

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

(Continued)

IV. BRAZIL

Brazil, largest of the American Republics, has an area of 3,800,000 square miles, a seaboard of 4,060 miles, and a population estimated at well over 44,000,000. It is drained by two great river systems: the Amazon and the La Plata. The huge central plateau, 1,000 to 3,000 feet high, is crossed by two mountain chains: the coastal, with a maximum height of about 7,323 feet, and the inland range, with a peak of about 9,823 feet. There is also a central mountain system, the Goyana. This whole inland area consists mainly of *Chapadões* or large tablelands and deep river valleys. There are three climatic zones: the equatorial, with an average temperature of 81 F; the region between 10° S. Latitude and the Tropic of Capricorn, with an average temperature of 74 to 80 F in the lowlands and 64 to 70 F in the higher part; and the area south of the Tropic of Capricorn, with an average temperature of 62-66 F. The southern part of Brazil, including Rio de Janeiro, is considered sub-tropical; northern Brazil, tropical, except for the more bracing climate of the uplands. The rainfall varies greatly; Rio de Janeiro averages about 44 inches a year; Belem, Pará, about 100 inches; Porto Alegre (Rio Grande do Sul), about 30 inches; Recife (Pernambuco), about 75 inches; Santos (São Paulo), about 77 inches; São Paulo, about 70 inches; and Salvador (Baía), about 52 inches. Certain parts of the interior are subject to severe drouths.

Plague has been present, in ports, at least, in all but five (Amazonas, Goiaz, Mato Grosso, Minas Gerais and the Territory of Acre) of Brazil's 21 States and Territories. It first appeared in 1899 in São Paulo (Santos, October 18; São Paulo, December);¹ in the Federal District (January 8)² and Ceará (Fortaleza)³ in 1900; in Pernambuco

* See General Review.

¹ Plague was first diagnosed in Santos in October, 1899. (*Braz. Méd.*, Nov. 1, 1899, p. 404.) Subsequent studies seemed to indicate suspicious rat mortality in dock warehouses as early as July, and suspicious human cases in September. Also, municipal physicians reported that around August there were perhaps 100 cases of a mild disease with fever and buboes, mostly in children, reported to the city clinics. Bacteriological examinations were negative. (Andrade, Nuno de: *Braz. Méd.*, Nov. 8, 1899, p. 411.) This first appearance of plague was witnessed by a number of men destined to become famous in Brazilian medicine. The first diagnosis seems to have been made by Moura Ribeiro; it was confirmed by Adolpho Lutz and Vital Brazil from São Paulo, and later by Chapot-Prévost and Oswaldo Cruz from Rio de Janeiro. Dr. Brazil contracted plague while working in the isolation hospital at Santos, but fortunately recovered after treatment with serum, and lived to direct the Butantan Institute and continue his studies on snake poisons. (Rocha, Ismael da: *Braz. Méd.*, Nov. 1, 1899, p. 397.)

² Machado, Octavio: "Etiologia e Prophylaxia da Peste," Rio de Janeiro, 1901. Cases again appeared April 18; some considered this a reinfection. Three of the patients had newly arrived from Portugal on the *Clyde*, entering Rio April 5; the fourth was a frequent visitor of the others. The *Clyde* had a clean bill of health, and no precautions were taken in regard to passengers, baggage, or cargo on her arrival in Rio.

³ In 1900, Ceará suffered one of its periodic drouths. Thousands of people invaded the larger cities, driven by hunger and thirst. Food, particularly flour and grain, was sent to Fortaleza by the Federal Government—by water. In this year there appeared a disease called *carço* fever, possibly from the nut

