XII. THE WEST INDIES AND CERTAIN EUROPEAN-AFRICAN ISLANDS

The history of plague in Cuba, Puerto Rico, and the other West Indian Islands, would almost lead to a belief in the immunity or resistance of tropical islands to plague, were it not for the similar "immunity" enjoyed by other, non-insular regions in America, and for the persistence of the disease in similarly-situated islands in other parts of the world.

If the most generally accepted theories of the origin of certain outbreaks are to be adopted, this history also affords a striking example of the necessity for frank reporting of the presence of pestilential disease in any locality—a necessity which, of course, has likewise been amply demonstrated by the story of plague in other areas.

BARBADOS

Plague does not seem to have invaded Barbados, although on at least two occasions plague-infected vessels were received at the port (March 25, 1901, the Norwegian *Hama*, from Capetown, in ballast, with two cases suspicious of plague among the crew; the vessel was disinfected and proceeded on her course;[1] and, May 21, 1928, the *Tymerica*, from New Orleans, with a suspicious case, later confirmed, of plague; the vessel was en route to Cape town). Barbados continues to inspect rats; in 1937, 2,485 were killed and 208 examined at Bridgetown; none were plague-infected. The majority were *norvegicus* with a few black rats.[2]

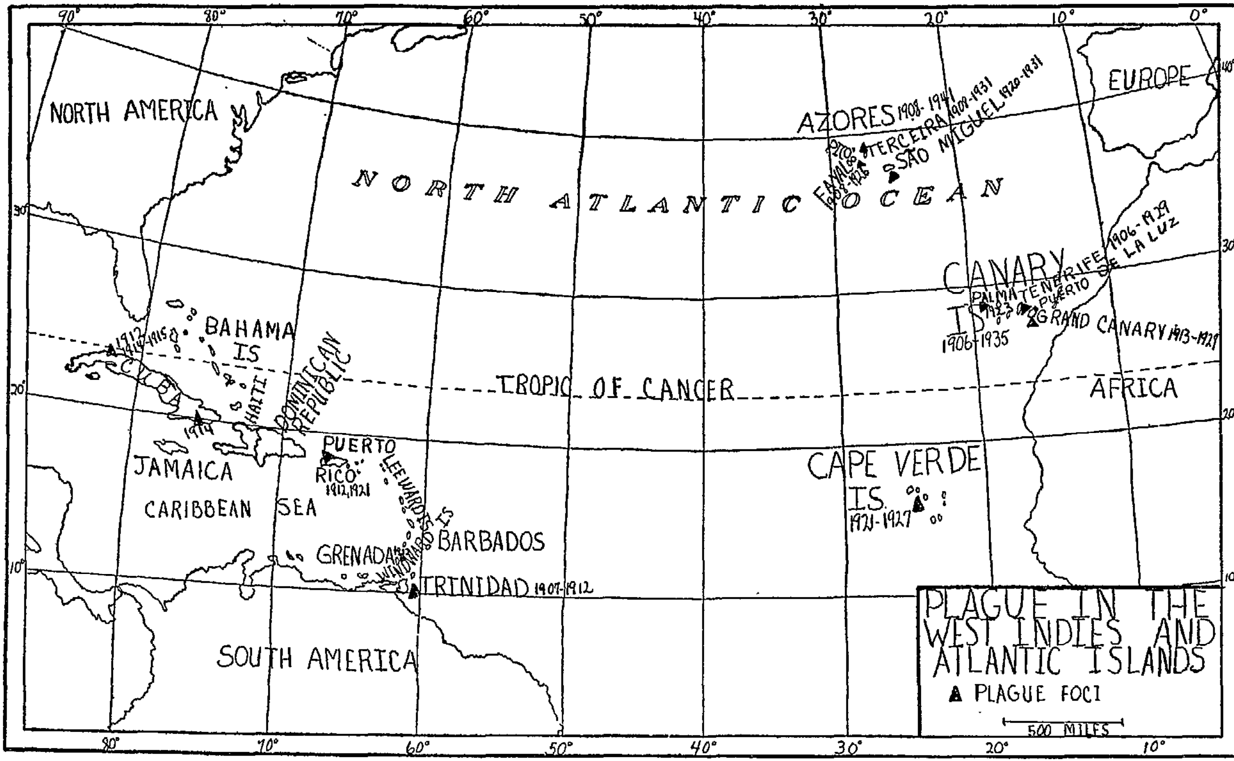
CUBA

Cuba, the largest of the West Indian islands, has an area of 44,164 square miles and a population of about 4,227,597. The country is hilly in the extreme west and south, undulating in the north, and flat in the center. The humidity is somewhat decreased by the constant sunshine. The climate is moderately warm in the north, modified by ocean breezes, and warmer in the south. Nights are generally cool. The temperature ranges from 60–98°F. Rainfall averages 54 inches a year. Summer is the rainy season; from December to April it is dry, though not rainless. Cuba has 15 ports and several sub-ports.

The history of plague in Cuba is that of two short outbreaks, in 1912 and 1914–15, with a total of about 69 cases 22 deaths. Practically the entire bibliography appears in *Sanidad y Beneficencia*, official organ of the Department (Secretariat) of Health and Charities.

[1] Low, R. Bruce: "Report on the Progress and Diffusion of Plague Throughout the World, 1901," in Rep. Med. Off., Local Governing Board, London, p. 278; U. S. *Pub. Health Rep.*, June 22, 1928, p. 1639.

[2] Office International d'Hygiène Publique: "VII Relevé annuel . . . concernant la destruction des rats dans les ports et a bord des navires, etc.," Paris, 1939.


PLAGUE IN THE WEST INDIES AND ATLANTIC ISLANDS
PLAGUE FOCI
500 MILES
NORTH AMERICA
EUROPE
AFRICA
SOUTH AMERICA
NORTH ATLANTIC OCEAN
TROPIC OF CANCER
CARIBBEAN SEA
AZORES 1908-1941
TERCEIRA 1909-1931
SÃO MIGUEL 1920-1931
CANARY IS 1906-1935
TENERIFE 1906-1929
PUERTO DE LA LUZ
GRAND CANARY 1913-1929
CAPE VERDE IS. 1921-1927
BAHAMA IS
CUBA
JAMAICA
HAITI
DOMINICAN REPUBLIC
PUERTO RICO 1912, 1921
LEEWARD IS
WINDWARD IS
BARBADOS
GRENADA
TRINIDAD 1907-1912

With the first appearance of plague in the New World in the late XIX Century, Cuban authorities became alarmed. Dr. Barnet of the National Health Department declared in a lecture in 1903 that Cuban physicians must be prepared to recognize the disease.[3] At about the same time, the outbreak of plague in Ensenada and Mazatlán, Mexico, although on the other side of the continent, caused the Cuban authorities to take precautionary measures against Mexican vessels and to send observers to Mexican ports, but prompt and effective action by the sister republic soon brought the epidemic to a close.[4]

The exhaustive Handbook of Sanitary Practice published by the Department of Health of Habana in 1905 devoted considerable attention to plague prevention and control measures, with emphasis on rat and flea destruction. It also reminded Cuban health officers that if plague did break out in the Republic, the government was under obligation to report the fact immediately to the Pan American Sanitary Bureau (then International Sanitary Office of the American Republics), in accordance with the resolution of the International Sanitary Convention (Washington, 1902).[5] As a matter of fact, when the disease finally appeared, Cuba was prompt in announcing its presence.

There appears to be good ground for the belief that it was the failure of the health authorities of another country to acknowledge the presence of plague in certain possessions, which resulted in the spread of that disease to Cuba in 1912, for the most generally accepted opinion is that the source was the Canary Islands, where plague was said to have been present but unreported since 1907.[6] The recently-infected island of Puerto Rico was also considered a possible source, and rice ships from India have even been suggested, though the latter theory is greatly discounted.[7]

