandise is stored awaiting transportation to the southern provinces by muleback. In 1909 the Indian *caserío* or hamlet of Tolte (altitude higher; temperature 53.6 F), which maintained commercial relations with Huigra, was stricken by plague, and it is thought that the contagion was man-to-man, by means of *P. irritans*.¹⁵ The mortality was 70%.

In 1912 and 1913 plague appeared in Durán and Naranjito, in the lowlands. It appeared in Milagro at various times, during January-April, until 1929.

The rest of the plague in Central Ecuador concerns the mountains. It appeared in various towns along the Guayaquil and Quito Railroad (Huigra, 1909, 1913, 1916-17; Chunchi; Sibambé, 1922, 1936-37; Alausí, 1913, 1916-17, 1928-29, 1932, 1939; all in Chimborazo Province; Ambato, in Tungurahua, 1916-17, 1919, 1923, 1926; and Quito, in Pichincha, rat infection, 1926, no human cases) and spread to neighboring towns and Indian villages. In many instances, no evidence of rats could be found in these villages, and every evidence of man-to-man contagion through the human flea. Some epidemics were preceded by epizootics among the guinea pigs kept in the house for food, and in 1939, dead rabbits had been implicated. (See below.) Typical rat epizootics occurred in the railway towns. Riobamba, Chimborazo, although located on a branch railway line, does not seem to have been infected by that means, although it has suffered epidemics due to imported cases (10 cases, Nov. 1929, among relatives of a case from Pungalá; 16 fatal cases pneumonic plague in 1938, the original infection from Alausí). Latacunga, in León, also on the railway, has not had plague,

¹⁴ The Public Health Delegate, Dr. Sáenz, observed in 1937 that the last general epidemic of plague in the Portoviejo area was in 1919 when around 70 persons were said to have died of pneumonic plague, and bubonic cases also occurred. Since then there had been reports of deaths from a plague-like disease among dwellers in the mountains, the cases being without medical attention. (Report of Dr. Henry Hanson, January 17, 1937, to Pan American Sanitary Bureau. There seem to be no official records of this information.)

¹⁵ Miño, *supra*, p. 8. This would be one of the earliest records of such infection.

although it has appeared in the Guaitacama and Guanailín areas. Suárez recorded 741 cases 445 deaths of plague for Chimborazo 1913-1939;¹⁶ and Miño estimated the number of cases 1909-1933 at 1,060.¹⁷ In 1933 systematic inspections were being made of 94 old plague foci in that Province.¹⁸ Miño in 1933 estimated that 187 cases had occurred in Tungurahua from 1916-1929, and 68 in León (Guaitacama and Guainailín) in 1926 and 1929.¹⁷ The only plague in Pichincha seems to have been a rat infection observed in Quito in April and May 1926 and June-July 1927. In the latter period two infected rats were found in warehouses where merchandise from the coast was stored.¹⁹ No plague was reported from the Province of Cañar until 1933, when 45 cases, 31 deaths occurred in *Sitio* Quilloag.²⁰

Southern Zone.²¹—The Province of Loja maintains a constant interchange with Peru, by means of the port of Paita and the towns of Piura and Sullana (Peru). There are indications that plague invaded this province (locality of Casaderos) about 1919, but no cases were confirmed bacteriologically until 1921 (Alamor, Tambillo, Manga-hurco). In 1923 the *cantón* Celica was invaded; in 1925, *cantón* Paítas and the city of Catacocha. In 1925 also there was a severe plague epidemic in the Ayabaca area, Peru, which crossed the border giving rise to cases in Calvas. Until recently it was believed that rats played little, if any part in Loja plague, a number of observers testifying to the absence of that animal; but in March, 1935, A. Ramos Díaz of the Lima Plague Laboratory was sent to Ecuador by the Pan American Sanitary Bureau (under the cooperative control campaign arranged by Peru and Ecuador) to investigate suspicious cases. He not only was able to confirm the existence of plague, but also found a plague-infected rat.²² In 1939 Sáenz Vera found evidence indicating a reservoir of plague among Loja rats living in a wild state.²³ (See below.) Miño estimated that around 990 cases had occurred in Loja from 1921-1933. At least 400 must have occurred since then. There were 285 from March-Dec. 1939.