(Recife, March 28),⁴ and Rio Grande do Sul, 1902;⁵ Maranhão (São Luiz, October) and Pará (Belem, November 7), 1903;⁶ Bafa (São Salvador, July), 1904;⁷ Paraná (Paranaguá),⁸ Espirito Santo (Victoria), Sergipe (Aracajú), and the State of Rio de Janeiro by 1906;⁹ Paraíba (Campina

or kernel-like appearance of the swollen glands, characterized by fever, headache, weakness, and pain in the gland regions. Death occurred in 3 to 5 days; convalescence was long. It was preceded by a rat epizootic. There were few cases among the refugees, who lived almost in the open air, camping on the edge of the city on sandy, very dry soil, subject to intense sunlight; furthermore, food was scarce among them. Most of the cases were among townspeople who lived in dark houses, where the humidity was greater and where there had accumulated clothing, food, and rubbish. Fialho believes that in view of the epizootics, the clinical history of the disease, the occurrence of cases in sites where conditions were more favorable to rat and flea activity, and the excellent possibility of transportation of infected rats from Rio de Janeiro, where there then was plague, this Fortaleza epidemic was plague. Some investigators had diagnosed it as an "acute adenitis of malarial origin," in which connection one might recall de Freitas' remark (de Freitas, Octavio: "Os nossos medicos e a nossa medicina," Recife, 1904, p. 196) on another occasion (lead poisoning from the water system) regarding the popularity of the doctrine "everything to malaria" (*tudo a malaria*.) (See also Barbosa, P., & de Rezende, C.: "Os Serv. de Saude Pub. no Brasil, 1808-1907," Rio, 1909, Vol. I, pp. 480-481, mentioning the confusion of malaria with plague and other diseases.) With reference to the *peste negra* (black plague) reported during the 1877-80 drouth, one of the most severe in Ceará history, Fialho states that the medical commission sent to investigate the matter pronounced the disease to be hemorrhagic smallpox. He also observes that Rodolpho Theophilo, describing the drouths of the 19th century, stated that he had never seen in that period a disease like bubonic plague, or, as it was described on the Civil Register, "infectious adenitis," or popularly, "caroço fever." Gavião Gonzaga also stated that plague appeared in Ceará in 1900. (Fialho, Amadeu: *Rev. Hyg. & Saúde Púb.*, June 1935, p. 183. Also Justa, Antonio: *Ceará Méd.*, Jul.-Aug. 1936, p. 1.) De Freitas (of Pernambuco) reported that a terrible epidemic of smallpox occurred in connection with the 1877-79 drouth in north-eastern Brazil, killing 2,525 persons. He reported other severe epidemics of smallpox in 1818, 1825, 1890, 1895, and 1896 in connection with drouths or political upheavals which brought hundreds of unvaccinated persons crowding into the capital. De Freitas, O.: *supra*, pp. 63, 262.

⁴ According to Parreiras, de Freitas has reported "plague" in Pernambuco in 1896, 11 cases; 1897, 13; 1898, 10; 1899, 7; 1900, 26; 1901, 15; and 1902, 11. (Parreiras, Decio: *Arch. Hyg.*, Rio, June 1935, p. 46.) It is to be noted, however, that in his 1904 book (see Note 3), which contains his 1902 paper on plague, de Freitas said that the first plague death was reported March 28, 1902, in Recife. (P. 229.)