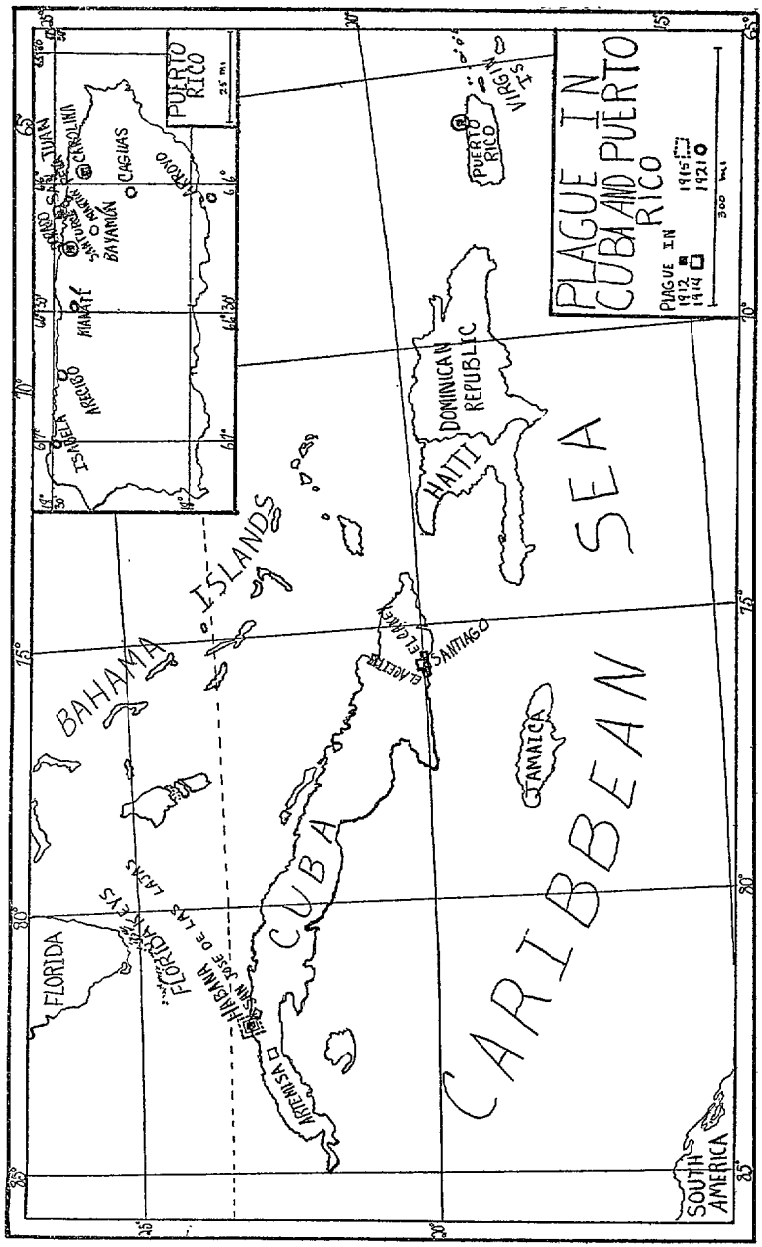
[3] Barnet, Enrique B.: "La peste bubónica," (Conf. Apr. 1, 1903, in Hosp. No. 1), Junta Superior de Sanidad, Cuba, 1903, 38 pp. He remarked in discussing plague transmission that it was easy for Cuban physicians to accept the theory (then still opposed in some quarters) of insect (i.e., flea) transmission, because of their own Finlay's leadership in pointing out the insect-transmission of yellow fever ("*Para los médicos cubanos en general, la transmisibilidad de algunas enfermedades por los insectos es tesis que está ya perfectamente demostrada, y en esa teoría se basa en firme la gloria de nuestro inmortal Finlay,*" p. 24).

[4] Chief cause for alarm was the shipment of goods from Mazatlán and other western ports by rail across the Isthmus of Tehuantepec, and thence by boat to Cuba.

[5] Departamento de Sanidad de la Habana: "Manual de Práctica Sanitaria," edited by numerous physicians and compiled by Dr. E. B. Barnet, Habana, 1905, 1114 pp. (pp. 495, 527, 660, 664, 908, 1025, 1038, 1039, 1041).

[6] Guiteras, Juan: "La peste bubónica en Cuba," *San. & Benef.*, Jul.-Sept., 1912, pp. 150-166; English text, pp. 167-178. Some years preceding the outbreak, the Cuban authorities had been informed by a Dr. Fernando Escobar of the existence of a serious outbreak of plague in Santa Cruz de Tenerife, Canary Islands, during the latter half of 1906. Apparently no official confirmation could be obtained, but rumors of the presence of the disease continued to persist, and when Dr. José T. Cartaya was sent in September, 1910 to investigate methods of handling plague and cholera in the laboratories and quarantine stations of the United States (being there given by Surgeon-General Wyman some letters "that were of much assistance") and Europe, he was specifically ordered to investigate also the plague situation in the Canaries. He returned firmly convinced that there had indeed been plague in the Canaries in 1906-7, 1908, 1909, and probably, although he could find no cases, in 1910. Residents and even the authorities talked freely but unofficially about the great epidemic (the city named a street for Dr. Comenge, who came from Spain to combat it). (Cartaya, J. T.: "Peste bubónica en las Canarias," *San. & Benef.*, Jan. 1911, pp. 94-96; English text pp. 98-100.) Dr. Guiteras informed the Surgeon General of the U. S. Public Health and Marine Hospital Service of the occurrence. (*San. & Benef.*, Jul.-Sept. 1912, p. 312.) At least 23 vessels from the Canary Islands, with boxed onions and potatoes, and sometimes, wheat, for Habana merchants, arrived in Habana between Jan. 2 and May 27, 1912, a few of them via Puerto Rico. (Domínguez, Alfredo: "El servicio de desratización y la peste bubónica," *San. & Benef.*, July-Sept. 1912, pp. 253-291; English, pp. 292-303. Domínguez himself seems to attribute the infection to Puerto Rico, but many of the Puerto Rican cargoes he lists appear to have come on Canary Island vessels.) See also CANARY ISLANDS.

[7] Guiteras, J.: "La peste bubónica en Cuba," *San. & Benef.*, Sept. 1914, pp. 313-324, English text, *Ibid.*, Nov. 1914, pp. 537-550. He pointed out that the interval between the outbreak of plague in Puerto Rico and its entry into Habana was very brief; that the first Cuban cases were not from the wharves where


PLAGUE IN CUBA AND PUERTO RICO
PLAGUE IN 1915 1912 1914 1921
300 mi
PUERTO RICO
25 mi
CAGUAS
BAYAMON
ARECIBO
MAYAGUEZ
SAN JUAN
CAROLINA
GUAYNABO
SAN JUAN
PUERTO RICO
VIRGIN IS.
DOMINICAN REPUBLIC
HAITI
SEA
CARIBBEAN
CUBA
ISLANDS
BAHAMA
FLORIDA
FLORIDA KEYS
HABANA
MATANZAS
SANTIAGO
EL COBRE
GUANTANAMO
JAMAICA
SOUTH AMERICA

PLAGUE IN THE WEST INDIES

	C	D
CUBA		
Habana, June 30–July 22, 1912	3[a]	2
" Feb.–June 22, 1914	25	6
" Feb.–Aug., 1915	21	9
Artemisa, Feb.–June 22, 1914	1	
San José de las Lajas, Feb.–June 22, 1914	1	
Santiago, June 23–Sept. 16, 1914	13	3
El Aceite	4	1
El Caney	1	
	69	21
GRENADA		
Grenada, May 1912 (Imported from Trinidad)	1	1
PUERTO RICO		
San Juan,[b] June–Sept. 1912	52	35
" Feb.–Aug. 1921	10	8[c]
Carolina, 1912	3	
" 1921	4	
Dorado, 1912	1	1
" 1921	1	
Arecibo, 1921	1	
Bayamón, 1921	1	1
Caguas, 1921	6	2?
Isabel, 1921	1	
Manatí, 1921	3	
Martín Peña, 1921	1	
Santurce, 1921	2	
S. S. Guillermito, off Arroyo, 1912	1	1
	87	48
TRINIDAD		
Port of Spain, June 1907	2	2
" June–Sept. 1908	20	16
Trinidad, 1909	10	9
Port of Spain, Feb.–July 1910	2	
Tacarigua, April–May 1910	7	5
Port of Spain, Feb.–May 1911	7	1
" April–July 1912	10	4–6
Tunapuna, April–June 1912	3	3
	61	42
TOTAL FOR THE WEST INDIES, 1907–1921	218 C	112 D

[a] Possibly one other fatal case in June.
[b] San Juan figures include the Puerta de Tierra quarter.
[c] There were at least 11 deaths on the island, according to hospital reports.

On June 20, 1912, the very day on which the Cuban health authorities received the official report of the presence of plague in Puerto Rico, an anonymous note from a resident advised them of the occurrence of an

Puerto Rican steamers tied up, but 12 blocks away, near those where sailing vessels from the Canary Islands, hauling onions, potatoes, and garlic, remained tied up for weeks selling their cargo; that because of inability to ascertain the true situation in the latter islands, Cuban quarantine measures against them had been inconstant and none were in force in 1912; and finally, with regard to the suggestion, erroneously attributed to him, that plague had been imported in cargos of rice and bales of sacking from India, he did not consider this likely, and that furthermore, no ships entering Habana were more free from rats and in better sanitary condition than the Indian vessels, nor did any cases occur near their wharves. In fact, some guinea pigs were experimentally left for 10 days among the stored rice and sacking at these wharves, with no results, although this procedure had been successful in proving the presence of infected fleas in other localities.