Characteristics of mountain plague.—Climatologically, the central and southern mountain area of Ecuador may be divided into two zones: first, that including the Province of Pichincha and parts of that of Carchi, the *hoyas* (valleys) of Guaranda, Alausí, Yunguilla, Cañar and Azuay, and all of the Province of Loja except the Zamora and San Lucas Valleys; and secondly, the region including

¹⁶ Suárez, Pablo Arturo: La peste en la provincia de Chimborazo, *El Comercio*, Quito, Apr. 25, 1939, p. 8; *Bol. Of. San. Pan.*, Nov. 1939, p. 1072.

¹⁷ Miño, *op. cit.*, p. 64.

¹⁸ *Bol. Of. San. Pan.*, Feb. 1935, p. 104. (Mosquera, A.: La sanidad en el Ecuador.)

¹⁹ Suárez, P. A.: "Algunas observaciones sobre la peste negra y la pulga cheopis en el Ecuador," Quito, 1927, p. 10.

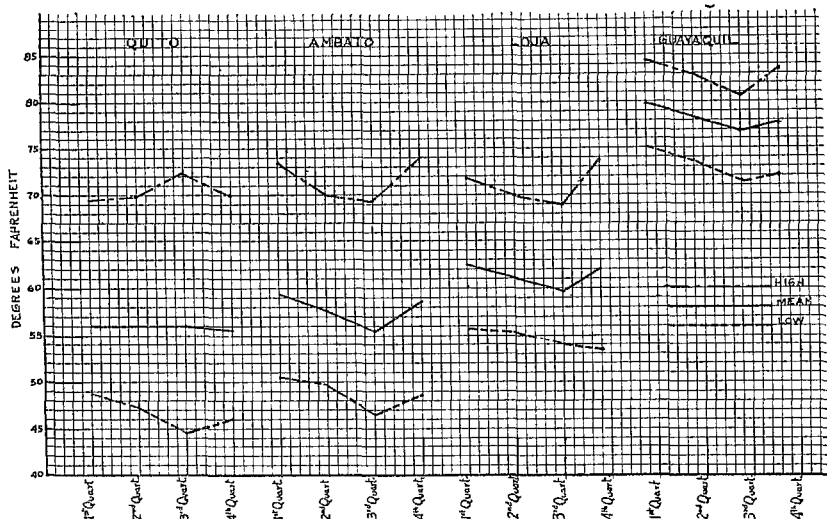
²⁰ Miño, *op. cit.*, pp. 18, 65.

²¹ While the Province of Cañar (combined administratively with Azuay) is included in reports of the Southern Zone, its plague seems to be related to Chimborazo. One report stated that the Quilloag infection was brought in by an ambulant vendor resident there who had gone to Achupallas (Alausí area) on business and returned with some clothing from a house in which the inhabitants had died about a month previously. (Miño, *supra*; and *Bol. Of. San. Pan.*, Jul. 1935, p. 623.)

²² Letter from Dr. J. D. Long to Pan American Sanitary Bureau, April 8, 1935.

²³ Sáenz Vera, C.: La peste en la Provincia de Loja, *Bol. Of. San. Pan.*, Jul. 1940, p. 661.

the Provinces of León and Tungurahua, the valley of Tulcán and perhaps Bolívar, in the Province of Carchi; all of Chimborazo excepting Alausí; the valley of the Paute (forming part of Azuay and Cañar); and the Zamora and San Lucas Valleys of Loja. The first-named area is characterized by a dry season from June to September with no rain, cloudless skies, rapid evaporation, cold nights and mornings but hot days so that average temperatures remain the same as other months; toward the end of September rains begin, humidity increases, minimum temperatures rise and maximums drop, the average remaining constant; from



Graph showing temperature fluctuations, by quarters, in Quito (Pichincha Climatological Area), Ambato (Tungurahua), Loja City (Zamora Valley), and Guayaquil (Lowlands, port). Quito, Ambato, and Loja, 1930-1931; Guayaquil, 1927-1929. Based on data from Martínez and Eskey.