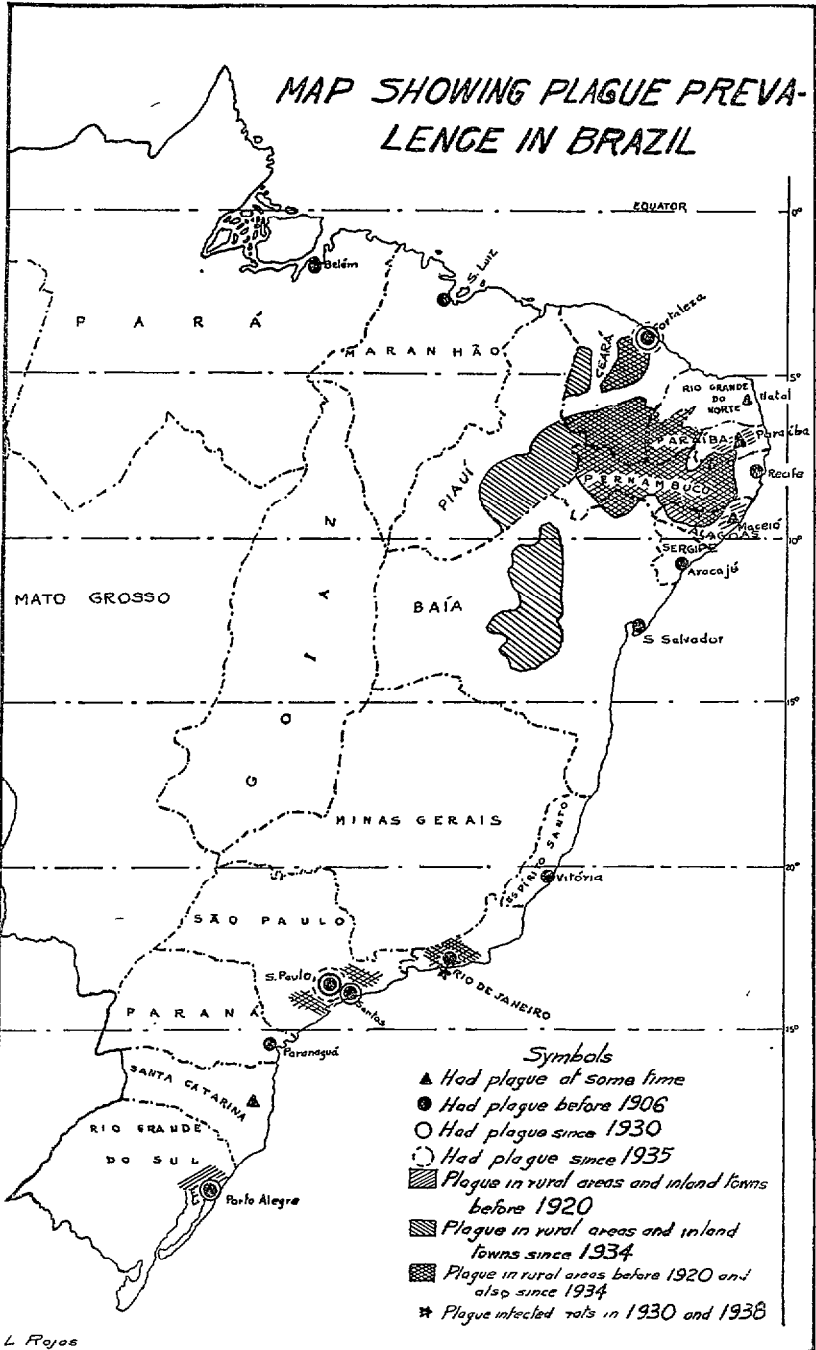
⁵ Duprat seems to feel that plague in Rio Grande do Sul has always been imported; and states that every time it has appeared in Rio Grande it could be traced to a single one of the warehouses receiving grain, flour, or fodder from Argentina. The disease appeared toward the end of 1902. He notes that during the World War, when the Rio Grande firm handling Argentine flour was put on the Allied Black List, the importing business was transferred to a commercial house on the frontier, on the bank of the Uruguay river, and that then several villages in the interior of the State, till that time immune, had cases of plague. (Duprat, A.: *Rev. Hyg. & Saúde Púb.*, May 1935, p. 155, 164.) Similar statements have been made for other parts of the country. (See, for instance, Mattos, E.: *Arch. Hyg.*, Rio, 1927, Part 1, p. 125; *Bol. Of. San. Pan.*, Sept. 1928, p. 1146.) The question of the origin of outbreaks is always troublesome. As examples may be mentioned the conflicting claims of Ceará and Pernambuco regarding the 1924 epidemic (Fialho, A.: *Rev. Hyg. & Saúde Púb.*, June 1935, pp. 185-6) and the recent outbreak in Miguel Pereira, State of Rio de Janeiro, in November-December 1938. (Pinotti, Mario, et al.: *Arq. Hyg.*, Rio, Feb. 1939, p. 117.) In the latter instance, there were 12 cases and rat epizootics in a previously immune focus; the infection was traced to a warehouse containing goods from several sources including Rio de Janeiro and São Paulo. The investigators concluded, on the basis of epidemiological and climatological data, that the infection came from the Federal District, where plague rats were found in the Alfredo Maia railway station in December, 1938. Barros Barreto (*Bol. Of. San. Pan.*, Sept. 1940, p. 366), on the other hand, seems to imply that the Alfredo Maia plague came from Miguel Pereira.

