PLAGUE IN THE AMERICAS (*Continued*)*

VII. PERU

Peru was the first country on the West Coast of South America to be invaded by plague.

The republic lies between 69 and 81° West Long. and 3 and 19° South Lat. It has an area of some 482,275 square miles and a population estimated at six millions, about two-thirds of it Indian. The country may be divided into three geographical regions: a narrow coastal strip, rainless, but intersected by fertile, irrigated river valleys; the Sierra or Andean region, with an average height of 12,000 feet, and the Montaña, or eastern, forested lowlands. Unanue, the great Peruvian medical writer and climatological observer, divided the climate into four zones in relation to altitude: the warm, or ardent, running from the sea-level plains to 4,000 feet, with a temperature of from 16 to 24 C (60.8–75.2 F), average 20 C (68.0 F); the temperate, from 4,000 to 12,000 feet, with a temperature from 9 to 16 C (48.2–60.8 F) average 13 C (55.4 F); the cold, from 12,000 to 15,000 feet, average temperature as low as 4 C (39.2 F), with poor and dwarf vegetation; and the glacial zone, from 15,000 to 21,000 feet.[1] The eastern Amazon area is very hot. There is practically no rain on the coast, except at Tumbes, but the heat is moderated by the Humboldt current, and at times in the winter, when heavy fogs come in from the ocean, the coast is cool. The dry season is from November to April, the wet season, from May to October. Summer months are January through March; winter, July through September. At Lima the coldest mean winter temperature is rarely below 58 F; the highest mean summer temperature was 79 F, in an abnormal year; it usually runs between 70 and 75 F. The mean minimum temperatures of Lambayeque, winter and summer, are practically the same as those of Lima; but the maximum winter temperatures are about 10 degrees higher at Lambayeque. The mean relative humidity is high along the entire Peruvian coast; between Lima and Lambayeque it seldom falls below 80 mm.[2]

Of Peru's 20 Departments and 114 Provinces, 10 Departments (including 37 Provinces) and the three special Provinces[3] of Tumbes, Callao, and Moquegua, have been invaded by plague. None of the coastal Departments has escaped infection. The worst hit have been Lambayeque, Libertad, and Lima, on the coast, and inland Cajamarca. The nine major seaports (Callao, Pisco, Mollendo, Pacasmayo, Paita, Salaverry, Eten, Ilo, and Pimentel[4]), 14 minor seaports, and 13 "caletas"

* See General Review.

[1] Unanue, Hipólito: "Observaciones sobre el clima de Lima y su influencia en los seres organizados, en especial el hombre," 1806, 4th ed., 1914, pp. 12–13. (This is one of the outstanding contributions to American medicine.) Unanue applied to the Andes the words of the Arabian poets: "Her head crowned with winter, her shoulders mantled with spring; autumn resting on her breast, and at her feet, the summer sleeping."

[2] Eskey, C. R.: "Epidemiological Study of Plague in Peru, with observations on the Anti-plague Campaign and Laboratory Work," September, 1931. MS, files U. S. Public Health Service. (A summary of this paper appeared in *Pub. Health Rep.*, Nov. 18, 1932, p. 2191. References here are to the original paper unless otherwise specified.) For medical geography of Peru by Provinces, see Lorente, S., & Flores Córdova, R.: "Estudios sobre geografía médica y patológica del Perú," Lima, 1925, an interesting, if incomplete, monograph.

[3] "Constitutional" provinces not incorporated in Departments.

[4] According to Eskey, this was a minor port until about 1926.

or small harbors used by coasting vessels, have had plague at some time or another, though it rapidly disappeared from most of them.

TABLE A.—*Dates of Plague Infection in Peru by Departments, Maritime and Inland Provinces, and Major and Minor Ports.*[1]

Departments and Special Provinces

Tumbes (Province, coast): 1909-1940
Piura (coast): 1904-1940
Lambayeque (coast): 1904-1940
Libertad (coast): 1903-1940
Ancash (coast): 1909-1939
Lima (coast): 1903-1940
Callao (Province, coast): 1903-1936
Ica (coast): 1903-1927
Arequipa (coast): 1903-1936
Moquegua (Province, coast): 1909-1919
Tacna[2] (coast): 1904-1927 (?)
Cajamarca (inland): 1905-1940
Junín (inland): 1911-1926

Coastal Provinces

Tumbes: 1909, 1915, 1922, 1940
Paita (Piura): 1904-1909, 1911-13, 1916, 1918-24, 1928-29
Piura (Piura): 1906-23
Lambayeque (Lambayeque): 1904-24, 1926-34, 1936-37, 1940
Chiclayo (Lambayeque): 1904-40
Pacasmayo (Libertad): 1903-40
Trujillo (Libertad): 1904-40
Santa (Ancash): 1909, 1911-27, 1930, 1933, 1935, 1937
Chancay (Lima): 1909, 1918-40
Lima (Lima): 1903-40
Cañete (Lima): 1918-19, 1921-40
Callao: 1903-31, 1933-36
Chincha (Ica): 1924, 1926
Pisco (Ica): 1903, 1906, 1908, 1912
Ica (Ica): 1912, 1926-27
Camaná (Arequipa): 1909-10, 1920, 1929, 1936
Islay (Arequipa): 1903, 1905-17, 1920-24, 1926, 1928-29
Moquegua: 1909, 1919

Inland Provinces (Mostly Mountainous)

Ayabaca (Piura): 1922-29, 1931-32, 1935, 1938-40
Huancabamba (Piura): 1920, 1923-24, 1926-31, 1933-34, 1936-40
Sullana (Piura): 1908, 1912, 1916, 1918-24, 1939
Cutervo (Cajamarca): 1913, 1920-23, 1926, 1937
Chota (Cajamarca): 1909-11, 1913, 1918, 1920-22, 1925-26, 1928-29, 1939
Hualgayoc (Cajamarca): 1906, 1908, 1916, 1921-23, 1926, 1928, 1930-31, 1934-35, 1939-40
Cajamarca (Cajamarca): 1905, 1918, 1921-27
Cajabamba (Cajamarca): 1940
Contumaza (Cajamarca): 1909, 1912, 1914, 1918-21, 1926, 1936, 1940
Otuzco (Libertad): 1906, 1908, 1914, 1918, 1920, 1926-27, 1930-31, 1934-36
Huamachuco (Libertad): 1908, 1914
Santiago de Chico (Libertad): 1915
Pataz (Libertad): 1910
Huaylas (Ancash): 1926
Yungay (Ancash): 1911, 1915
Huaras (Ancash): 1922, 1926
Bolognesi (Ancash): 1926-28
Cajatambo (Lima): 1925, 1930
Canta (Lima): 1915, 1919, 1926-27, 1934
Huarochiri (Lima): 1907-9, 1911-12, 1914, 1920
Yauli (Junín): 1918
Huancayo (Junín): 1911, 1926[3]

Major Seaports

Paita (Piura): Apr. 28, 1904-1920, 1922, 1926-30
Pimentel (Lambayeque): 1907, 1914, 1917, 1920, 1928-29
Puerto Eten (Lambayeque): Sept., 1904-1912, 1914, 1916, 1918-20, 1927-28, 1930, 1933
Pacasmayo (Libertad): Aug. 1903-1920, 1922, 1926-30, 1937
Salaverry (Libertad): June 27, 1904, 1906-9, 1911-24, 1926, 1929-30, 1934, 1940 (rats)
Callao (Callao): Apr. 28, 1903-1931, 1933-36, 1940
Pisco (Ica): Apr. 28, 1903, 1906, 1908, 1912
Mollendo (Arequipa): July 26, 1903, 1905-17, 1919-24, 1926, 1928-29
Ilo (Moquegua): 1909, 1919

Minor Seaports

Tumbes (Tumbes): 1909, 1915, 1922, 1940
Talara (Piura): 1921-22
Huanchaco (Libertad): 1905-14, 1919, 1923, 1929, 1932-33
Chimbote (Ancash): 1908, 1912-13, 1920 21, 1927, 1933
Samanco (Ancash): 1921
Casma (Ancash): 1913-25, 1930, 1935
Huarmey (Ancash): 1916, 1919, 1922-24, 1930
Supe (Lima): 1921, 1925-26, 1930-31
Huacho (Lima): 1918-23, 1926-31, 1933-35, 1940
Chancay (Lima): 1919-20, 1922-26, 1928
Ancón (Lima): 1907, 1912, 1915, 1919, 1922, 1926
Cerro Azul (Lima): 1907, 1924, 1938
Lomas (Arequipa): 1907-08
Chala (Arequipa): 1907, 1920