With regard to the failure of plague to appear among longshoremen in Cuba, Guiteras suggested that this may have been because the wharf rats were wet nearly all the time and relatively free from fleas, in contrast to the rats in warehouses further inshore. (*Ibid.*)

unusual rat mortality within a block of the Caballería wharves of Habana.[8] It was found that this mortality had been observed during the preceding two weeks, and had ceased by the time of the investigation. The capture, examination, and destruction of rats was ordered. All rats proved negative to plague examination, as did 8,457 caught between June 24 and September 1 in the same district. On July 2 it was learned that a warehouse employe had fallen ill June 27 and died June 30, from a disease characterized by rapid septicemia and swelling of the right subinguinal glands. The body was exhumed and examined, but no plague bacilli were found.

The first confirmed human case of plague was a non-fatal one in a Spaniard, a stable-hand, who fell ill on June 30. The diagnosis was established by cultures on July 6, and the presence of plague in Habana officially announced. Guinea pig inoculation later confirmed the diagnosis.[9] Two more cases, both fatal, developed, one confirmed on July 9 and the other on July 22. One other suspicious, fatal case may have occurred in June in addition to the June 27 case. All were in the same neighborhood, although the last patients lived three blocks distant from the first.

A systematic campaign of rat extermination extending far beyond the suspected area and including the wharves and two towns across the bay was begun immediately.[10] The measures included cleaning up of premises, removal of trash and rubbish,[11] fumigation (with sulfur) of infected buildings, rat-proofing of buildings where rat harbors were found, proper food storage, safe garbage disposal (enforcement of an ordinance requiring covered metal cans), and rat trapping and poisoning. A cyanide-generating apparatus invented by Dr. Hugo Roberts, Cuban Chief of Quarantine, was used for killing rats and fleas in rat burrows.

The rapid end of the outbreak and its failure to spread, were attributed to the prompt discovery of the disease and the active control measures taken, the solid, rat-proof nature of Habana's buildings, and the new, closed-sewer system installed the previous year in the infected section.[12] Rat examination was continued for all of 1912 and part of 1913, with negative results.[13]

[8] It was intimated that the writer of the note was a merchant in the infected area, who chose to remain anonymous in fear of the recriminations of his colleagues should the resulting investigations prove damaging to trade.

[9] In his report on this first outbreak, Guiteras attributed the successful termination of it in large part to the *promptness* of the action taken—control measures having been started as soon as the first suspicious circumstances were reported. He protested against the policy of waiting, in the case of plague, until confirmation by guinea pig inoculation is obtained, a process which he described as "often quite dilatory," observing that "there are many who are not displeased to find an excuse for delay. . . . Far be it from me to belittle the importance of the laboratory as a necessary aid to diagnosis . . . but the successful sanitarian should be able to decide, in each individual case, how far he may go in waiting for the complete bacteriological information." (*San. & Benef.*, July-Aug. 1912, p. 167.)

[10] Domínguez, *supra*, Note 6.

[11] For many days an average of 1500, and even 2000 tons of waste was carried out to sea by the disposal barges, in contrast to the normal 450 tons. (Guiteras: *San. & Benef.*, July-Aug. 1912, p. 167.)

[12] *Ibid.* On July 10, 1912, Guiteras wrote to his old friend W. C. Gorgas, then in Panama: ". . . we have had the good fortune that the hypothetical rats that brought the infection (from Puerto Rico? from Canarias?) landed at these *almacenes* that have recently been newly paved with cement, and where the "alcantarillado" [sewerage system] work of last year has brought down to a marked degree the rat population." (*San. & Benef.*, June 1912, p. 712.)

[13] From July to December 1912, 121,797 rats were caught outside of Habana: Pinar del Rio Province, 919; Habana Province, 4,543; Matanzas, 2,635; Santa Clara, 1,928; Camaguey, 397; Oriente, 2,386. (Morales Lopez, Juan F.: "Servicio de desratización," *San. & Benef.*, Sept. 1913, pp. 342-351. In Habana the deratization squads gathered 3,700 rats during the first 20 days of the campaign, and 9,000 more were turned in for the 5 cents per rat offered. (Dominguez, *supra*, Note 6.)

In February, 1914, unusual rat mortality was reported by Dr. Julio Arteaga in the 1912 focus, with the first human case of plague on the 22nd of the same month. Guiteras believed this was a recrudescence, due to the close watch maintained upon all possible outside sources of infection, but the question has never been definitely settled.[14]

During this second outbreak, which spread clear across the island to Santiago, there were 27 cases 6 deaths in Habana and vicinity (Feb. 22 to June 22, 1914, including one case in Artemisa and one in San José de las Lajas, towns receiving food supplies from Habana), and 16 cases 4 deaths in Santiago (June 23 to September 16, 1914, including 4 cases in El Aceite and one in El Caney).[15] Rat plague was reported at Jaruco, near Habana.[16] There was a recrudescence of the disease in Habana in 1915, with 21 cases 9 deaths from February 8 to August 15.

Energetic measures based on rat destruction and rat proofing were enforced. Foci were fumigated, usually with hydrocyanic acid gas under canvas. Rat examination was continued for some time, later being limited to the water front and sewers.[17] Plague has never reappeared in Cuba.

An interesting feature of the second campaign was a contest held on the occasion of the III National Cuban Medical Congress (December, 1914) with a prize ($250) offered by the Department of Health and Charities for the best plan for plague eradication. Some of the leading public health men of the country, Drs. J. A. López del Valle and Enrique B. Barnet (the successful contenders), Mario G. Lebredo, and Arístides Agramonte, competed.[18] The campaign itself was directed by Juan Guiteras, then Director of Health. Some of the achievements were of more than passing value: Guiteras developed the fumigation of premises with hydrocyanic acid gas, and Roberts' apparatus for injecting this gas in rat burrows and harbors has already been mentioned.

Rats.—In 1908 Guiteras and his colleagues began studying rats and fleas in the Laboratory of the Las Animas hospital. It was found that *norvegicus* was the most common rat, although *alexandrinus* and *musculus* were also encountered.[19]

[14] Guiteras, J.: *supra* (*San. & Ben.*, Sept. 1914).

[15] Villuendas, Florencio: "Peste bubónica," (Santiago), *San. & Benef.*, Sept. 1914, pp. 348-352.

[16] Guiteras, J., *supra* (*San. & Benef.*, Sept. 1914, p. 313). The Artemisa case (50 km. from Habana) was in a food store which had received supplies from the infected area of Habana, and the patient had killed an infected rat full of fleas (he covered the rat with alcohol and burned it). After the place had been fumigated with sulfur dioxide under canvas, no other human or rat cases occurred. The Jaruco rat plague (40 km. from Habana) was found in a railroad warehouse where goods from Habana were stored. The building was in an isolated spot, of corrugated iron on a solid concrete foundation. It was fumigated with cyanide under canvas; no further plague occurred. The Santiago cases were thought possibly to have arisen from the action of a Habana merchant who, when an employe took sick, distributed his stock of goods to various parts of the island.

[17] Guiteras, *supra* (*San. & Benef.*, Sept. 1914, p. 313), and Agostini, I. P.: "Notes on the Evolution and Organisation of the Public Health Service in Cuba, and Epidemiological Conditions up to the Present Time," Ministry of Public Health, Cuba, 1924, p. 20.

[18] López del Valle, J. A., and Barnet, E. B.: "Plan de Campaña Sanitaria Contra la Peste Bubónica," *San. & Benef.*, June 1915, pp. 650-703; Lebredo, Mario G.: "Plan de Campaña Sanitaria, etc.," *Ibid.*, Jan. 1915, pp. 60-112; and Agramonte, Arístides: "Plan de Campaña Sanitaria, etc., "*Ibid.*, pp. 113-145

[19] Guiteras, J.: *supra, San. & Benef.*, June 1912, p. 625.

Fleas.—The most common flea on Habana rats is *X. cheopis*. *R. alexandrinus*, though not the most prevalent rat, carried the most fleas. Studies made between 1908 and 1912 showed that the flea population of Habana decreased about 50% during the wet season, being at its lowest in June, according to Guiteras.[20]

Sacks.—Several instances of transportation of plague for short distances by fleas in sacking were reported by Guiteras, notably the focus in a storehouse which was a distribution center for new baled sacks and for used sacks gathered from various parts of the city. There were three cases from this focus: two in draymen engaged in collecting sacks from all kinds of shops and stores where they were sold second-hand, and the third in a boy who received the sacks and inspected them for repairing. The last case developed a very violent septicemia. No foodstuffs were stored in the building, and very few rats were found dead before fumigation, but the "guinea pig test" (placing of guinea pigs in the building), showed that the place was plague-infected.[21]

Kinds of plague.—Cuba's plague was nearly all bubonic, although some septicemic cases were reported. The fatal case of July 22, 1912, had a "polymorphous" eruption, with pustules, which began on the 23d; serum was given, to no avail. It was noteworthy that the focus of infection was always the place of work, never the residence, and that all foci at a distance from the original center were stables, foodstuff depots, or bakeries; there was no evidence of intermediary links or of rat migration as a cause of spread (that is, actual migration; the transportation of rats in merchandise was frequently considered probable).