⁶ It continued sporadically in Belem to May, 1912, affecting different parts of the city. There were 40 cases, 21 deaths in the original epidemic, Nov. 1904-Apr. 1905, and the disease reappeared in December, 1905, continuing till March, 1906. (Vianna, Arthur: "As epidemias no Pará," Pará, 1906, pp. 131-155.)

⁷ The first confirmed case of plague in Salvador, Bafa, was that of a drug clerk who died July 7, 1904, after three days' illness. It was thought that the infection came from Rio de Janeiro, since the store bought supplies there. (*Pub. Health Rep.*, Aug. 1904, p. 1024.)

⁸ March 6, 1901, cases confirmed in Paranaguá. (*Braz. Méd.*, 1902, p. 105.)

⁹ Cruz, Oswaldo: "Peste," 1906, mentions the infection of these localities. (Cited by Silva, Jr., M.: *Arch. Hyg.*, Rio, Mar. 1936, p. 155.)



Grande), 1912;¹⁰ and Alagoas (Palmeira dos Indios), 1914.¹¹ It has also been reported in Santa Catarina, Piauí, and Rio Grande do Norte.¹²

The course of plague in Brazil may be divided roughly into three periods: that of the initial invasion, from 1899 to about 1906, when it attacked the great Brazilian ports, and in some instances, inland cities connected with them by rail (São Paulo); a second period, lasting up to about 1920, when little was heard from the disease; and a third, from 1920 to 1930, when it disappeared from nearly all ports (last cases, Belem, 1912 (1922 case imported); Recife, 1924; Maceió, 1925; Paranaguá, 1926; Salvador, 1928; Rio de Janeiro, 1928 (last human case; last plague rat, 1930 except for some in December, 1938, possibly imported); Santos, 1931; Porto Alegre, 1933)¹³ and began to be reported in rural districts in the interior. At the present time it seems to persist only in São Paulo State and in a large region in the Northeast; it has not been reported elsewhere in the last five years. The last case in a port was in September, 1936 in Fortaleza. In 1939 all plague except three cases occurring in two Pernambuco cities (Canhotinho, 2, Limoeiro, 1) and 3 cases in São Paulo, was in the rural zone.¹³

São Paulo.—Plague seems to have been endemic in the State of São Paulo since its introduction in 1899. The original focus, Santos, with only 32 deaths in 40 years (1899 through 1939), has not suffered as much as the city of São Paulo, a fact attributed by some to the sanitation of the port during the campaigns against plague and yellow fever under the direction of Emilio Ribas.¹⁴ From 1899 through 1939, 120 deaths were reported for São Paulo city and 232 for the State. There were no plague deaths in the State in 1916, 1918, 1933 and 1937-38; none in São Paulo City in 1901, 1909, 1916-18, 1923-24, 1933 and 1937; and none in Santos in 1905, 1908, 1911-12, 1914-16, 1918-23, 1925, 1927, 1929-30, 1932-35; 1937-39.^{15, 16} While the predominating form of plague has been bubonic, there were 37 cases of pneumonic plague (33 in São Paulo) and 2 of septicemic plague among the 129 cases reported from 1926-1938. The majority of bubonic cases occurred during the sultry days of summer, with the peak in January; the figure for July is large because of the pneumonic plague outbreak in São Paulo city in 1936.

Plague control in São Paulo is in the hands of the State. It includes rat destruction, rat examination, flea classification and general sanitation. In 1939 mass inoculation of material from rats was begun with the cooperation of the Butantan Institute.¹⁶

¹⁰ According to Camarra da Motta, plague was brought into Campina Grande by rats carried in cotton machinery from Recife. Rat and cat epizootics were observed. (*Arch. Hyg.*, Rio, 1936, p. 187.) Here again the disease was called *caroço* fever. It was confirmed as plague by Octavio de Freitas of Recife. (Maroja, Flavio: *Rev. Hyg. & Saúde Púb.*, June 1929, p. 591. He does not mention the origin.)

¹¹ Barros Barreto, João de: "Actas X Conferencia Sanitaria Panamericana," 1933, p. 147.