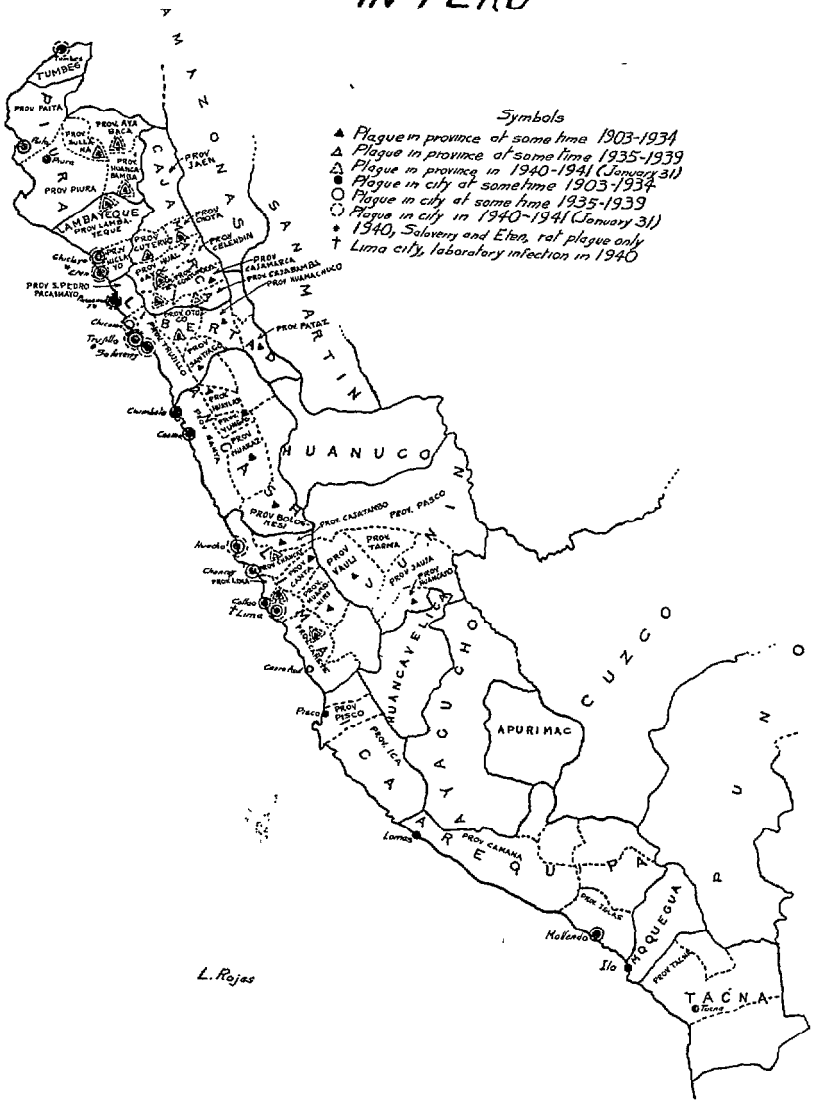
Caletas, or small local harbors, not visited by seagoing vessels

Lobitos (Piura): Infected 1921, had plague 1 year
Colón (Piura): 1916, 3 years
Sechura (Piura): 1912, 3 years
San José (Lambayeque): 1908, 9 years; 1931
Malabrigo (Libertad): 1907, 5 years
Chicama (Libertad): 1907, 4 years; 1931, 1940
Huamán (Libertad): 1922, 2 years; 1935
Guanape (Libertad): 1908, 1 year
Santa (Ancash): 1920, 2 years
Lurín (Lima): 1915, 5 years
Chilca (Lima): 1918, 8 years
Mala (Lima): 1919, 6 years; 1932-33, 1936, 1940
Mejía (Arequipa): 1905, 1 year

[1] Data to 1930 from Eskey's tables. (MS report, September, 1931, *supra.*) The Departments, Ports, Provinces, are arranged in order from North to South. Figures since 1930 have been compiled from various sources and are probably incomplete, since reports were not always made by town and province.
[2] Formerly part of Chile. See Chile.
[3] Pneumonic plague epidemic originating in a case from Lima.

(See Table A.) Seven of the major ports were infected within the first 18 months following the original invasion.

MAP SHOWING PLAGUE PREVALENCE IN PERU



Peru has the unhappy distinction of having had more plague than any other American country, and no plague-free years since its introduction. In all, some 21,348 cases in over 630 localities are estimated to have occurred from 1903–1940.[5] The disease reached its height in 1908, with 1,691 cases in 53 foci, and there was a second peak in 1926, with 1,200 cases in 66 foci, following heavy rains and floods of the previous year.[6] It seems to have appeared in "irregularly spaced waves of increased incidence with a tendency for each successive wave to be of less severity,"[7] and over the whole period the annual *number* of cases has decreased notably (from some 743 cases per year in 1903–31 to 116 per year in 1931–1940 following the creation of the Peruvian Antiplague Service and the beginning of the cooperative control campaign with the Pan American Sanitary Bureau[8]). There has been little reduction in the total number of foci, since the eradication of the disease from old coastal plague-spots has been balanced by its appearance in new rural or mountain areas. (See Table B.) From 1903 to 1930, 88% of Peruvian plague occurred in the coastal privinces;[9] in 1939, 66% of the cases and 60% of the foci were in that area.[10]

Plague appeared in Peru in 1903, attacking Pisco and Callao at almost the same time. The first diagnosis seems to have been made in Pisco, May 5, in a customs-house worker first seen May 3. Subsequent investigation revealed a suspicious death May 1, and an apparently mild case before that, both in customs-house employees. Dead rats were found on the customs-house premises during the latter part of April.[11]

[5] From 1903–1934, some 20,582 cases occurred in 630 foci. (Long, J. D.: "La peste bubónica en la costa occidental de Sudamérica en 1934," *Bol. Of. San. Pan.*, Jul. 1935, p. 617.) In 1935 there were 103 cases in 27 foci; in 1936, 152 in 57; 1937, 141 in 55; 1938, 59 in 29; 1939, 130 in 49; and 1940, 181 cases in 49 foci. Figures for 1941 are running far below 1940 and 1939.

[6] It was believed that the rains forced infected animals to seek shelter in populated centers, and also concentrated them, thus producing the larger human incidence. The disease was more prevalent among isolated communities in regions where plague occurs among field rats, than in ports and large towns. (Eskey: MS. See Note 2.) This was the largest number of foci ever reported.

[7] Eskey, cited in "An. Rep. Pan Amer. San. Bur.," 1932, p. 18. He observed that the initial epidemics have usually been more severe than those occurring later in the same communities, with the exception of Callao and Lima, where the original epidemics were mild and the later ones severe; and that there has been a tendency toward voluntary disappearance of plague in communities where the initial epidemics were very severe. Reinfection accounted for the continued presence of the disease in many places. He also reported that by the end of the first 12 years of plague the number of cases had dropped to about half the number reported per year before that time, and at the end of the second 12 years (1927), it again fell to half the number of cases during the immediately preceding 12 years. (Eskey: MS.)

[8] The Peruvian Antiplague Service was created in 1929, placed on a permanent basis October 1930, and began functioning effectively by 1931. (Dirección General de Salubridad: "Decreto Supremo creando el Servicio Nacional Antipestoso," Lima, 1929; Mostajo, B.: "Peste bubónica en el Perú," report for 1939, Files of Pan American Sanitary Bureau.) The cooperative control campaign carried on by the Peruvian authorities and the Pan American Sanitary Bureau began in 1930. (See Below.)

[9] Eskey: MS.

[10] Mostajo: *supra*, Note 8.

[11] Artola, M. R.; Arce, J., & Lavorería, D. E.: "La peste bubónica," 1903, p. 42. Diagnosis by Dr. E. Mestanza. See also: Mestanza, E.: "Peste," *Ref. Méd.*, Nov. 15, 1940, p. 711. His first diagnosis was malaria, then typhoid, but on finding the swollen glands he began to think of plague, a disease then unknown on the West Coast. The infected houses and customs house were burned, at his order, and no further cases appeared. On October 5, 1939, a special meeting of the Peruvian Medical Association was held in honor of Dr. Mestanza, at which he recalled his experience.