The mortality was low; 22% in Habana in 1914; 21% in Santiago and vicinity that same year; and 42% in Habana in 1915.[22] Guiteras and Recio declared that "we believe that the results obtained speak favorably for the action of the Paris serum. They evince, likewise, from a sanitary point of view, the success of our efforts in ferreting out cases."[23] One reason for the prompt discovery of cases and foci was said to have been the availability of hospital attention for everyone, either in the charity hospitals or in those of the mutual benefit associa-

[20] *Ibid.*; also López, José M.: "Apuntes sobre las pulgas," *San. & Benef.*, Aug. 1914, pp. 176–177. He reports that experiments with fleas showed that *P. irritans* can jump 12 cm (4¾ in.) and *X. cheopis* 10 cm. (4 in.); and can live at least six days without feeding, laying eggs for two days. (The latter experiment was not prolonged beyond six days, and of course subsequent research has shown that fleas can live much longer without food. The information on jumping of fleas was put to practical use by having sanitary employees wear boots rubbed with crude petroleum, and the only such employe to get plague was a new man who had worked one day without boots in the stables used for street-sweepers' carts and animals. The usual footgear of warehouse workmen was a hempen sandal which gave a good grip on the floor but was very open to fleas. (Guiteras, *supra*, *San. & Benef.*, Sept. 1914, p. 313.)

[21] Guiteras, *Ibid.* See also Note 7.

[22] Habana, 27 C 6 D, 1914; Santiago, 16 C 4 D, 1914; Habana, 21 C 9 D Feb. 8–Aug. 15, 1915; the possibility that some of the 1915 cases were not recognized immediately must not be overlooked, since some appeared rather sporadically, and as stated, early identification tends to increase chances of recovery.

[23] Guiteras, Juan, & Recio, Alberto: "Sero-terapia de los casos de peste en la Habana y resumen de los mismos," *San. & Benef.*, Sept. 1914, pp. 325–347; English text, *Ibid.*, Nov. 1914, pp. 550–570.

tions of which many workers were members. Guiteras also expressed the opinion that the effort usually made in America to discover even mild cases may be responsible for the generally lower plague mortality, since individual case records show that the course of the disease may be very severe.[24]

Vaccination and serum-therapy.—Vaccination was used principally for personnel having to enter plague foci. Careful studies were made of the effects of serum-therapy in Cuban patients, which showed very favorable results. It was said of the treated cases, "none seems to have presented, during the invasion, the characters of unusually mild cases. Some of them were seriously in danger of their lives. The buboes suppurated in all of them but one."[25] Of the total of 27 cases 6 deaths in Habana in 1914, 23 received intravenous injections of serum; five of these apparently died, a rate of 21%;[26] in one hospital (Las Animas) the mortality rate in treated cases was only 0.09%.[27] Good serum was used, intravenously: 80 cc in the vein immediately after diagnosis, another 80 cc in six hours if the temperature had not dropped, and in 12 hours if it had; if it continued to fall, 80 cc more after 24 hours, and 40 cc every 24 hours thereafter until it was normal (a total of 200–600 cc being given).[28]

Control.—Control methods have been discussed under the handling of the various epidemics. Cuba was one of the first countries in which cyanide rather than sulfur was extensively used for fumigation.

Seasonal incidence.—Cuban plague seems to have avoided the early part of the dry season (December to April), although the flea population is said to decrease during the rainy period, being at its lowest in June. (See Fleas.) Cases occurred from June to July, 1912, from February to June, 1914; and from February to August, 1915, in Habana; and from June to September, 1914, in Santiago.

Research.—Cuban research has included trial of new control methods; studies of fleas and their habits; and careful observation of treatment, as already discussed above.

[24] Guiteras, *supra*, *San. & Benef.*, Sept. 1914, p. 313; he pays tribute to the alert interest of the medical profession in Cuba, the strong national health organization, the Habana health department, and the prompt reporting of suspicious cases by the private hospitals of the associations. In contrast to the situation in some other countries, no individuals were found in a dying condition, without medical care, nor were any bodies found in the streets or elsewhere.

[25] Guiteras and Recio, *supra*.

[26] One of the fatal cases had received serum obtained in 1912. Of the 4 non-serum-treated cases, one was very mild and had been diagnosed late; two were *pestis minor*, requiring no treatment, and one was a violent septicemic case. Twenty cases, with 3 deaths, were treated with serum under the supervision of health department officials, the mortality rate being 10%. (Guiteras & Recio, *supra*.)

[27] Las Animas Hospital; 12 C 1 D, rate 9.09%; all bubonic cases; the fatal case did not begin treatment until the 4th day, and then received only small doses. Casa de Salud La Covadonga: 7 C, 2 D, rate 28.57%; all bubonic; of the fatal cases, one began treatment on the third or fifth day, dying 3 hours later, the other, on the 4th day. Purísima Concepción Hospital: 5 C 2 D among serum-treated cases, 40% mortality, and 7 C 3 D in another group of serum-treated cases, 42.86% mortality. (*Ibid.*)

[28] Only three of 11 cases observed had serious reactions, and those not worse than in diphtheria; two gm. of calcium chloride was administered every 24 hours to prevent such reactions. (*Ibid.*)

GRENADA

Grenada, the most southerly of the Windward Islands, lies between 12°30′ and 11°58′ N. Latitude and 61°20′ and 61°35′ W. Longitude. It has an area of about 120 square miles, and the population in 1911, shortly before plague was reported, was estimated at 67,848. The climate is regarded as dry and pleasant from December to May and damp and hot during the other six months; the average annual rainfall is 80 inches, except in the interior, where it is nearly twice as much. The island is very mountainous. Near sea level the maximum mean temperature is 90°F. and the minimum, 68°F. The principal crop is cocoa.

Despite the presence of plague in other West Indian islands, particularly Trinidad, the disease apparently made its way to Grenada but once: in May, 1912, a fatal case of plague was reported in an individual who arrived from Trinidad May 1, fell ill May 2, and died May 7.[29]

JAMAICA

In early July, 1912, at the time plague was discovered in Habana, a Jamaican vessel left the latter port and returned home. The ship was fumigated, and 67 rats were found and examined, nine were suspicious for plague, and two proved to have the disease, as shown by cultures and experiments on animals. No plague was found among 853 rats caught on the wharves and elsewhere in Jamaica.[30] It was thought by local authorities that discovery of the ship-borne infection may have prevented an invasion of the island.

PUERTO RICO

Puerto Rico is situated between 65°30′ and 67°30′ W. Longitude and 18° and 18°30′ N. Latitude. It has an area of 3,435 square miles and a population of 2,000,000. The climate averages 76°F. for the year, with the coolest season from November to April. The island has suffered two outbreaks of plague, in 1912 and in 1921, with a total of about 88 cases.

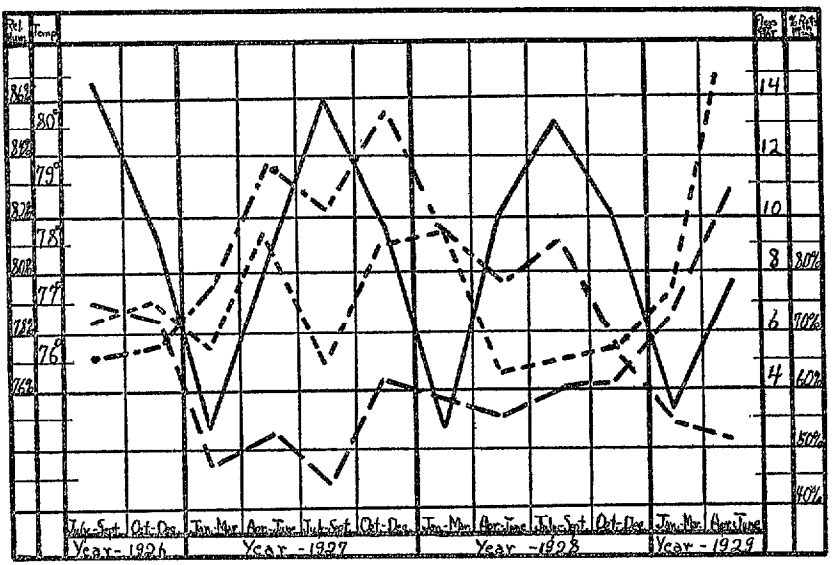
One June 16, 1912, a suspicious case of plague was reported in the Puerta de Tierra quarter of San Juan, capital of the island.[31] The diagnosis was confirmed by June 19, by which time 13 or more human cases had occurred, and the acting Governor immediately announced the presence of plague. The first case fell ill June 12, was observed June 14, and died on the 17th. There seems to have been an epizootic among rats in the latter part of April or early May, and 66 infected rats

[29] U. S. *Public Health Reports*, June 7, 1912, p. 927. Low, *supra*, also reports the case.