¹² Justa, A.: *Ceará Méd.*, Jul.-Aug. 1936, p. 2. Camarra da Motta mentions that in 1935 the health authorities of Natal (Rio Grande do Norte) told him the last case of plague in that State was in 1920, no human or rat plague having been reported since. (*Arch. Hyg.*, 1936, p. 187.)

¹³ Barros Barreto, João de: *Bol. Of. San. Pan.*, Sept. 1940, p. 866 (Report to the VIII American Scientific Congress, May 1940).

¹⁴ Brazil, Vital: *Arch. Hyg. & Saúde Púb.*, S. Paulo, June 1936, p. 9. He mentions the prompt diagnosis of plague, the efforts of Ribas to secure serum and to establish an institution for its manufacture (the Butantan). Ribas himself attributed the failure of plague to spread in Santos to the clean streets and houses and the continuous war on rats. (*Braz. Méd.*, Nov. 1, 1901, p. 405, quoted by da Rocha.)

¹⁵ Rangel, E.: *Informes Estatísticos sobre a peste no Brasil*, Rio de Janeiro, 1928. (Departamento Nacional de Saúde.)

¹⁶ De Oliveira, Waldomiro: *Bol. Of. San. Pan.*, Dec. 1939, p. 1138; Prado Jr., F.: *Ibid.*, Oct. 1940, p. 97.

Plague in the Northeast.¹⁷—The area in northeastern Brazil in which plague appears to be endemic includes part of the States of Alagoas, Baía, Ceará, Paraíba, Pernambuco, and Piauí. Rio Grande do Norte, in this area, has not had plague since 1920.

The capitals of four of these States: Fortaleza, Ceará, population 150,000; Recife, Pernambuco, 510,000; Maceió, Alagoas, 140,000; and Salvador, Baía, 375,000, are seaports and natural outlets for the region; all have had plague. The last cases in these ports occurred: Recife, February 1924; Maceió, 1925; Salvador, 1928; and Fortaleza, Sept. 1936.

The plague area extends from the seacoast region of Ceará (Fortaleza), across the neighboring lowlands, the hill towns on the west, and south by way of the *sertão*—region of drouth and desert plants (*caatinga*) on through the similar region in Paraíba, to the *brejo* or swampy area in eastern Paraíba. It extends down through more *cariri* (round rocks, stony ground, palisades, fibrous plants and spiny vegetation), into Pernambuco and through a region including *mata* (thick woods) and *agreste* (area of scanty and low vegetation) of varying altitudes. In Alagoas, plague is found in both the *mata* (wooded) and *sertaneja* (semi-arid) regions. Southern Ceará and western Pernambuco are mostly hilly and desert areas. The plague region of Baía, extending from Salvador in the direction of the Pernambuco frontier, consists of meadows, fields and small elevations.

The usual type of construction is haphazard, without impermeable floors. In the rural areas, buildings are often kilometers apart. They are generally either old ruined ranch houses used as dwelling places and storehouses for grain and fodder, or primitive huts with beaten earth floors, cracked walls, and roofs of straw, palm leaves, or tile, supported by small poles, the whole affording excellent hiding places for rats. The huts are used for storage (*milho* or corn, *feijão* or beans, and *algodão* or cotton), as well as for living quarters. In addition to the shelter and food offered by the dwellings of man, there are innumerable retreats in the enormous quantities of rock found in the bottoms and sides of valleys, and often piled up by man. Due to a scarcity of fence wood in the *cariri* and high *sertão* and the abundance of stones, there are many rock fences piled together without mortar, which stretch for miles through certain parts of the country.¹⁸ The inhabitants of this area are engaged chiefly in the growing of grain, cotton, and mandioca, the first two products being stored in the dwellings and outbuildings. Cotton frequently fills the whole house and neighboring buildings. It is sent in bales to the centers of population, where it is opened for classification, and left a long time awaiting removal to warehouses or rebaling. The connection between cotton and plague was suggested as far back as 1923.¹⁹ In the factories of mandioca flour, the rat finds good food and the flea an atmos-

¹⁷ Barros Barreto, J. de: "Actas X Conf. San. Pan.," 1938, p. 144; *Bol. Of. San. Pan.*, Sept. 1940, p. 866.