The first known patient in Callao[12] fell ill April 28, and the plague diagnosis was made in another case May 7. There were 10 cases of a

TABLE B.—*Total Number of Cases of Plague Reported Annually in Peru from 1903 to 1940. Listed by Departments from North to South; And Number of Towns Reported Infected each Year.*[a]

Year	Dept. of Piura and Prov. of Tumbes	Dept. of Lambayeque	Dept. of Cajamarca (Mountainous)	Dept. of Libertad	Dept. of Ancash	Dept. of Junin (Mountainous)	Dept. of Lima and Prov. of Callao	Dept. of Ica	Dept. of Arequipa	Prov. of Moquegua	Total Cases of Plague reported	Number of towns and villages reported infected
1903				75			42	4	51		172	6
1904	174	123		238			405				940	12
1905	80	208	14	170			157		146		775	18
1906	85	61	19	305			118	1	52		641	22
1907	267	146		492			243		22		1170	44
1908	180	270	20	880			310	1	30		1691	53
1909	70	226	198	231	2		222		44	6	999	41
1910	49	204	4	285			121		43		706	27
1911	93	121	18	313	40	14	221		59		879	36
1912	206	122	33	325	15		115	15	61		892	35
1913	24	259	29	302	25		188		42		869	33
1914	94	107	16	334	34		120		54		759	34
1915	56	102		123	8		143		23		455	31
1916	78	90	2	129	62		125		24		510	34
1917	14	19		213	5		124		39		414	27
1918	171	67	23	391	10	1	162				825	49
1919	128	25	12	211	16		214		47	1	654	47
1920	204	53	39	174	23		214		51		758	45
1921	205	49	125	142	55		286		12		874	48
1922	90	75	205	129	40		251		14		804	53
1923	162	78	138	185	6		309		2		880	48
1924	35	13	29	48	38		244	3	8		418	30
1925	29	78	61	58	7		311				544	24
1926	124	82	308	156	120	21	325	55	9		1200	66
1927	15	11	31	54	7		174	1			293	38
1928	170	13	8	76	3		90		1		361	29
1929	38	36	9	107			102		19		311	40
1930	11	35	8	178	4		142				378	45
1931[b]	10	22	14	24			34				200	53
1932[b]	1	9		14			34				57	33
1933[b]	3	23		18	2		63				107	58
1934[b]	5	9	2	12			18				46	31
1935[b]	1	5	3	23	2		57				103	27
1936[b]	7	16	9	63			52		6		152	57
1937[b]	27	15	1	51	3		39				141	55
1938	0	5	1	11	0	0	42	0	0	0	59	29
1939	33	12	10	35	1	0	39	0	0		130	49
1940	27	15	29	52			57				181	49

[a] Figures from 1903-1930 from Eskey's table. (See Note 2, Text.)

[b] Figures 1931-1937 for Departments compiled from preliminary and sometimes incomplete reports. Total cases and number of foci from yearly summary of the Peruvian Antiplague Service, in most instances.

suspicious illness among the workers of the Santa Rosa flour mill, Callao, from April 28 to May 7; four of the patients died suddenly and two after

[12] Artola *et. al.*: *supra.* According to J. F. Martínez, the first clinical diagnosis of plague in Peru was made by a 6th year medical student, Luis Oscar Romero, in the Guadalupe Hospital, Callao. After making the clinical diagnosis, Romero demonstrated the presence of the plague bacillus by the microscope, and made guinea pig inoculations . . . only to have not only the guinea pigs, but also his microscope, incinerated in the name of sanitation. He was finally reimbursed for the cost of the instrument. (Martínez, J. F.: "Acotaciones sobre medicina e higiene en el Callao," 1939, p. 134.) Bacteriological confirmation of both Callao and Pisco cases was obtained.

an illness of two or three weeks (60% mortality). Unusual numbers of dead rats were reported in the mill and in other parts of the city. The occurrence of two mild, non-fatal cases of a disease suggesting plague, in February or March, in the railroad station area, has already been mentioned.[13]

The origin of Peruvian plague remains a mystery. The Committee which studied the original epidemics at the instance of the Academy of Medicine[14] did not hazard a guess as to the source, although some of its members apparently had their private theories.[15] Castañeda suggested that the *Serapis*, from Bangkok, which left rice in Callao and Pisco in December, was the most likely of several vessels which he named,[16] and others have considered the *Amasis*, a German steamer out of San Francisco, which arrived in Callao in February after having been in quarantine in various ports, as the means of importation.[17]

[13] See General Review.

[14] Artola, *et al.*: *supra*, p. 66. They did suggest that the importation was possibly through sick rats from a vessel rather than from contaminated merchandise, for the reason that during the period when dead rats were being found at the mill, they were also seen in various other places in Callao, and also that during the month of May the number of rats in Callao decreased notably, the animals disappearing entirely from some of their former haunts—apparently fleeing the infected areas.

[15] Dr. Arce is recalled as expressing the verbal opinion (1904) that plague was probably brought to Callao by a steamer which carried jute bags from India, although he admitted that it may have been introduced some other way. (Personal recollections of Dr. B. J. Lloyd, from unpublished memoranda in the files of the Pan American Sanitary Bureau.) Dr. Lavorería, of the Committee, was a member of the Peruvian delegation which informed the II International Conference of American States (October, 1905) that, while the origin of Peruvian plague was unknown, it was "very possible that plague came to Peru in a cargo of rice and wheat left by a German steamer in various Peruvian and Chilean ports." ("Transactions," 1905, p. 176.) Mr. Milne, owner of the mill, is said to have attributed the infection to a cargo of wheat on a vessel from Australia. (Personal recollections of Dr. Lloyd.) Dr. Lloyd's finding of plague-infected rats on a steamer while en route to Peru in April, 1904, and the reported presence of dead rats on a sister ship a year previously, have already been cited. (See Ecuador, Note 3.) The master of a German steamer also informed Dr. Lloyd that rats had died on board his vessel for several weeks, without any human illness occurring, about a year before the doctor arrived in Peru. In view of such circumstances, Dr. Lloyd in 1904 expressed the opinion that plague had been carried up and down the West Coast "by infected rats on merchant vessels for an indefinite period, certainly for more than a year." (*Pub. Health Rep.*, May 27, 1904.)

[16] Castañeda, A.: "La peste bubónica en el Callao en Abril de 1903," *Crón. Méd.*, Lima, Jan. 31, 1903, p. 13, and following issues. See also General Review.

[17] Mestanza said that the *Amasis* arrived in Pisco in March, from San Francisco and Callao, carrying wood, conserved food products, jams, dried fruit, etc. She had not been received at Salaverry because she has touched at Mazatlán, where plague was present. He observed that if the *Amasis* were the carrier of the infection to Callao, it could have been brought on to Pisco either by the same vessel, the rats coming ashore in cargo or swimming, or by sick rats in cargo directly from Callao. (*Ref. Méd.*, Nov. 15, 1940, p. 711.) Other statements include those of the U. S. Minister at Lima, May 12, 1903: "the germs of the disease are alleged to have been brought either from India in a cargo of rice or from Australia in a cargo of wheat, both of which were imported for the mill," (*Pub. Health Rep.*, June 12, 1903, p. 939); of C. E. Paz Soldán ("La Sanidad Pública en el Peru," presented at the VI Pan American Sanitary Conference, 1920, p. 26) that Mazatlán and Australia were among the possible sources; and of the Peruvian delegation to the VIII Pan American Sanitary Conference, which implicated "a vessel from Australia with a cargo of flour," (Dep. de Sanidad Púb.: "La Sanidad Pública—Perú ante la VIII Conferencia Sanitaria Panamericana," 1927, p. 42.) The U. S. Vice-Consul at Callao reported that the outbreak in the flour mill occurred among laborers engaged during the night in cleaning a cess-pool from which a number of dead rats were removed, the rest of the 80 mill employees being unaffected (*Pub. Health Rep.*, June 12, 1903, p. 939), but the report by Arce *et al.* (*supra*, p. 4-5) mentions the finding of dead rats in other parts of the city, as well as in the various floors and sections of the place, including the garden, and spaces under the roof, and a room in which sacks were stored.

Eskey has said: "It is possible that Pisco and Callao were infected by the same vessel, but more probable that Callao was the first port infected, and the disease spread from there up and down the coast.

Whatever its origin, plague spread rapidly along the West Coast, infecting most of the principal ports within two years,[18] and eventually reaching inland and even mountain communities. The course of the infection in Pisco and Callao was typical of the variation seen throughout Peru: the former city had but four cases in 1903, and very few thereafter (a total of 18 cases have been reported, in 1903, 1906, 1908, and 1912); whereas Callao had 33 cases in 1933, and a total of 780 cases from 1903 to 1940, only the years 1932–34, and 1937–41 being free from human plague.

According to the observations made by Eskey[19] in his epidemiological studies in connection with the cooperative plague control campaign begun by the Peruvian authorities and the Pan American Sanitary Bureau in 1930, the spread and persistence of Peruvian plague has depended principally on the rat and the nature of its harbors.[20] Cities well outside the favorable climatic zone, notably Paita and Mollendo, have suffered heavily from human plague because their wooden buildings were especially attractive to rats; Lima city, on the other hand,

---

There are several theories regarding the original source of infection, but no proof that any particular vessel was responsible." (MS report, *supra*, p. 4. See Note 2.)