[30] Low, supra, 1911–12, p. 53. (Citing the "Report on the Work of the Government Bacteriologist, April–Sept. 1912," by Dr. H. H. Scott, Pathol. Lab., Kingston.) Nor were any plague-infected rats found among 670 destroyed in Kingston in 1937. They were *norvegicus* and *rattus*. (Off. Int. d'Hyg. Pub.: "VII Relevé annuel . . . concernant la destruction des rats, etc.," Paris, 1939.)

[31] The city of San Juan had in 1912 a population of about 50,000. It was located on a headland separated from the mainland by two well-bridged estuaries; the old city, water-front district (La Marina), and suburb of La Perla were on the point, separated by ¼ mile of un-built-upon land from the Puerta de Tierra quarter, the latter largely of frame construction and scene of the heaviest infection. It, in turn, was separated by unoccupied land and estuaries from the modern suburb of Santurce. (Creel, R. H.: "Plague eradication in Puerto Rico," *Jour. Amer. Med. Assn.*, May 17, 1913, pp. 1527–32.)

were found during the campaign. The last human case in the island was September 8, in a San Juan suburb, and there was a total of 56



Relation of Humidity and Temperature to Flea Prevalence in San Juan, Puerto Rico, 1926–1929*

Key: Relative Humidity (%) - — - — -. Number of fleas per rat ----------. Temperature (°F) ————. Percentage of rats with fleas — — —.

* From the graphs by A. L. Carrion, *Pub. Health Rep.*, Jan. 22, 1932, pp. 198, 200. The author points out that during the last part of 1929, a cyclone struck the island, hindering the work, so that data for this period are rather unreliable.

cases, 36 deaths (mortality 65%).[32] The source of the infection was believed to have been the Canary Islands.[33]

[32] Creel gives 55 C. Grubbs reported 56 C 36 D for the island. (Grubbs, S. B.: "The Plague Outbreak in Porto Rico," *Jour. Amer. Med. Assn.*, Jan. 24, 1914, p. 288.)

[33] Grubbs, *supra*. Venezuela had been suggested, but it was considered an unlikely source, since vessels leaving Venezuela for Puerto Rico had first to undergo fumigation under the supervision of a U. S. Public Health Service officer. Guiteras, of Cuba, had suggested the Canary Islands as the origin of Cuban plague, and in view of the considerable traffic with them and the unacknowledged presence of the disease there, this seemed very likely. (See CUBA and CANARY ISLANDS.) In a later article, Grubbs remarked that the Canaries were probably the source of the 1921 plague in Puerto Rico also, stating that the reinfection followed shortly after the discontinuance of routine fumigation of cargo from those islands. (Grubbs, S. B.: "Fumigation of Vessels from Plague-infected Ports—Observations with Especial Reference to the Necessity for Fumigating Crates and Similar Cargo," U. S. *Pub. Health Rep.*, Jan. 12, 1923, p. 59.) In 1912 crates of foodstuffs, etc., from the Canary islands, consigned to the interior of Puerto Rico via San Juan, were opened and repacked, and after some rats were found in them, all such freight was fumigated. Sulfur was used at first (in a warehouse, or on lighters under a tarpaulin), but required a long exposure and did some injury; cyanide gas was later tried and was a great improvement; it was used either on lighters or in a special galvanized iron shed. Goods from Spain were also fumigated. It was stated by Fauntleroy that plague rats were destroyed in certain warehouses where merchandise from Spain and the Canary Islands was stored in large quantities.

Recognition of the outbreak was immediately followed by a clean-up of the city, during which tons of rubbish were removed.[34] The control work was based upon examination of rats, and so energetic was the campaign against these animals that in the Puerta de Tierra district they were reduced to 10% of their former numbers by January 1913. Rat-proofing was widely and thoroughly carried out throughout the city.[35] Freight cars leaving the city were inspected, but none of 57 rodents taken from cars proved to be infected.

Despite such precautions, or perhaps before they were instituted, the disease spread from San Juan to neighboring villages.[36] (In contrast to its behavior in Cuba during the first outbreak there.) Of the 66 infected rats found from the beginning of the campaign to January 1913, 7 were from Carolina (July) and 6 from Caguas (Sept. 13, Oct. 14, Dec. 9, 21) and Arecibo (Oct. 11 and 25). One plague rat was found dead in Río Piedras. Rats were also trapped in Ponce, Mayaguez, Aguadilla, Bayamón, Manatí, and other localities, but none were plague-infected.

In addition to the cases in San Juan, there were human plague cases in Carolina, 14 miles away (June 26, in a freight handler; two others, the last July 16) and Dorado, 20 miles distant (July 13, a fatal case in a boy who had, one week previously, been a stowaway on a freight car en route from San Juan to Arecibo.) There was also a fatal case on the coasting steamer *Guillermito*, bound from San Juan to Arroyo.[37]

During February, 1921, dead rats began to be found in houses in Tetuán Street, San Juan, and the householders threw them into garbage cans with the other wastes, which were taken to the incinerators. The occurrence came to the notice of the Health Department, which investigated, and on February 17 its Biological Laboratory found plague in one of the rats. Again the source of infection was suggested to be the

[34] Sixty large truck-loads of waste were removed from old San Juan in one night. "No one imagined that behind those nicely painted walls were such quantities of waste material." (Grubbs, *supra*, 1914.)

[35] The ordinance provided that dwellings, food depots, warehouses, docks, stables, and chicken-yards must be rat-proofed. Buildings were to have a concrete foundation or be elevated two feet above ground; food depots (restaurants, warehouses, etc.) must have concrete floors and side-walls and a tight closure of doors and windows. All groceries, meat markets, bakeries, restaurants, markets, and warehouses were so treated. Stables were required to have concrete floors; they were not regarded as serious hazards, since the principal fodder was grass. Docks were to have concrete floor and walls. The greatest difficulties were with the old *mamposteria* construction (mixture of stone, sand, clay, and lime), and it was finally decided to place a concrete capping 2 feet in depth on such walls, extending upward from a concrete floor. Pipes in courtyards were required to have rat-guards. The cost of rat-proofing the 1,125 buildings in Puerta de Tierra was $80,000. For rat-trapping, 3,000 traps were used in San Juan and 3,000 elsewhere; 40 trappers, 10 foremen, and 1 inspector were employed, and poison (600 lbs. arsenic and phosphorus, July 1-Jan. 1) was also distributed. The maximum rat catch was during the last week of July. (Creel, R. H., *supra*, Note 31.) The campaign was carried out with the assistance of U. S. Public Health Service officers, who were sent upon the request of the acting Governor for help. The author remarked that the efforts of civilians are effective aids in reducing rat populations, but these efforts flag when human cases cease, and that "anti-plague work accomplished in the first days of a threatened epidemic, when popular opinion is strongly approving all sanitary requirements, should be of as permanent a nature as possible. Rat proofing cannot be instituted too soon or enforced too vigorously."

[36] It was reported that rats had been seen escaping from railway cars before the inspection service was started. On the other hand, a considerable rat mortality was observed on the San Juan-Caguas turnpike two or three weeks before the first plague rat was found in the latter, locality. (Creel, *supra*.)

[37] Low, R. Bruce: "Report on the Progress & Diffusion of Plague," etc. 1911-12," p. 54.