December to March the weather is about the same; from March to June there is slightly more rain and the humidity is higher. In the second region the picture is much different: from June to September the sky is always cloudy, the sun often invisible, cold rains are frequent, but usually a slight drizzle; humidity is very high, the average temperature drops so low that it is intensely cold even at noon and in the most sheltered valleys. In September, haze and humidity decrease, evaporation becomes more rapid, cold winds are moderated and even become warm, rains are real showers, and the average temperature rises considerably; vegetation is springlike. From December to March the temperature continues to rise, even to hot, rains are more frequent; and from March on, humidity and cloudiness increase, rainfall is the same or higher, evaporation decreases, and in May the first snow begins to fall in the Cordillera. The average temperature in Quito during the four quarters of the year is 55 F, 55.2, 55.4, 55, yearly average 55.1; and in Ambato, 58.4 F, 57.2, 55.2, 58.6, yearly average 57.2; in Loja in 1930-31 it was 62.4 F, 61, 59.7, and 61.2, but this was a warmer year than usual.²⁴ While

²⁴ Martínez, Nicolás G.: "Estudios meteorológicos y climáticos," Observatorio de Quito, 1932. The maximum and minimum temperatures for the quarters are also given for 1930-31, in Quito, Ibarra, Guaranda, Ambato, Tulcán, Cuenca, and Loja. (Quito: 1st quarter: minimum 48.5 F; maximum 69.5; average 56; 2nd: 47, 60, 8, 56; 3d: 41.6, 72, 56; 4th: 46, 70, 55.8. Ambato: 50.2, 73.8, 59.2; 49.5, 70, 57.5; 46.4, 69.4, 55.5; 48.6, 74, 58.8. Loja, 55.9, 71.8, 62.4; 55.4, 70, 61; 54, 60, 59.7; and 53.8, 73.8, 62.) See also Eskey's

plague has appeared in both climatological areas, a few distinctions may be noted: Except for Ambato, which is on the railway line, Riobamba, which is also on the railway line, but which seems to have suffered only as the result of imported cases, Pungalá, and Loja city, where plague also seems to have been in imported cases, and the Guaitacama area of León, where plague was apparently from imported human cases and was soon eradicated, the disease seems to have occurred almost exclusively in the first of these regions, mainly from January to June, the rainy season, when temperature extremes are not so pronounced. (However, it is said that plague occurs in Indian *caseríos* at any time of the year, and it has been observed in Riobamba in November, and in September in Achupallas, a locality apparently in the Alausí area.) In most of the railroad towns it appears to be related to rats and *cheopis*, with epizootics preceding human cases. (Alausí, 1913, 30 percent of rats infected; Ambato, where plague appeared every three years 1916-1929.²⁵) Elsewhere, with the exception of the Casanga valley of Loja, the disease seems to have little connection with either rats or *cheopis*. It has appeared in localities where *cheopis* has not been found and ignored others where *cheopis* does exist, as in León, where it occurred in Guaitacama, which had rats but no *cheopis*, and failed to strike Latacunga, 15 km. away, with a *cheopis* index of 1.3.^{26, 27} Other characteristics of mountain plague include: a preference for natives and those living under poor hygienic conditions, especially persons using the same garments day and night and sleeping on the floor in contact with domestic animals, especially guinea pigs; a history of contact with sick persons or with their clothing; in some places a tendency to localize and in other very similar places, a tendency to spread to neighboring areas (especially where the commercial traffic permits free hospitality and a long stay of the infected transient in contact with other persons); an incubation period of as many as 15 days; predominant form bubonic, with cervical or groin localization; often an epidemic outbreak began with *angina pestosa*, and only bacteriological examination revealed its true nature.²⁸

One of the first mountain outbreaks in which rats seemed to play no part was that in the *caserío* Nizac, Chimborazo (average temperature about 53.6 F), about 1914, which formed a very resistant focus until 1930. The epidemic outbreaks were preceded by an epizootic among guinea pigs without any rat mortality having been proven in any case, the Indians stating that rats are seldom found there.

Table 5 (*Pub. Health Rep.*, Sept. 12, 1930, p. 2176) giving monthly averages for temperature and rainfall in Ambato and Quito over 14 years. He has noted that altitude and temperature are not necessarily related, for both Riobamba (on a plateau) and Latacunga are lower than Quito, but are colder; and Guamate, 1,000 feet higher than Riobamba, has a very similar climate. Riobamba has less rainfall than Quito or Ambato; Quito has more rain than Ambato but seems to have a lower humidity. (*Pub. Health Rep.*, Sept. 5, 1930, pp. 2084-2087.)

²⁵ Miño seems to have predicted the invasion of Ambato, stating that that city would be infected before Riobamba, inasmuch as freight trains from Durán went directly to Ambato without entering the other city and remained there long enough for rats to leave the trains. (Miño, *supra*, p. 10, citing his 1913 report.)

²⁶ Suárez, "Algunas observaciones, etc.," p. 14.