[18] This rapid spread of plague by sea (even though this was the principal means of communication) is interesting in view of the fact that Callao was the only Peruvian port where vessels tied up at wharves, the cargo being handled in other ports by lighters from ships anchored in the roadstead. Lima, connected by rail with Callao, did not report any plague infection until October 6, 1903, later than the distant ports of Pacasmayo and Mollendo. This preference for the sea route was thought by Eskey to point to the rat rather than to the flea as the principal carrier. (*Pub. Health Rep.*, Nov. 18, 1932, p. 2196.) Lloyd has made some interesting observations regarding rats which indicate their ability to go places without gangplanks or cables. He once found a plague-infected rat inside a large box brought to land from a vessel. (An. Rep. U. S. Pub. Health Serv., 1915, p. 250.) At one time he was assigned to a temporary smallpox isolation camp on an island in the Behring sea, and though the island could be reached only by row-boat, at the end of two months when the camp was abandoned, an adult female rat and half a dozen young were found. On another occasion, he saw a rat jump out of an old trunk when it was opened for inspection, before being disinfected. (Unpublished personal observations of Dr. B. J. Lloyd, files of Pan American Sanitary Bureau.)

[19] See Note 2.

[20] Eskey has said that "there is no doubt that the extent of the rat infestation of buildings has determined the morbidity of plague in the different communities from north to south in Peru regardless of differences in climatic conditions." (*Pub. Health Rep.*, Nov. 18, 1932, p. 2195.

The buildings in the various ports and cities often dated from colonial times or from the early days of Independence. Those along the coast, especially in central and southern Peru were and are mainly of large sun-dried clay bricks (adobe). *Quincha* (a cane framework plastered with a thick clay and mud coating) is a modification more common in the north than in the south, and is also used for second stories where such existed. All houses except the very cheapest have a hard plaster veneer inside and out; the veneer of new or remodelled buildings is often of cement. The walls of adobe buildings do not offer very good rat harbors, though unveneered walls often have openings where rats may nest. *Quincha* buildings frequently have double walls, especially in northern Peru, affording harbors. Houses of the poorest class have no floors, and rats may burrow through the earth. In northern Peru the floors of buildings are more often elevated, because of the heavier rains, and wooden floors are more common than in the south. In Lima and Callao the floors, when raised, often rest on a solid clay base. Most of the poorer tenement houses in these two cities have cement floors; the better buildings have tile. Second story floors are rarely ceiled on their under surface. Roofs of most cheap buildings are made by placing grass or leaf thatching over cane poles and covering it with clay; the roofs are thicker in the north, and often ceiled. Ceilings are rare in the south. Frame or wooden buildings are rare except at Paita and Mollendo, where nearly all construction is of wood, and at Salaverry, where half of them are; these wooden buildings have more double walls, ceiled roofs, and similar harbors, than the adobe and *quincha* structures. (Eskey: MS report. See Note 2.) Another custom affording rat harbors was that of filling in the space under the floor with ashes to prevent dampness. (Martínez, J. F.: *supra*, p. 116.)

has had a fairly low morbidity rate despite the presence of a large *exterior* rat population and infested sewers and a more favorable climate.[21]

However, aside from the influence of rat harbors, Peruvian plague has favored certain climatic zones more than others. In the colder region south of 13°, where the average mean annual temperatures were below 65 F) the incidence was very low, except for the port of Mollendo; epidemics were mild and of short duration, and the disease soon disappeared from the few foci, all of which were near the coast. Two thirds of the ports in this region were never infected, nor were small farming communities. The extreme northern region (north of 5°, mean annual temperatures 75° or higher) was also unfavorable to plague; the disease occurred in but three of the eight seaprots, and the outbreaks were mild and of short duration. In the neighboring area between 5 and 7°, where the mean annual temperature was over 71 F, severe epidemics have occurred in the larger communities, but except for Paita and Catacaos, the average incidence per 1,000 population was not as great as further south, and the smaller communities remained free of plague.[22]

The central part of Peru, between 7 and 13° (where the mean monthly maximum temperatures of the warmer, northern part rarely exceed 85 F and the mean monthly minimum temperatures of the colder, southern part seldom fall below 55 F) and especially that between 7 and 9° (where the average annual mean temperature is from 69 to 71 F) has suffered most from plague. The disease has spread very rapidly in this area, it has been much more persistent, and the incidence of human plague, both rural and urban, has been greater than elsewhere. The disease has shown little tendency to disappear voluntarily, in contrast to the situation in the districts north and south of this region.

Climatic data are not available for the mountains, but it may be noted that no plague has been reported from the higher altitudes south of 12°, even in communities (such as Arequipa) which have direct rail communication with infected ports. While the original mountain infections were undoubtedly derived from foci on the coast, the disease seems to have become firmly established in the most northern mountain

[21] To present a clearer picture of the prevalence of plague in certain ports and cities, Eskey has estimated the average number of cases per thousand population per year, warning that the figures do not represent the actual number of cases per thousand. The index for Paita was 6.78 (highest for any port); for Mollendo, 2.71; for Lima city, 0.38. The figures for ports from north to south may be of interest, showing the generally heavier incidence in central Peru, with the exception of Paita and Mollendo: Tumbes, 0.14; Talara, 0.27; Paita, 6.78; Pimentel, 0.26; Eten, 1.34; Pacasmayo, 3.08; Huamchaco, 3.80; Salaverry, 3.38; Chimbote, 1.79; Samanco, 1.12; Casma, 1.52; Huarmey, 1.70; Supe, 2.04; Huacho, 1.48; Chancay 1.22; Ancon 0.26; Callao 0.39; Cerro Azul 0.43; Pisco 0.07; Lomas 0.87; Chala, 0.69; Mollendo, 2.71; Ilo, 0.09. (MS report, Table 9. See Note 2.) Towns not seaports, of more than 4,000 population: Sullana, 1.76; Piura, 1.27; Catacaos, 4.34; Lambayeque, 1.35; Chiclayo, 1.43; Ferreñafe, 1.51; Chepén, 0.91; S. Pedro, 4.36; Trujillo, 2.06; Ascope, 0.79; Barranca, 1.10; Lima, 0.38; Chosica, 0.74; Chincha, 1.13; Ica, 0.01. None south of Ica in towns of more than 4,000, except for the port of Mollendo. (*Ibid.*, Table 12.)

[22] These observations on plague and climate are summarized from Eskey's report. (See Note 2.) His tables were made from data furnished by the statistical division of the Peruvian health department.

provinces (Piura) and to have had no further relation to coastal epidemics, whereas south of this area, there does appear to be a relationship, with outbreaks in the mountains following flare-ups of the disease on the coast.[23] There has evidently been a connection between some outbreaks of plague in northern Peru and southern Ecuador (see Ecuador). The first cases reported from the Peruvian provinces were in 1920 (Huancabamba) and 1922 (Ayabaca) but whether these were the earliest it is impossible to determine.

The inland, mountain Department of Cajamarca has had cases in one province or another nearly every year since 1905, though the average yearly incidence per 1,000 population has not been as great as in the Piura mountains.[24] Many short, severe epidemics have occurred at altitudes of over 8 and 9,000 feet in Cajamarca Department. Contumaza province is connected by rail with infected coast towns in the Department of Libertad,[25] but most of the cases in the Department of Cajamarca and in the mountain provinces of Piura have been in isolated communities connected only by mountain trails over which freight must be carried by pack animals.[26]

The two outbreaks of plague in the Department of Junin are of interest, since both occurred in a valley less than 4,000 feet above sea level but accessible only by crossing mountains 14,000 feet high.[27]

An important focus of Peruvian plague has been the *hacienda*, an agricultural community or small village, with a floating population of from 50 to 200 persons, or, in a few instances, as many as 2,000.[28] The two chief products, both on the coast and in mountain valleys, are sugar cane and cotton. In the northern part of Peru, rice is grown. Corn is raised to some extent on all farms. South of the Department of Lima are large vineyards and orchards.

Plague invaded the *haciendas* rapidly—those in the Trujillo district were reporting cases before the city had been infected from its neighboring port (Salaverry). In the Province of Lima, the third and ninth cases of the primary epidemic were reported from haciendas several miles from Lima in opposite

[23] As in 1915–17, when plague decreased both on the coast and in the mountains of this area; 1918, when there was a flareup on the coast and the disease reappeared in the mountains; 1920–26, when it was active in both regions, and 1927, when it decreased in both. (Eskey.)

[24] To 1930. (Eskey.)