Canary Islands.[38] Plague rats were found at the Puerta de Tierra and Santa Elena incinerators. Both rat and human plague spread to other towns in the island.[39] Of a total of 30 human cases from February 18 to August 31, 1921, 6 were in San Juan proper and 4 in Puerta de Tierra, and the rest in Arecibo (1), Bayamón (1), Caguas (6), Carolina (4), Dorado (1), Isabel (1), Manatí (3), Martín Peña (1), and Santurce (2).[40]

From February 17 to June 30, 78,300 rats were examined, of which 456 were suspicious (88 positive), and 5 additional plague rats found from July to September made a total of 93, distributed among: San Juan (44), Puerta de Tierra (11), Santurce (23), Río Piedras (6), Manatí (4), and Carolina, Caguas, Fajardo, Bayamón, and Guaynabo, one each.[41] At the beginning of the epidemic, dead rats were found in the plague area which failed to show macroscopic signs of plague, but which, on inoculation into guinea pigs, were found to harbor virulent plague bacilli.[41]

The last cases in the 1921 outbreak appear to have been 4 C 2 D in August in Caguas.[42] On Sept. 9, 1921, a plague rat was found on the S.S. *San Luis*, in San Juan harbor.[43]

Rats.—Of 39,295 rodents captured from June 23, 1912, to January 11, 1913, 23,453 (59%) were *norvegicus*, 4,210 (16%) *rattus*, 5,962 *alexandrinus* (15%), 5,137 (15%) *musculus*, and 233 mongoose (with 309 unclassified the first week). Of 66 infected rats, 37 were *norvegicus*, 4 *rattus*, 1 *alexandrinus*, and 24 unclassified, 23 were found in dwellings, 8 in food depots, 2 in stables, 2 on steamers, 10 dead on the street, and 21 were untagged as to origin. All three species of rats, but especially *norvegicus*, were found in dwellings; *alexandrinus* was the chief rat found in rural areas.[44]

From July 11, 1926, to June 30, 1929, the Bureau of Plague Prevention of the Insular Health Department carried on, in cooperation with officers of the U. S. Public Health Service, a rat-flea survey of San Juan.[45] Cage traps were distributed at the rate of 205 per day among 39 premises. Rats were obtained from but 1.8% of the localities trapped, and an estimated 4.2 rodents were captured per 1,000 traps set. Of the 1,005 live rats thus obtained (800 adults), 72% were *R. norvegicus*, 15% *R. alexandrinus*, and 13% *R. rattus*. There were 119 more females than males, and 168 (30%) of the females were pregnant (with an average

[38] Fauntleroy (cited by Grubbs, *supra*, 1923, Note 33) stated that in the 1921 outbreak the original focus was "in and about" a wholesale store where goods from the Canary Islands were stored.

[39] Morales Otero, P.: "Estudio epizoótico de la epidemia de peste bubónica en Puerto Rico, 1921," *Bol. Asoc. Méd. P.R.*, March 1923, pp. 49-56.

[40] *Pub. Health Rep.*, 1921. Ortiz gave a total of 33 cases. (Ortiz, Pedro N.: "Puntos fundamentales en el diagnóstico de la peste bubónica," *Bol. Asoc. Méd. P.R.*, March 1923, pp. 56-61.)

[41] Morales Otero, *supra*.

[42] U. S. *Pub. Health Rep.*, 1921.

[43] *Ibid.*

[44] Creel, *supra*.

[45] Carrión, Arturo L.: "Final Report on a Rat-Flea Survey of San Juan," *Pub. Health Rep.*, Jan. 22, 1932, pp. 193-201. See also the preliminary reports: Cox, O. H., Carrión, A. L., and Fox, Carroll: "Rat-Flea Survey of the Port of San Juan, a Preliminary Report," *Ibid.*, Mar, 16, 1928, pp. 611-616; and Carrión, A. L.: "Preliminary Report on a Rat Flea Survey of the City of San Juan," *P.R. Rev. Pub. Health & Trop. Med.*, v. 3, p. 131, 1927; v. 4, p. 84, 1928; and "Third Report," *Ibid.*, v. 5, p. 158, 1929 (also *Pub. Health Rep.*, July 4, 1930, pp. 1515-1520).

of 7.5 embryos; the largest number was 11). The concentration of rats was heaviest in the water-front and residential sectors (7 and 6.6 rats per 1,000 traps respectively, compared with 3.2 and 2.97 in the dock and commercial areas). (See also Fleas.)

Fleas.—In 1912, according to Creel, there were not enough live rats examined for fleas in July and August to give percentages. *X. cheopis*, *Ct. canis*, and *Echid. gallinaceae* were found, and on humans, *Rhynchoprion penetrans* (chigoe).[44] During the 1926–29 rat-flea survey, fleas were found on 56.9% of the 1,005 live rats caught (see Rats), the number of rats harboring such parasites varying from 47.7% of *norvegicus*, to 78.2% of *alexandrinus* and 82.9% of *rattus*. The flea indices for the respective species were 6.3, 7.1, and 8.4; for all rats, 7.1. The *cheopis* index was 7. While five species of fleas were found (*X. cheopis*, *Ech. gallinaceae*, *Ct. canis-felis*, *P. irritans*, and *L. musculi*), 98.5% of the 7,145 fleas caught were *X. cheopis*. The flea index per rat was highest at the docks (13.9), followed by the commercial district (5.8), the residential (3.5) and water-front zones (2.4). The highest number of fleas on a single rat was 303 (or more) on a female *alexardrinus* taken in a fertilizer warehouse in the water-front area (two other rats, from the same district, harbored 124 and 111 fleas). The number of fleas seemed to rise in accordance with the humidity, but showed little reaction to the temperature.[45]

Seasonal prevalence.—Plague in Puerto Rico seems to have preferred the warmer weather: the 1912 outbreak lasted from June through September, with rat plague possibly from April through December; and the 1921 epidemic was from February through August, with rat plague extending on into September.

Kinds of plague.—In the 1912 outbreak the cases were said to have been all bubonic, with a mortality of 65%.[46] Of 33 cases in 1921, 32 were bubonic (femoral bubo, 23 or 85%; femoral-inguinal, 3; axillary, 2; femoral-cervical, 1; inguinal, 1; femoral-axillary, 1; multiple, 1), and one primary pneumonic.[47] There were two cases of secondary plague pneumonia.[48]

Vaccination and serum-therapy.—Reports on the use of vaccine in Puerto Rico seem to be lacking, although residents of the island recall that vaccine was available in 1921. As to serum, Lavandero stated, following his 1921 experience with it, that "the curative value of anti-plague serum is, in our opinion, undeniable, if used in its proper time," and he emphasized the necessity of using large doses. He began originally by giving 100 cc intravenously every 12 hours, and by the end of the epidemic he was administering 500 to 600 cc daily, divided

[46] Creel, *supra*.

[47] Ortiz, *supra*.

[48] Lavandero, R.: "Observaciones clínicas y tratamiento de la peste bubónica, durante la epidemia de 1921," *Bol. Asoc. Méd. P.R.*, March 1923, pp. 40–41.

in two intravenous injections, with good results. Of 24 cases under his observation in the Isolation Hospital, 11 died, two of whom had received no treatment (one died of pneumonic plague ½ hour after entry, and one of secondary pneumonic plague, 1 hour after arrival); so that of 22 cases presumably receiving serum, 7 died (mortality 31%). It was stated that only 4 of the 7 fatal cases had received serum for some length of time, the others entering at a later stage of the disease (bringing the mortality for 19 cases down to 21%).[49]

Control.—Control measures have been described in connection with the two outbreaks. Mention may be made of the use of the "guinea pig test" to judge the efficacy of disinfestation: live animals were left on the premises, and in two instances they died of plague, whereupon the house was again disinfested.[50] Rat trapping and examination were continued after the eradication of the disease; in 1936–1937, 2,582 rats were trapped and examined in San Juan, none being found plague-infected.[51] Puerto Rico was one of the first places to use cyanide for ship fumigation.

Research.—Mention has been made of the bacteriological studies of rats during the two outbreaks, and of the three-year rat-flea survey of San Juan. In the 1921 epidemic human sputum was tested for plague bacilli, results not stated.[52]

TRINIDAD

Trinidad lies between 10°3′ and 10°50′ N. Latitude and 60°55′ and 61°36′ W. Longitude. It has an area of about 1,754 square miles and a population of about 440,373, including many East Indians. The island is hilly and has a tropical climate, with a dry season from January to May and rain from June to December (annual average, 63.72″). The coolest period is from December to April, and the daily temperature may range from 70° at dawn to 87° at two or three o'clock.[53] The chief city, Port of Spain, has a population of around 90,000. Principal products of the island are cocoa, sugar, coconuts, coffee, and citrus fruits.

Plague was reported in Trinidad from 1907 through 1912, with a total of about 69 cases.

The first recorded outbreak seems to have been in June, 1907, when two fatal cases occurred in a negro boy (8) and girl (9), who fell ill June 1 and were taken by their mother to the health center June 3;

[49] *Ibid.* He reported that both Pasteur and Lederle sera gave good results.

[50] Morales O., *supra.*

[51] Office International d'Hygiène Publique: "XVII Relevé Annuel . . . concernant la destruction des rats dans les ports, etc." Paris, 1939.

[52] Giulani, S.: "Examen de los esputos practicados en el Laboratorio Biológico durante la epidemia de peste bubónica en Puerto Rico, 1921," *Bol. Asoc. Méd. P.R.*, March 1923, pp. 61–63.

[53] In 1912, a plague year, the mean temperature was 75.4 F, ranging from 71.3 to 90.1; at Port of Spain the barometer averaged 30.061 (highest, 30.120; lowest, 29.923); and the average rainfall for the island was 81.68″ (ranging from 128 in the Caroni district to 34.15 at Moriugo on the southern coast). The greatest mean rainfall was in June (13.08″), while the driest month was March (0.08″). The rainfall for the year in Port of Spain was 79.6″. (Lloyd, R., *et al.*: "Twentieth Century Impressions of the West Indies, their History, People, Commerce, Industries and Resources," 550 pp., Lloyd's Greater Britain Publishing Co., London, 1914, p. 228.)

they died June 5 and 4 respectively, despite hospital care. Post-mortem examination showed evidence of bubonic plague, confirmed by microscopic examination of the blood. The house was disinfected and thereafter inspected daily; rat destruction and examination (with negative results in the latter) were begun; contacts were isolated. No further cases were reported in 1907.