¹⁸ In the 1936 epidemic at Crato, Marcello Silva found that 58 percent of the cases occurred in *mucambos* ("thrown together" houses of sticks and earth) or *taipa* (mud between poles) huts; 95 percent of the 157 farms on which plague occurred were in a poor state of preservation; and 94 percent in undesirable hygienic conditions. (*Arch. Hyg.*, Rio, Mar. 1936, p. 155.)

¹⁹ Nery da Costa, speaking of the epidemic in Fortaleza in 1919 and in Alagoas in 1921, said that "cases of human plague have always been subsequent to a rat epizootic, and a factor which has attracted our attention is that this epizootic is intimately related to cotton; the 'queda de ratos' [fall of rats from rafters]

phere favorable to its multiplication. In addition to all this, waste is not effectively removed, forming another attraction to rodents.¹⁷

The plague region in Ceará and Paraíba (except the western part) and in Pernambuco to Alagoas de Baixo is well provided with railway lines. Part of the Alagoas lines are impassable during the rainy season, especially those serving the *sertanejo*. There is a line to Joazeiro, on the Pernambuco frontier, in Baía. Most of the localities in Ceará, Paraíba and Pernambuco are not well served by cart roads, since they are usually impassable during rainy seasons. Some places are accessible only by horseback.

The first cases of plague reported in interior towns or regions of the Northeast seem to be those in Campina Grande, Paraíba, 1912; Palmeira dos Índios, Alagoas, 1914; Garanhuns and neighboring towns, Pernambuco, 1917; and Jardim, Ceará, 1918. The first two towns are on railway lines to the coast; Jardim is far inland, on the Pernambuco border. Quebrangulo, Alagoas, and Quixeramobim, Iguatú, Cedro, Lavras, and Aurora, Ceará, had plague in 1921; the Cearan towns are all on the Fortaleza railway line.²⁰ Justa reports that rural epizootics were observed in Ceará as early as 1917, and he himself witnessed one in 1921.²¹ Cases were reported in Jardim and Brejo Grande, Ceará, in 1924, after which there was a lapse until 1933 (Ipú, S. Benedicto, Palmeiras, Pacoty, Guaramiranga, Santos Dumont, etc.)²⁰ In addition to the Garanhuns, 1917, cases, Silva has found reports of plague in Pernambuco in 1919 in Triunfo, Villa Bella, Salgueiro, Novo Exú, Granito, and Ouricury. He states that in southern Ceará and northern Pernambuco (Jardim-Triunfo area), plague has been more highly fatal than in the rest of Ceará.²²

According to Barros Barreto,²³ plague seems to be declining in Piauí, Ceará and Baía, with a tendency to concentrate in Pernambuco and Alagoas and to spread toward Paraíba; in Pernambuco it tends to leave the *sertão* municipalities near Ceará, Piauí and Baía, to approach the coast and the Alagoas boundaries and part of Paraíba. He reports that from 1934 to 1939 there were 1,542 cases of plague in northeastern Brazil, distributed as follows:

| Year | Piauí | Ceará | Paraíba | Pernambuco | Alagoas | Baía | Total |
|------------|-------|-------|---------|------------|---------|------|-------|
| 1934 | — | 155 | — | 31 | 22 | — | 208 |
| 1935 | 4 | 231 | 2 | 437 | 54 | 94 | 822 |
| 1936 | 16 | 137 | 4 | 89 | 1 | 67 | 314 |
| 1937 | — | 2 | 5 | 23 | — | 5 | 35 |
| 1938 | — | 3 | 5 | 71 | 6 | — | 85 |
| 1939 | — | 3 | 1 | 33 | 40 | 1 | 78 |
| Total..... | 20 | 531 | 17 | 684 | 123 | 167 | 1542 |

occurs preferably and initially in cotton gin sheds; in houses where, as in Quebrangulo, there are compartments used as cotton store rooms; and in warehouses of the Great Western railway in which bales of this material are deposited. Above all, the loose cotton of the store rooms of houses and of cotton gins, is alive with fleas, their quantity attracting attention when one enters these places." (*Rev. Med.-Cirurg. Brasil*, Rio, 1923, Nov., p. 523.)

²⁰ Silva, M.: *Arch. Hyg.*, Rio, Mar. 1936, p. 166.