[25] However, this would not necessarily mean that all cases were traceable to these towns. An inspection trip in February, 1940, by Dr. Anthony Donovan, Traveling Representative, Pan American Sanitary Bureau, and Dr. A. Ramos Díaz of the Peruvian Antiplague Service, showed plague to be rather widespread in the Cascas and San Benito districts of Contumaza, with *Rattus alexandrinus* "the apparent reservoir." (Report of Dr. Donovan to the Pan American Sanitary Bureau, 1939-40.)

[26] Eskey: MS. Dr. J. D. Long has reported instances of possible transmission of plague by fleas carried by muleteers. See below, Fleas.

[27] Eskey: MS.

[28] The workers are housed in solid blocks or *rancherías* of small, one story adobe houses, or, in northern Peru, in dwellings built of cane. Living conditions on many haciendas are very poor, though legislative attempts at improving conditions date back many years. (Eskey, MS.) On small farms or *fundos*, the workers often live in *ranchos*, or huts with walls of poles, a clay-and-thatch roof, and earthen floor. According to Lorente and Flores C., rural hygiene legislation and the voluntary action of some property holders has greatly improved the situation in some places. ("Estudios sobre geografía," etc., *supra*, p. 78.)

directions, and within the first year and a half, 19 other haciendas were invaded. In Libertad, sugar-cane is the principal *hacienda* crop. In Lima, where crops are more varied, the greatest incidence of plague has been in the recently-infected Cañete valley, where cotton is raised (16 out of 18 *haciendas* infected within 2 years); next in order come *haciendas* growing both sugar cane and cotton (only about ¾ of these were infected, over a period of 28 years); while those raising bananas, vegetables, and dairy cattle, have had the lowest incidence of infection.[29] From a study of the statistical relationship between urban and *hacienda* plague, Eskey concluded that in certain areas (Chiclayo, Pacasmayo, Lima, Callao) plague might eventually disappear from the *haciendas* once it had been eradicated from the cities; but in others (Trujillo, Piura mountains), the rural plague seemed to persist independently of that in towns.

Reinfection.—According to Eskey, Lima and Callao were the only places "where plague was reported in 1930 that the statistics do not indicate that reinfection has occurred."[30] He expressed the belief that Chiclayo had probably been reinfected three times, Trujillo once, most of the other coastal towns at least four times, Paita probably six times. Except for the second epidemic at Mollendo, the reinfection was never as severe as the original invasion. He has observed that the invasion of new ports or reinfection of others coincided very closely with the severity of plague among the rats at Callao, as indicated by the number of human cases reported.[31]

In 1934, after studying the circumstances surrounding the increase of Peruvian plague in 1933, Drs. J. D. Long and Benjamin Mostajo[32] advanced the theory that the introduction of plague on several occasions was due to the importation of infected fleas in bales of empty jute bags from India.[33] The factors on which the theory was based included: the appearance of cases of plague in five widely scattered localities among persons who had handled freshly opened bales of jute bags (or who had been in the vicinity of such bags) which had been left at 13 Peruvian ports by the steamer *Solafric* out of Calcutta in 1933; that no plague occurred among the crew of the *Solafric* or among stevedores; that dead fleas were found inside bales of jute bags from the *Solafric*; that moths and lice which

[29] Eskey: MS.

[30] Eskey: cited in "An. Rep. Pan Amer. San. Bur.," 1932, p. 19.

[31] During 1903 and 1904 (accompanying the initial epidemic at Callao), seven seaports were reported infected; during 1905 there was a lull in the Callao epidemic and little invasion of other ports; during 1907, 1908, 1909, there was a marked increase at Callao and 12 additional seaports were invaded, and even as late as 1920 22, additional ports have been infected when plague was severe at Callao. Eskey observed that "it is believed that Callao has been the source from which plague has spread to most of the other ports because it is the only place where rats have direct access to vessels from shore." (MS, p. 47.) He also said that "the fact that plague has spread more slowly by railroads seems to warrant the conclusion that live rats which pass between vessels and the shore are more involved in the dissemination of plague than infected fleas carried in cargo as this means of infection would be equally applicable to shipments by land or sea. In case of an epizootic of plague among rats on board a vessel—a condition unlikely to occur in railway cars—both infected rats and fleas are liable to be carried ashore in cargo." (MS, p. 45.) The fact that ship-wise port rats are especially liable to seek vessels when fleeing from a severe epizootic was mentioned, together with the opinion that plague probably spreads more easily during violent outbreaks because rats will flee a violent outbreak but not always an endemic.

[32] Traveling Representative, Pan American Sanitary Bureau, and Chief of the Peruvian Antiplague Service, respectively.

[33] *Bol. Of. San. Pan.*, Nov. 1934, p. 1016. "Experiencias con pulgas como portadores de peste bubónica."

revived after being trapped for 80 to 90 days in bales of jute bags were found in recently arrived bales; that the inside temperatures of bales arrived from India within a week was so cold that the bales became damp inside from condensation of the air; that the inside temperature of bales from the *Solafric* six months after arrival in Peru were still 2° to 3° C lower than the temperature of the warehouse; that particles of cooked food were found inside the bales; that some of the bales were shipped directly to the boat from the Indian factories so that the fleas might not have died, but have entered into a state of hibernation as the vessel reached cold climates; and that the localities where plague appeared after the receipt of the jute shipments, had been free of it for from one to seven years.[34] It was pointed out that great quantities of jute bags and burlap are imported into Peru for sugar and cotton haciendas. Inasmuch as the investigations were begun several months after the arrival of the *Solafric*, it was impossible to prove whether or not live, infected fleas actually had been present in the inside of the bales of jute on their arrival, and, according to the investigators, since most bales of jute lay stored in Calcutta for several months at a warm temperature, the fleas would usually die before the cargo was ever placed on board ship; only when burlap or bags were shipped directly to the vessel from the factory, would the possibility of flea survival occur. The theory aroused much interest and discussion. (See General Review, and Chile.)

Rats (See also Table 4).—According to Eskey, *alexandrinus* and *rattus* were the predominating species in the towns of northern Peru, except Pacasmayo, where 99% were *norvegicus*. In the rural districts near Lima, *norvegicus*, *alexandrinus*, and a small, grayish field rat[35] were found. A few wild reddish-brown rats like those caught in the mountains of Ecuador were found in the mountain foot-hills.[36] *Alexan-*

[34] Hacienda La Quebrada, plague May 6 in bale handler (bales from Cerro Azul, first case for over a year); Callao, plague rats June 16 (first plague rats since Oct. 1930 except for "imported rat" Aug. 1931) and human cases Jul.-Oct. (first since May 1930); Chimbote, June 24, fatal septicemic plague in bale handler (first since 1927); Puerto Eten, June 19, infected rats in customs-house area (where bales were stored; first plague in well over a year) and guinea pig and human septicemic plague at a rice mill where jute bales had been sent from this port; Nepeña, suspicious deaths (this place had received bales from Samanco). Bales were left the last of April and first of May at Mollendo (April 27, 1933), Pisco, Cerro Azul, Tambo de Mora, Callao, Huacho, Supe, Samanco, Chimbote, Pacasmayo, Eten, Pimentel, and Paita.

Dr. Long has recalled a number of interesting observations regarding fleas, including an occurrence in Argentine, when a rat and fleas were transported in a bale from Rosario to an *hacienda* in Paraguay which had never before had plague; the development of plague in *peones* (laborers) in Iquique, Chile, who had been bitten by fleas while opening bales of empty sacks; and his own observation that fleas will burrow into blankets and not come out until stimulated by warmth. (Letter of September 18, 1933, from J. D. Long to Pan American Sanitary Bureau. The letter refers also to two large sugar *haciendas* which, in contrast to other such *haciendas* using large numbers of jute bags, were free from plague, and which, it was found, imported their sacks by way of Europe and stored them for some time; and to the fact that rice *haciendas* (which used the new sacks in order to stretch them) had more plague than rice mills, which use the sacks after they have been stretched by the unhusked grain. These were regarded as highly interesting coincidences.)

[35] Somewhat similar to *alexandrinus*; it is about the same color, has large ears, is only about ⅔ the size. Its tail is slender and about the same length as the body, lighter in color than the body, and has a fine indistinct segmented appearance. The rat has only 8 mammary glands, is not caught easily in snap traps and seldom enters a cage trap; is thought to be a kind of rice rat. (Eskey.)