The origin of these cases remains a mystery. While plague was present in Brazil, vessels from that country were closely inspected at Trinidad. The alternative suspect is an Indian vessel, the *Indus*, which left Calcutta Oct. 30, 1906, with 753 coolies for Trinidad. There had been 23 deaths en route, from "meningitis," "pneumonia," etc. The vessel was disinfected and the passengers were rigidly inspected at landing, but it is said that no precautions were taken with regard to the cargo of rice which was unloaded. The *Indus* went on to Cuba, having 11 more deaths on the way. There was no confirmation as to whether any of these cases were plague.[54]

From June to September 28, 1908, there were some 20 cases, 16 deaths, from plague, all in Port of Spain, the original focus being a tenement known as "Telegraph Yard," housing East Indian coolies, where four suspicious deaths had occurred in early May. There were 5 cases in 14 days from the "Yard," whereupon the remaining 81 roomers were moved to an isolation camp on the grounds of the isolation hospital, which latter, according to the Government analyst at Trinidad, had been built about six years previously "in anticipation of a possible introduction of plague from India by means of immigrants imported yearly for indenture on sugar and cacao plantations."[55] He also reported that the present plague foci were in the part of the town nearest the harbor, as much as half a mile apart, and that the origin of the infection was not determined.[56] Over 300 persons were sent to the isolation camp for 5 to 10 days observation from the beginning of the outbreak to July. Some plague foci were burned, rewards were offered for rats, and clean-up squads were organized. Five plague rats were found.[57]

Nearby islands became alarmed. St. Lucia instituted an anti-rat campaign in June, which included the distribution of Danyz virus, in fear of indirect infection from Trinidad (with which she had little direct communication). A conference of representatives of all British West Indian islands except Jamaica was scheduled to meet in Barbados in July, for the purpose of considering the best ways and means of handling vessels from plague-infected ports.[58]

[54] U. S. *Pub. Health Rep.*, Aug. 23, 1907, p. 1186; and Jan. 4, 1907; and Low, *supra*, 1906, p. 76.

[55] U. S. *Pub. Health Rep.*, June 12, 1908, p. 843, and rest of year.

[56] In connection with two fatal cases on September 26 and 28, it was reported that both were in employees of a department store in Port of Spain who had been handling sole leather supposedly imported from Venezuela (U. S. *Pub. Health Rep.*, Oct. 23, 1908, p. 1552). Venezuela and Trinidad had been engaged in imposing quarantines against each other about this time.

[57] Low, *supra*, 1911–12, p. 56. (Notes 1 and 37.)

[58] U. S. *Pub. Health Rep.*, July 17, 1908, p. 1041 (reporting the departure of the Health Officer of Castries, St. Lucia, for the conference. No further reference to it was found.)

In 1909, 10 cases, 9 deaths, and 9 plague rats were reported from Trinidad.[59]

In 1910, 9 cases, 5 deaths of plague were reported, the first February 18, the last, July 12. Seven of them were in April and May at Tacarigua, 10 miles from Port of Spain (an outbreak among coolies on a sugar plantation, which was quickly brought under control by the health authorities. Haffkine vaccine was given to the coolies).[60]

During 1911, 7 cases were reported, February 10 through May 9, mostly in March and April, and all in Port of Spain. There was one death, and 3 plague rats were found.[60]

Some 13 cases, 7–9 deaths were recorded from April to July, 1912 (6 cases in April, beginning April 1, one of them in Tunapuna, 8 miles from Port of Spain, and 5 in June, two at Tunapuna; and two in July). All 3 Tunapuna cases were fatal. It was stated that in Port of Spain there was seldom more than one case, or at most, two, in a focus, and the cases usually occurred in different sections of the city, without any apparent connection. Suspicious cases were immediately isolated and a bacteriological examination made; premises were disinfected, and contacts isolated. Rat extermination work went on continuously, and the number of these animals was said to have decreased. Of more than 16,000 examined only three were infected.[60, 61]

There do not seem to have been any subsequent reports of plague from Trinidad.

VIRGIN ISLANDS

A notice in a London paper (*London Shipping Gazette*, June 2) in 1908 reported a telegraphic notice of a fatal case and two suspicious cases of plague at St. Thomas, Danish West Indies. No further reference to these supposed cases has been found, and Low is of the opinion that perhaps they were not plague.[62]

THE AZORES, CANARY AND CAPE VERDE ISLANDS

While these groups fall outside the scope of the present paper, it has seemed well to discuss briefly a few known or alleged instances of their connection with American plague.

AZORES (Europe)

Plague was alleged to have been brought to the Azores by emigrants returning home from Brazil,[63] but it must be recalled that there were

[59] Low, *supra*, 1911–12.

[60] Report of Consul Hale, June 20 (U. S. *Pub. Healyh Rep.*, July 12, 1912, p. 1120); subsequent *Pub. Health Rep.*, 1912; and Low, *supra*, 1910, 1911–12.

[61] R. Lloyd *et al.*, (*supra*, note 53) reported 12 cases for 1912 (p. 228: "there are . . . recurrent outbreaks of plague and yellow fever, which are due to proximity to the continental ports of Spanish America. In 1912 there were 12 cases of bubonic plague and 6 cases of yellow fever in Trinidad; 75 percent of these cases were fatal"). Once again the popular idea of "importation."

[62] Low, *supra*, 1908, p. 24.

[63] Low, R. Bruce: "Report on the Progress & Diffusion of Plague, etc., 1908"; also, *Ibid.*, 1910.

PLAGUE IN THE AZORES[a]

DATE	TERCEIRA ISLAND				SÃO MIGUEL ISLAND				FAYAL ISLAND				PICO ISLAND		TOTALS	
	Island		Angra-Heroismo		Island		Ponta Delgada		Island		Horta		Lages			
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
1908	June-Dec.	194	108													
1909	To Oct.	62	20						19[b]	6						
1910																
1911																
1912																
1913	Dec.	1														
1914																
1915	July	P														
1916	Nov.	P														
1917																
1918																
1919	Sept.	P							P							
1920	Oct.-Dec.				149		49									
1921	Sept.									1						
	Sept.-Nov.				250[c]		50[c]									
1922	Jan.-Feb.								6	4						
	Jan.-Dec.				546[d]		154[d]									
1923	Nov.-Dec.													8		
	Year				200	84			6[e]	3	(3)					
1924	Sept.-Oct.				4[f]											
	Nov.													1[g]		
1925	Nov. 1924-Jan. '25				33	14										
1926	Jan.-Nov.				20	7[h]										
	Aug.										2	2				
1927	Apr.-Dec.				16		2									
1928	Dec. 1927-Nov. 1928				30	12										
1929	Jan.-Jul.														4	
1930	Jan.				20		9									
1931	Year														151	
	Jul.-Sept.		22													
	Nov.	16		6[i]		1		5								
1932															121	
1933															61	
1934															80	
1935															51	
1936															35	
1937															15	
1938															38	
1940	Jan.-Sept.														2	
1941	Jan.-Sept.														2	

TOTAL NUMBER OF CASES FOR THE AZORES, 1908-1941 2,128

[a] From: U. S. *Pub. Health Rep.*; "Annual Epidemiological Report," Health Section, League of Nations; and Low, R. B., "Reports and Papers Bubonic Plague," Local Governing Board, London. Undoubtedly these figures are incomplete.

[b] Aug. 1908-Jan. 1909.

[c] Approximate figures. Including cases from Relva, Ribeira Grande, Santo Angelo, and Capelas.

[d] From Arrifes, Fenaes d'Ajuda, Ribeira Grande, Livramento, Ponta Delgada.

[e] Including 3 C 3 D Castelo Branco and the 3 C from Horta.

[f] Including cases at Arrifes and Faja de Clima.

[g] Castelo Branco, Present; Feteira, 1 C.

[h] Including 4 C 1 D at Furnas, 27 miles from Ponta Delgada.

[i] Including 16 C 6 D at Práia da Vitória.