²⁷ In regard to *cheopis* in the mountains, Eskey's suggestion may be mentioned: that mean temperatures play little part in determining the survival and reproduction of *cheopis*, and that if mean *high* temperatures did not reach 70 F, the flea would not be found in a locality. In Ambato and Quito, with only about 2° difference in mean temperatures, it was found that *cheopis* just manages to exist, and possibly reproduce a little in certain months; in Quito it reaches its highest incidence in September and October, when the mean high temperature is 70 or over, although the mean temperature is lower than that of Ambato during the same months and the *cheopis* index has fallen in that city. *Cheopis* seems to reproduce during part of the year at least in Alausí and Ambato. The plague epidemics occur when the *cheopis* index is highest; it begins to fall in June in Ambato when the mean *high* temperature drops below 70. (*Pub. Health Rep.*, Sept. 5, 1930, p. 2091. His observations on Ecuadorean fleas and rats will be cited at greater length below.)

²⁸ Suárez, *supra*, pp. 10-11.

In addition to those in the Alausí zone, similar outbreaks have occurred in the Achupallas region (altitude 7,800 ft.; av. temp. 50.0 F), Guamote (10,000 ft., 1918-1932, some 20 foci) and Pungalá (9,500 ft., av. temp. 54 F, 1927, 1932).²⁹ In May, 1939, Sáenz made a series of investigations in connection with Chimborazo plague, and was unable to find any evidence of infected rats in eight localities (Aguayzate, Casaguaico, Licto, Pungalá, Quimiag, Cajabamba, Columbe and Guamote), nor could any rats be caught, but the Aguayzate outbreak had been preceded by an epizootic of guinea pigs (*cobayos*), 12 of them dying in the house of the first case and the first 3 dead guinea pigs were used as food. In the previous March there had been a big guinea pig epizootic in Casaguaico, over 90 animals dying, and the Aguayzate epizootic was thought to have been carried by some guinea pigs brought from Casaguaico. In February, 1938, two plague-infected wild rabbits (*conejos*) had been found dead in the fields at the time of the Puculpala epidemic; and it was stated that the finding of dead rabbits is not unusual and that they are full of fleas, and are used as food by the Indians when found dead.³⁰

The situation in the Casanga valley (including the *sitios* of Colangue, Cofradía, Palo Montón, Guimina, La Florida, Playas, Yamana, Opoluca, San Antonio, La Condamina, Almendrales and others) in the Province of Loja, differs from that in Chimborazo. The valley has a milder climate than the surrounding areas, and grows sugar corn and yucca on a large scale. It has long been a plague focus. Investigating the area in September and October 1939, Sáenz Vera and Murdock learned that the fields of Loja, especially the lower areas, are infested by rats in large numbers (with an unusual increase in 1939); that these have their burrows at a short distance from dwellings; that plague outbreaks in the region have always been preceded by an epizootic among the rats, followed by one among domestic guinea pigs; that rats have often been found mingling with guinea pigs; and that rats are not common in the towns. The prevailing species seemed to be *norvegicus* and *alexandrinus*. No evidence was found of epizootics among *ardillas* (squirrels) or wild rabbits (*conejos*). It was thought that plague might be transmitted to man both by contact with rats (workers in the fields) and through the intervention of the *cuy* (guinea pig). Another interesting observation was the report of great mortality among monkeys (*monos*) from time to time in the Alamor area, preceded by rat epizootics, and characterized by gland swellings in the dead monkeys.³¹ (See below.)

(To be continued)

²⁹ Miño, *supra*, pp. 8-14; and Eskey. In June 1932, Drs. J. D. Long, Traveling Representative, Pan American Sanitary Bureau, and J. Illingworth Icaza, Director of Public Health on the Coast, made an inspection of the work in Chimborazo, visiting Riobamba and Quintul, and after considerable investigation decided that the rat did not seem to be a carrier in that area. (Miño, *supra*, p. 13-14.)

³⁰ Sáenz Vera, C.: Brote de Peste en la Provincia de Chimborazo, *Bol. Of. San. Pan.*, Jan. 1940, p. 40.

³¹ Sáenz Vera, C.: La peste en la Provincia de Loja, *Bol. Of. San. Pan.*, Jul. 1940, p. 681. He has noted the possible relation between plague in wild animals and the greater frequency of the pneumonic type in the mountains; the colder weather also being a factor. See below, Pneumonic plague. Long (Letter to Pan American Sanitary Bureau, April 8, 1935) observed that the rats live in fields, gardens, and tagua trees, where they build nests.