[36] This may be the rodent classified by the Smithsonian Institution from specimens sent by Dr. Henry Hanson as *Sigmodon Peruanus*. These specimens were found during inspection of the antiplague work at Trujillo and Salaverry, July 15, 1937, and were characterized by short tails, plump bodies, and teeth shorter and broader than those of *norvegicus*, *alexandrinus*, or *rattus*. Fleas from these rodents were classified by A. Ramos Díaz as *Rhopalopsyllus litargus*. Similar rodents were seen in the Provinces of Huancabamba, Peru, and Loja, Ecuador. (Report of Dr. Henry Hanson, Traveling Representative, in "An. Rep. Pan Amer. San. Bur.," 1937-38, pp. 23-24.)

drinus and *rattus* were most prevalent where buildings offered the best harbors;[37] *norvegicus* bred prolifically in sewers, on the banks of irrigation ditches and rivers, garbage dumps, cotton, sugar cane and corn fields, banana plantations, vegetable patches, and orchards. Over 99% of the rats caught in sewers were *norvegicus*. Eskey remarked that "the lack of heavy rains and the moderate temperatures of Peru favor a large exterior rat population which is limited only by the food and water supply."[38]

It was observed that apparently the majority of Lima rats were born during the warm months and matured the following spring. The decreased incidence of plague in non-reinfected communities after a few years suggested a decreased susceptibility in surviving animals; the persistence of plague in communities despite a low human incidence was considered as possibly due to the presence of few rats in buildings (rendering their contacts less frequent, so that they would neither be exterminated nor be immune) and the invasion of buildings for one cause or another by sewer and other rats from exterior harbors.[39]

Mice.—In the 1903–1904 outbreak in Lima a large number of mice were reported found in infected buildings, and health officers have since often removed dead mice from the rooms occupied by plague cases. In June 1931 such a mouse was found to be plague-infected. It is thought this animal may possibly play an intermediary role between rats and humans.[40]

Wild rodents and other animals.—Plague infection among wild rodents has never been demonstrated in Peru, despite careful search.[41] The only other animal mentioned in the reports is a sick cat with swellings in its neck which was killed and incinerated when found in a Callao hotel during the 1903 outbreak.[42] There was no bacteriological examination of the cat.

Fleas (See Tables 5 and 6).—The species of fleas found in Peru are *X. cheopis*, *L. musculi*, *C. londiniensis*, *Rh. cavicola*, *Rh. litargus* (found on the grayish wild rat), *Ct. felis*, *Ech. gallinacea*, *Sternopsylla texanus* (on a bat), and *Hectopsylla* sp.[43] *X. cheopis* was the most common rat flea throughout the entire Peruvian coast area and a few were also found on guinea pigs, dogs, cats, opposums, and man. According to Eskey, "it can be reasonably concluded that *X. cheopis* is probably the only transmitting agent responsible for the continuous and severe epidemic of plague that has occurred in Peru since the introduction of the disease in 1903."[44] The only other flea considered of importance in Peruvian plague is

[37] However, Donovan found an apparent reservoir of *alexandrinus* in the rural area of Contumaza (Cajamarca). See Note 25.

[38] Eskey: *Pub. Health Rep.*, Nov. 18, 1932, p. 2195.

[39] *Ibid.*, p. 2197.

[40] Eskey: MS.

[41] Long, J. D.: "An. Rep. Pan Amer. San. Bur.," 1939–40, p. 15.

[42] Artola, *et al.*: *supra*, p. 4.

[43] Eskey: This *Hectopsylla* is said to be a different species than *H. suarezi*, though greatly resembling it. The female stays with the host after death and it is difficult to remove it without tearing off the mandibles or head. (In one instance, *Hectopsylla* remained on a dead rat for three days, ignoring a live animal which was placed with them.) The adult females were the largest fleas found in Peru; the males the smallest; there was but one male to about every 200 females. It was found only on rats (especially *norvegicus*) and guinea pigs, and more frequently on rats in buildings than others. Several rats had 50 or more, and one had 449 (with only 2 males). *Hectopsylla* attach themselves to the region about the mouth, nose, eyes, and ears.

[44] Eskey: *Pub. Health Rep.*, Nov. 18, 1932, p. 2199. The *cheopis* index was greater for rats caught in or near buildings, in cotton, sugar cane, and cornfields, and in untreated garbage dumps. The *cheopis* index of sewer rats and those inhabiting the banks of irrigation ditches was lower than that considered

P. irritans. Infected *P. irritans* were found on *ponchos* used by a plague-stricken family in January 1938, and Ramos Díaz has suggested that since both *X. cheopis* and *P. irritans* have been found on guinea pigs, the former may act as an intermediary between rats living in the fields and the domesticated guinea pigs, and the human flea as the vector between guinea pigs and humans. Infected human fleas carried on clothing may also be the cause of human cases not preceded by epizootics.[45]

Other parasites.—In June, 1934, Dr. Benjamin Mostajo and Laboratory Technician Colichón Arbulú of the Peruvian Antiplague Service removed 9 lice (*P. capitis*) from the head of a person ill with plague, ground the lice and inoculated them into a guinea pig, which died of plague. Head lice from healthy persons were then placed on infected guinea pigs, and later inoculated into healthy guinea pigs, infecting them with plague. Healthy guinea pigs which had merely been placed with live, infected lice, did not become ill, so that the experiments seem to indicate that lice may be infected both naturally and experimentally, but are unable to transmit plague by biting. As noted in Ecuadorian plague, however, lice may be important in the production of tonsillar plague, due to the native custom both in Peru and Ecuador of cracking them between the teeth. Tonsillar plague (*angina pestosa*) is said not to be rare in the mountains of northern Peru.[46]

It may be mentioned that experiments with the guinea pig flea, *Rh. cavicola*,

---

necessary for the propagation of plague epidemics. The *cheopis* index for the total number of *rattus* and *alexandrinus* was greater than that of *norvegicus*, but if infested rats only were counted, *norvegicus* was most heavily parasitized. An apparent slight reduction in the number of *X. cheopis* during the warmer months was probably due, in his opinion, to the fleas spending less time on their hosts during that period, and not to an actual reduction in their number. The exterior temperatures of Lima are favorable to the flea the year around. In feeding experiments it was found that the average length of life of unfed *cheopis* (14) was between 4 and 5 days when the mean temperature was 63.3 F and the relative humidity very high; one unfed female did not die until between the 7th and 8th days. (*Pub. Health Rep., supra*, p. 2199.)

[45] Ramos Díaz, A.: "Epidemiología de la peste bubónica en la Sierra del Depto. de Lambayeque," *Bol. Of. San. Pan.*, Sept. 1938, p. 776. At La Montañita, on an *hacienda* in the Department of Lambayeque, a woman died Jan. 5, 1938, after 3 days' illness; the circumstances were concealed from the authorities lest her *ponchos* and other effects be burned, and the clothing was taken home by relatives. On January 27 and 30 two children in the family of the relatives fell ill, and recovered after the administration of antiplague serum, which was also given to other contacts. Infected *P. irritans* were found on the *ponchos* of this family. In the house of the first case, 15 days after her death there was an epizootic among her guinea pigs (22 died). The second family had no guinea pigs in its hut. The diagnosis of plague in the original case was confirmed bacteriologically from plague germs recovered from the rib marrow after exhumation according to the method of Uriarte of Argentina. In the vicinity, 20 rats were trapped, all *rattus*, and four wild rabbits. Murine infection could not be proven, but *rattus* was believed to be the reservoir. Guinea pigs in this area had many fleas, 50 to 60% of which were *P. irritans*, and the rest *Rh. cavicola*. Ramos Díaz and H. Colichón Arbulú were able to confirm experimentally the ability of *P. irritans* to transmit plague. Ramos Díaz has said that *P. irritans* carried in clothing may possibly be a factor in the appearance of sporadic cases along the coast, not preceded by murine epizootics; and also that *rattus*, intensively combated in the coast, no doubt has sought refuge in the *serranía* or hills, where it infects, through guinea pigs, *P. irritans*, and thus, man.

In 1934 Long reported that the first cases of plague in over three years in Huancabamba were four cases the first of which occurred in a woman who kept an inn at which muleteers stopped; she fell ill after an epizootic among her guinea pigs. The other three cases were thought to have originated from infected guinea pigs bought at Lacchán, the site of the inn. Huancabamba lies in the province of the same name, at 9,842 feet. A similar outbreak occurred in Andabamba (Cajamarca province), at 8,202 feet. (Long, J. D.: "La peste bubónica en la costa occidental de Sudamérica en 1934," *Bol. Of. San. Pan.*, Jul. 1935, p. 622.)

Of more than 1,000 fleas from clothing, bed-clothes, saddle-cloths, etc., 80 to 90% were *P. irritans*; the rest, *Rh. cavicola*, and a very few *cheopis* and *canis*. (Long: *Ibid.*, p. 622.)

Eskey noted in 1931 that the greatest seasonal incidence of human plague occurred at the time of year (December to February) when *P. irritans* attacks both man and rats most frequently, but said that this might be mere coincidence, and pointed out that certain inland towns where *P. irritans* is found have remained free of plague. (MS.)