P—Present.

many other possible sources, including Portugal herself.[64] From June, 1908, when the first reported outbreak seems to have occurred (256 C 123 D from June 1908 to Oct. 1909), through September 1941, some 2,128 cases have been recorded, in the islands of Terceira (about 295 C, including cases in Angra-Heroismo and Praia da Victoria), São Miguel (about 1,273 C, mostly in Punta Delgada and area, including Arrifes, Capelas, Faja de Clima, Fenaes d'Ajuda, Livramento, Relva, Ribeira Grande, and Santo Angelo, and reaching Furnas, 27 miles away), Fayal (about 35 C, mostly at Horta, Castelo Branco, and Feteira), and Pico (8 C, at Lages). Only the years 1910–12, 1914, 1917–18 and 1939 have no reported cases.[65]

There do not seem to have been any allegations of infection of an American focus from the Azores.[66]

CANARY ISLANDS (Africa)

In November and December, 1906, 28 C 12 D of "infectious fever" were reported at Santa Cruz, Tenerife, Canary Islands. A medical officer was sent by the Spanish Government to investigate, and the outbreak was officially reported as enteric fever.[67] Unofficially, it seems to have been recognized as plague, with about 69 human cases and some infection in rats.[68] Rumors—and denials—of plague in the islands persisted, and in 1910 a representative of the Cuban Government visited them to see what the situation was and what control measures were being taken. He returned convinced that the disease was present there.[69] There were still no official reports on plague in the Canaries, but in February, 1913, five fatal cases were reported in Santa Cruz. And finally, on November 30, 1924, an "official declaration" was made

[64] Plague was reported in Portugal in 1899, 1910, 1920-1923, and 1928, and possibly other years, chiefly in Lisbon and Oporto.

[65] Information taken from Low, 1898–1912; U. S. *Pub. Health Reports*, and "Epidemiological Report," Health Organization, League of Nations.

[66] Rat examination is maintained at Ponta Delgada. In 1937, 243 rats were destroyed and examined, none being found infected; 223 were *norvegicus*, 14 *musculus*, and 6 *rattus*. (Off. Int. d'Hyg. Pub.: "VII Relevé annuel . . . concernant la destruction des rats, etc.," Paris, 1939.)

[67] Low, *supra*, 1906, p. 99.

[68] Grubbs, S. B.: *supra*, *Jour. Amer. Med Assn.*, Jan. 24, 1914, p. 288. He stated that the royal delegate informed the Spanish government that the disease was plague but that he had suppressed the knowledge, "apparently," to quote Grubbs, "believing that the tranquillity and commerce of the Canary Islands was more important than the health of the world. In this policy of suppression the authorities to whom the report was submitted must have agreed, for the report was not made public or the presence of the disease announced."

[69] See CUBA. Plague acquired a new synonym subsequent to the 1906-7 outbreak, according to Cartaya: "Indian typhus." He said that "it is unnecessary to apply to any person in particular, since every one in Santa Cruz is ready to give the most minute details as to the epidemic, and even the authorities, both civil and military, were willing to talk to me freely about it." He was told by a local editor that the presence of plague in the islands was known at the time in Europe, interfering greatly with commerce, "the disturbance not being greater because the Government refused to recognize the disease officially." Even the Spanish mail omitted Santa Cruz from its regular itinerary. A vessel which had been chartered to carry a number of families was received "by a gunshot quarantine at Las Palmas and had to put back into Tenerife." Santa Cruz de las Palmas was said to have had a small outbreak subsequent to the one in Tenerife. (Cartaya, J. T., *supra*, Note 6.)

PLAGUE IN THE CANARY ISLANDS[a]

DATE	GRAND CANARIA				TENERIFE								PALMA		TOTAL	
	Island		Las Palmas		Island		Sta. Cruz		Laguna		Realejo Alto					
	C	D	C	D	C	D	C	D	C	D	C	D	C	D	C	D
1906					28		12									
1906–07															69	
1908																
1909																
1910																
1911																
1912																
1913 Feb.					5										5	
1914																
1915																
1916																
1917																
1918																
1919																
1920 Oct.			Rat													
1921																
1922																
1923			34		27		46[b]		27							
1924			3[c]						1		3		1			
1925 Dec.			1				3				3		2			
1926 Dec. 1925–Feb. 1926					3											
Aug.–Dec. 1926			1[d]		1		3						2			
1927 Jan.–Dec.							1									
Jan.–Feb.					1[e]											
June									17		1					
1928															38	
1929									3							
1930 Jul.–Sept.															1	
1931 Jan.–Mar.																1
1932 Jan.–June															9	8
1933																
1934																
1935 Jan.															1	
1936																
1937																
1938																
1939																
1940																
1941																
TOTAL, about															249 C	

[a] From U. S. *Pub. Health Rep.*; "Annual Epidemiological Report," Health Section, League of Nations; and Low, R. B.: "Reports and Papers Bubonic Plague," Local Governing Board, London. Very incomplete figures.

[b] Including San Juan de la Rambla.

[c] Puerto de la Luz. It was pointed out that this focus is in frequent communication with plague-infected African ports.

[d] Alarife, 1 C 1 D.

[e] Miguel, 1 C.

P—Present.

to the effect that the occurrence of plague had been reported in the Canary Islands, at Grand Canary and Tenerife, since the year 1907.[70]

From 1906 through 1935, about 215 C have been reported, with none for 1908–12, 1914–19, 1921–22, 1933–34, and 1936–42, but there appears

[70] U. S. *Pub. Health Rep.*, March 27, 1925, p. 629. It was further reported that the measures ordered to be carried out to extinguish the foci of infection had been unsuccessful, owing largely to local indifference, and that a commission had been appointed to study the existing foci and to propose measures for their destruction.

In 1928 the Consul of a Central American country found himself in difficulties because the sanitary

to be reason for belief that plague occurred in some of these as well. The foci have included Grand Canary (Las Palmas, Puerto de la Luz, Alarife), Tenerife (Santa Cruz, Laguna, Realejo Alto, Miguel), and Palma.[71]

On the basis of circumstantial evidence, it has been suggested that the Canary Islands were the source of plague infection in four widely separated ports: San Juan, Puerto Rico (plague June 15, 1912; and possibly the 1921 outbreak as well); Habana, Cuba (plague July 4, 1912); New Orleans (plague rat found July 27, 1912); and Liverpool (plague rats found August 1 and 30, 1912). It was the usual practice for Spanish steamers, after leaving mainland ports, to take on onions and potatoes at Santa Cruz de Tenerife, on their way to the various places mentioned (at which they called in the order named).[72]

It must not be forgotten that plague also occurred in Spain (1906, 1922-23, and perhaps other years, chiefly in the ports of Barcelona, Cartagena, Malaga, Mijas, and Valencia), and in fact, it has been said that the Canaries may have been infected from Barcelona.[73] Mention might also be made of the fact that in 1902 two vessels from Argentina, the *Duca di Galliera* and the *Espagne*, called at the Canaries, to discharge passengers and take on coal, and after continuing their voyage, arrived in European ports (Genoa and Marseilles) with plague cases on board. It was stated that there was no plague in the islands.[74]

CAPE VERDE ISLANDS (Africa)

Plague was reported in the Cape Verde Islands in 1921–23 (August, 1921, 6 C 3 D; March and Sept., 1922, Present, both at St. Vincent), and 1927 (last case?). It has also been reported occasionally on vessels which had touched at these islands, though without any certainty as to whether or not they had picked it up there.[75]

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uthorities at Tenerife persisted in denying the existence of cases of plague which were admitted even by the Ministry of State at Madrid, and he was in doubt as to what to report on the bills of health of outgoing vessels. It was apparently decided that, if an admission of the facts could not be obtained from the local authorities, the Bill of Health should be issued in conformity with the data furnished by them but with the notation that supplementary information had been given the Captain, addressed to the authorities of the Consul's country, to be presented at the first port of call in the latter place. This supplementary information would, of course, contain the unofficial data on the disease, and would afford t he port officials some indication of what to watch for. (Correspondence with Costa Rica, Pan American Sanitary Bureau, 1928. The circumstance is illustrative of the intricate problems which arise in international sanitation.) Incidentally, another synonym for plague cropped up in the Canaries at this time: the hapless consul reported that deaths were entered on the Civil Register as due to "*yersinosis*."

[71] Figures from Low, from U. S. *Pub. Health Rep.*, and from League of Nations.

[72] Grubbs, S. B., supra, Note 68.

[73] Guiteras (*San. & Benef.*, Nov. 1914, p. 537) commented that the authorities of the Canary islands had "stoutly persisted in their policy of concealment, though these same Canary Islands had been the victims of the same policy practiced by Barcelona during the plague outbreak there in 1906."

[74] Low, *supra*, 1903, p. 303. It will be recalled that the Argentine ports were plague-infected at this time. However, the Canary Islands were also in communication with other plague infected localities. In 1925, in mentioning the occurrence of plague in Puerto de la Luz, Canaries, it was stated that this port is in close contact with African plague ports, receiving 5 to 6,000 vessels a year. (*Pub. Health Rep.*, Apr. 10, 1925, p. 743.)

[75] *Pub. Health Rep.* and League of Nations.