[46] Mostajo, B., & Colichón Arbulú, H.: Infectabilidad del *Pediculus capitis* con el bacilo pestoso, *Ref. Méd.*, Aug. 15, 1934, p. 524. See also *Bol. Of. San. Pan.*, Jul. 1935, p. 619.

revealed identical results: the insects could become infected, but were unable to transmit the disease by biting.[47]

It was thought that bed-bugs might possibly act as intermediaries from infected mice in sleeping quarters, but this was merely conjecture without any experimental or other evidence.[48]

Seasonal incidence.—According to Eskey, in all sections of Peru the annual plague epidemics tend to reach their greatest height during the summer months (Jan.–Mar.). Even when the winter temperatures of one community are about as high as the summer temperatures of another, the annual peak in both places usually occurs during the summer. When winter months are warm the number of human cases begins to increase during the last winter month or early in the spring and reaches its highest point early in summer; in colder climates the annual rise begins late in spring and the peak occurs in late summer. In the towns of northern Peru, where the morbidity rate has been high, there has been a more decided seasonal prevalence, with short and violent epidemics, whereas in Callao and Lima there has been but slight difference between the percentage of cases during the summer and winter months.[49] Unseasonable epidemics have occurred in all parts of Peru, including Mollendo. The seasonal incidence in some rural communities depends on the crop seasons and varies considerably from that of towns in their vicinity. Where cotton is grown, the seasonal incidence depends almost entirely on the migratory movement of rats.[50] In Lima and vicinity changes in climatic conditions over 22 years seemed to have had no effect on the annual number of cases, but in warmer northern Peru (especially Piura and Lambayeque) it is said that unusually high temperatures probably reduce plague prevalence.[51]

Kinds.—The majority of Peruvian plague has been bubonic, with the inguinal bubo the most common localization, followed to a lesser degree by the axillary and the cervical. According to records kept from 1904–1907, less than 3% of the cases were pneumonic. There was a suspicious pneumonic case in connection with the original outbreak in Callao in 1903,[52] and two other cases showed symptoms of secondary pneumonic plague.[53] It is said that pneumonic cases have occurred especially at the beginning of summer.[54] In June, 1904, six pneumonic cases were reported at Colán, near Paita.[55] One of the two

[47] *Bol. Of. San. Pan.*, Jul. 1935, p. 622.

[48] Eskey: MS.

[49] Eskey: *Pub. Health Rep.*, Nov. 18, 1932, p. 2196. He has observed that possibly the mingling of rats during the spring mating may partly account for the increase in plague then, though there is no positive evidence of this.

[50] *Ibid.*, pp. 2194, 2197. Dr. Long has also emphasized this point. (Letters to the Pan American Sanitary Bureau.)

[51] Eskey: MS.

[52] Artola *et al.*: *supra*, p. 29.

[53] Castañeda: *supra*, p. 66.

[54] Lorente and Flores C.: *supra*, p. 86.

[55] *Pub. Health Rep.*, 1904.

epidemics in the Department of Junin was pneumonic, with 21 cases, the original infection coming from Lima. The vesicular form of plague (*viruela pestosa*) found in Ecuador is rare in coastal Peru. *Angina pestosa* is found in the northern mountains. A few atypical cases have been observed.[56] Mortality records of Lima to 1930 showed a total mortality of 51%, varying from 40% to over 60%.[57] According to another report (1925), the mortality for the capital was about 30%, and elsewhere, about 50%.[58]

Vaccination and serum-therapy.—Both vaccination and serum-therapy have been regarded favorably in Peru, though there is not a great deal of specific information on their use. In 1925, Lorente and Flores Córdoba reported that, to test its value, vaccination on an intensive scale was practiced on almost all the inhabitants in Piura, Cajamarca, Lambayeque, Libertad, and Lima, and it was found that, especially in Cañete and Chiclayo, such vaccination, carried out in winter, maintained those areas almost free of plague. General sanitation measures were carried out along with the vaccination.[59] Eskey in 1931 stated that "prophylactic vaccine has probably reduced the human incidence to some extent.[60] However, in recent years the tendency is to place little reliance on mass vaccinations, but to concentrate on the destruction of rats and sanitation of premises, giving injections of serum to contacts when a case of plague appears.[61] Serum is the customary treatment for plague cases. In Paita in 1904 the mortality among 30 serum-treated cases was 23% and among the entire group of 56 cases, 53%, during two months.[62]

Control.—When plague slipped past the quarantine barriers which were the principal sanitary precaution of the times,[63] in 1903, it was immediately evident that the division of health authority which had existed since the establishment of the National, Departmental and Municipal Boards of Health in the early days of the Republic (1826)[64] was an obstacle to unified and effective work against this

[56] Two cases in Lima, about 1933, and Aug. 1934, fatal cases positive on inoculation, but with no plague pathology at autopsy, and no plague bacilli in the spleen. (Letter from J. D. Long to Pan Amer. San. Bur., Sept. 5, 1934.)

[57] Eskey.

[58] Lorente and Flores C.: *supra.*

[59] *Supra*, p. 87.

[60] MS.

[61] Serum was manufactured in the Laboratorio Nacional de Vacuna y Seroterapia (National Vaccine and Serum Laboratory) in 1925, and is at present being made by the National Institute of Hygiene, which took over the functions of the earlier institution.

[62] *Pub. Health Rep.*, 1904, p. 1797.

[63] These were generally a matter of locking the barn door after the horse is stolen, inasmuch as they were applied with most vigor after a pestilence had entered the country during a period of relaxation. This experience has been, of course, universal. Peru was an early advocate of international cooperation in liberalizing quarantine procedures; she took part in the 1881 International Sanitary Convention in Washington, and called a conference of her own in 1887. See: Paz Soldán, C. E., & Lorente, S.: "Cien años de política sanitaria marítima en el Perú," 1924; and Moll, A. A.: "The Pan American Sanitary Bureau," *Bol. Of. San. Pan.*, Dec. 1940, p. 1222.

[64] The decree of September 1, 1826, said to have been due to the work of Dr. Unanue and his friend José María Pando, provided for a Supreme Board of Health with supervisory and appointive powers over the

invader. In November, 1903, a national Department of Health (*Dirección de Salubridad*) was created,[65] with Dr. Julian Arce as Director. An extensive program of health work was undertaken,[66] in addition to the campaign against plague which was the first objective. Isolation hospitals were built or improved; three ship disinfection stations were established (Callao, Paita and Ilo) to prevent the reintroduction of the disease and its spread to foreign ports from Peru; and measures for the care of patients were prescribed.[67] However, the respective rôles of the national and local bodies were not yet clearly defined, and provincial governments were still jealous of their authority in matters of local sanitation, building construction, and hygiene, and after the first wave of terror at the appearance of plague had passed, they resented national interference.[68] Peru promptly (August 23, 1906) ratified the Washington Sanitary Convention of 1905, and in conformity with its provisions issued regulations regarding bills of health, and declaration of contagious diseases, and her general maritime sanitary regulations (March 11, 1910).[69] These included various measures designed to prevent the spread of plague by rats. Other legislation bearing a relation to plague included a project for the sanitation of 32 cities, and the regulations regarding housing elsewhere referred to,[70] the former remaining mostly on paper. On January 25, 1929, a supreme decree was issued creating the National Antiplague Service, in the Department of Public Health.[71] The Director of Health (or his representative) was given wide authority; rat-proof construction of new buildings and improvement of old ones were required; provisions were made for bacteriological and epidemiological studies; and ship fumigation and other measures were specified.

special port Boards of Health and the Departmental Boards of Health; the last-named, in turn, exercised similar powers over the Local Boards of Health, which were immediately responsible for local health matters and sanitation, but which were to report any epidemic or epizootic disease to the higher Board (and it to the Supreme Board) for instructions. There were various quarantine provisions. The decree remained in force until 1887, when new regulations were adopted, retaining, however, the same general organization. Peru was thus one of the first countries in the world to have a *national* board of health, even though its functions were mainly advisory, supervisory, and regulative, with the execution of measures being left to the local body. The *Ley de Municipalidades* (Municipal Government Law) of October 14, 1892, definitely placed local sanitation in charge of the city authorities. (Paz Soldán & Lorente: *supra*; and Olaechea, A. S.: "Situación de la Sanidad y de la Asistencia en el Perú," Lima, 1933.) Of course, national boards of health in Peru, as elsewhere in Latin America, were largely a continuation of Colonial Protomedicates.

[65] *Ibid.*

[66] In addition to plague control work, other important activities of Arce's administration were the organization of the health department, organization of vital statistics, defense against yellow fever, an intensified campaign against smallpox, studies of sanitation in towns, the appointment of a commission to study hygiene of housing and the construction of houses for workers, and the drafting of a Sanitary Code. (Olaechea, A. S.: *supra*, p. 27.)

[67] Paz Soldán & Lorente: *supra*, p. 61.

[68] Olaechea: *supra*, p. 27.

[69] Paz Soldán & Lorente: *supra*, p. 81.

[70] Note 28.

[71] Dirección General de Salubridad: "Decreto supremo creando el 'Servicio Nacional Antipestoso,'" Lima, 1929. The antiplague service was retained in the reorganized Department of Health of the Ministry of Public Health, Labor and Social Welfare created in 1937. (Min. de Salud Púb., Trab. y Prev.: *Pub. Dir. Gen. Salub.*, Vol. I, No. 2, Mar. 1937.)

International Cooperation and the Pan American Sanitary Bureau.—On August 1, 1930, at Piura, an agreement was signed by the Ecuadorian and Peruvian health authorities providing for the joint combating of plague in their frontier provinces (Loja and Ayabaca) along lines suggested by the representatives of the Pan American Sanitary Bureau.[72] In 1930, preparations were made for a cooperative plague campaign in Peru, under the direction of Dr. John D. Long, Traveling Representative, Pan American Sanitary Bureau, with the collaboration of Pan American Sanitary Bureau Epidemiologist C. R. Eskey.[73] A similar campaign had already been carried on in Ecuador. (See Ecuador.) Personnel were trained at Lima and then sent to outlying provinces. Assistant epidemiologists were stationed in the principal ports to supervise trapping and poisoning of rats, to collect fleas, and to inoculate guinea pigs in order to detect plague infection. Five branch laboratories were established. Poison was relied upon to reduce the rat population, and trapping was used to obtain rodents for classification of fleas. Active antiplague measures were begun in Lima and Callao in November, 1930, and in other Provinces the following December and January. A notable drop in plague incidence followed. General sanitation of plague foci was also undertaken.[74]

In more recent years Traveling Representatives Henry Hanson, Anthony Donovan, and John R. Murdock of the Pan American Sanitary Bureau have participated in the cooperative plague control work in Peru; Dr. Donovan is at present making a study of all the plague foci in Peru since 1903.

As in Ecuador, public health physicians from other countries have come to inspect and study the work being done in plague control in Peru. They included Dr. Enrique Savino of Argentina (1932), Dr. Carlos A. Miño of Ecuador (1932); Dr. A. Macchiavello of Chile (1932); and Dr. Isaac Diez of Venezuela (1940). And in April 1940 a physician in Palestine wrote to Peru requesting information on rat control through the use of poison.

Among the most recent activities of the antiplague service have been the designing of a machine to mix poison; the preparation of an instruction manual

[72] *Bol. Of. San. Pan.*, Oct. 1930, p. 1242.

[73] Eskey, C. R.: *Pub. Health Rep.*, Nov. 18, 1932, p.2201.

[74] Feeding experiments made in Peru showed that rats almost invariably selected packages containing rice and corn baits. Ground dried fish, cheese, shrimp, and anise oil were of no value whatever. Coarse ground corn flour was preferred to very fine flour. (Eskey, *Ibid.*, p. 2205.) This was in interesting contrast to rat preferences in Ecuador (*q.v.*). Some dermatitis among arsenic handlers was observed in Lima (apparently due to an impure lot of poison). During an unspecified period (possibly Nov. 1930 to some time in 1931), 70 tons of poison were distributed, in small paper packages, in over 100 towns and their surrounding haciendas. Not a single instance of human poisoning was reported, and only a few domestic animals were alleged to have been killed. The number of rats trapped was not large, except at Lima, where 25,000 rats were caught. (Eskey: *Ibid.*, p. 2201.)

By 1932, 130 tons of poison had been distributed, the number of rats caught per 100 traps had decreased from 18 to 3 (maximum); the flea index per rat from a maximum of 34 to a maximum of 3. (J. D. Long, "Informe Anual," *Bol. Of. San. Pan.*, Oct. 1932, p. 1031. As elsewhere (see Chile) one of the results of the intensive war on rats was a decrease in non-plague pathology among them. (Long, J. D.: *Bol. Of. San. Pan.*, Jul. 1935, p. 617.) It is interesting to note that in the sanitation of Chiclayo (pop. 25,000), 581 auto truck loads of garbage and waste were removed; from Pacasmayo (pop. 6,000), 393 loads. (Report of J. D. Long, June 24, 1932, Files of Pan American Sanitary Bureau.)

for field workers;[75] the completion of a large wall map installed in the main office of the Service, with pins indicating the location of field employees;[76] the preparation and revision of detailed maps of plague foci;[77] and introduction of the use of "flame-throwers" to destroy fleas in rat nests.[78]

Research.—In addition to the experimental studies of Ramos Díaz, Colichón Arbulú, and Mostajo, with lice, guinea pig fleas, and human fleas;[79] Eskey's work with rat poison preferences;[80] Eskey's epidemiological surveys[81] and those of Long and Mostajo[82] and of Donovan and Murdock,[83] already mentioned; Colichón has experimented with the production of latent plague[84] and Ramos Díaz with the infection of rats through their eating livers and spleens from infected guinea pigs.[85] A new procedure in the handling of specimens of tissue was developed by Colichón.[86]

Martyrs.—Though in Peru as elsewhere there have undoubtedly been a number of heroic individuals, whether physicians, nurses, or laymen, who have lost their lives in caring for persons ill of plague, or in otherwise combating the disease, but the only instance of which a report has been obtained is that of a fatal laboratory infection in Lima in 1940.[87]

[75] By A. Ramos Díaz.

[76] Donovan, A.: Letters to the Pan American Sanitary Bureau, 1940. The map is kept up to date so that the location of every representative including those who are ill or on leave, is known; the map is said to be very useful, particularly since it affords an indication of which areas have sufficient personnel and which are lacking in that respect.

[77] Using small outline maps prepared by E. D. Hopkins, Sanitary Engineer, Pan American Sanitary Bureau.

[78] Originally employed in Brazil, the apparatus is proving very effective in Peru as well. A description will appear in the *Bol. Of. San. Pan.* in the near future.

[79] See Fleas and Other Parasites.

[80] See Note 74.

[81] See Note 2.

[82] On the rôle of fleas and jute bags in plague. See Reinfection.

[83] Various reports, including that of an investigation of plague in the Cañete valley. (See Annual Reports of Pan American Sanitary Bureau.)

[84] In 1934, a series of healthy rats were inoculated with plague-infected material by scarification, and a certain number of the rats, though very sick, recovered. When recovered rats were killed at intervals of 30, 60, and 90 days after recovery, no visible plague lesions were found, stained microscopic slides from spleen, liver, and lymphatic glands were negative, but an emulsion from them, inoculated into guinea pigs, killed them with typical plague. ("An. Rep. Pan Amer. San. Bur.," 1936, p. 4. Report of Dr. J. D. Long.)

[85] Healthy rats were fed on livers and spleens of infected guinea pigs; some did not die or become ill, and in the infected rats which died, it was observed that the pathology was unusual: One rat had lesions only in the mesenteric glands, one had ulcers in the interior of the intestine. Virulent bacilli were obtained from these tissues and also from the spleen and liver. Following this more careful search was made for involvement of cervical and mesenteric glands and the intestine, and a trapped rat was found which had a few small, whitish, elliptical intestinal plaques. Some Gram-positive and Gram-negative micro-organisms were seen, and some Gram-negative, bi-polar staining bacilli; after passage through guinea pigs, the second guinea pig died of typical plague. (*Ibid.*, p. 5.)

[86] The piece of spleen or gland secured from a human case at autopsy, or from a guinea pig, is placed in paraffine of 40 C melting point, in a tin ointment box; the box is then placed in a bored-out wooden block, and wooden covers are tacked on; the package can then be sent by mail with perfect safety and the specimen will keep for as long as 40 days. Guinea pigs inoculated from specimens prepared this way "have invariably died with typical plague." (Letter from J. D. Long, September 8, 1933.)

[87] The laboratory worker accidentally sucked a virulent plague culture into his mouth on March 18; he washed out his mouth with an antiseptic, but failed to report the accident. The next day he felt unwell, mentioned the occurrence, and was given a small injection of anti-plague serum; he became rapidly worse; sputum examinations revealed plague bacilli and the man was taken to the isolation hospital; the Director of the Institute was informed, and the patient treated with intravenous anti-plague serum and large doses of sulfapyridine, but to no avail; he died on the 22nd. All contacts were isolated and given serum, and no further cases developed. Possibly one reason why reports of infection of physicians and nurses are less common in Peru than elsewhere is the almost total absence of pneumonic plague. (Case reported in letter from A. Donovan, March 1940.)