²¹ Justa, A.: *Ceará Méd.*, Jul.-Aug. 1936, p. 2.

²² Silva, M., *supra*, p. 159. (According to O. de Freitas, Jefferson Ribeiro reported plague in Garanhuns in 1917; and Lator Motta, also cited by de Freitas, reported it in 1919 in the towns mentioned.)

²³ Barros Barreto, J. de: *Bol. Of. San. Pan.*, Sept. 1940, p. 866.

During this period there were 20 outbreaks of more than 15 cases in 17 localities (Piauí, 1, 1936; Ceará, 7, 1934-36; Pernambuco, 6, 1935-38; Alagoas, 1, 1934-35; Baía, 2, 1935-36). Nineteen of the outbreaks were in 1934-36, and only one subsequently (Garanhuns, 1938, 16 cases). The largest outbreaks were those in Novo Exú, Pernambuco, 1935, 191 cases; Crato, Ceará, 1936, 107 cases, and Grano, Pernambuco, 1935, 88 cases.

Most of the plague in Ceará occurred during the rainy season (February to June) and in Pernambuco, from July to October. The usual type is bubonic and noted for its mildness. (In 1935, in Ceará, the mortality for 231 clinically positive cases was 22.07%. For the Northeast, the mortality was 35% in 1935; 39.5 in 1936; 43 in 1937; 47 in 1938; and 30 in 1939.) Severe outbreaks do occur, however, the worst being one in the Triunfo area in 1925 with over 1,000 deaths. Walking plague has been reported repeatedly. Some observers have stated that the disease seems to be milder in children.²⁴

Only 7 cases 2 deaths (in the States of Alagoas and Pernambuco) were reported during the first six months of 1940, as compared to 43 cases 9 deaths in the same period in 1939, and no cases have been reported since March 1940.

Epizootics in the northeast.—Epizootics among rats, cats, wild rodents and other animals have been reported in connection with outbreaks of plague in the northeast. (See Below.) Recent studies²⁵ seem to show that not all of these epizootics, even among rodents, are due to plague.

Rats.—Rats have been implicated in Brazilian plague from the earliest times. *Norvegicus* seems to be the most common in the State of São Paulo (54-58%, 1926-38; Santos, 80.36%, 1937-38) as well as in certain ports (See Table 4), but in the rural zone of the Northeast, *R. rattus* predominates (90% in Ceará, where it is called *gabirú* or *rabo de couro*, "leathertail"; 74% in Triunfo, Pernambuco; and in Paraíba: 90% in Princesa and 62% in Campina Grande). In Alagoa do Monteiro, Paraíba, *M. musculus* was most common. Extensive epizootics among these animals (starting with the beginning and the ending of the rains in Ceará) have been reported in recent years (1933, 1934, 1935) as well as much earlier.²⁶ From their connection with human cases, these epizootics have been considered plague. However, the finding of non-plague but plague-like organisms in rats in Brazil has also been reported.^{27, 28}

Wild rodents.—One of the earliest references to a suspicious disease among wild rodents in Brazil seems to be Justa's observation of an epizootic among *mocós*,²⁹ as well as among rats and cats, in Aurora,

²⁴ Fialho, A.: *Rev. Hyg. & Saúde Púb.*, June 1935, pp. 193, 194.

²⁵ Macchiavello, Atilio. Studies in 1939-40, not yet published.

²⁶ Fialho, A.: *Rev. Hyg. & Saúde Púb.*, June 1935, pp. 185, 195. Rat epizootics have been reported in the Fortaleza area in Ceará since 1900, and in May, 1921, there was a widespread rural epizootic among rats in the Quixeramobim area, extending for leagues away from the cities.

²⁷ Smillie, Wilson G.: Plague-like organisms in the wild rats of São Paulo, Brazil, *Jour. Inf. Dis.*, Oct. 1920, p. 378 (Reprint.) Smillie isolated three strains of bacilli which he considered *pasteurellae*, but not plague strains; and also found *B. enteriditis*, which somewhat resembles *B. pestis* in morphologic and staining characteristics.

²⁸ Macchiavello, Atilio. Unpublished studies, 1939-40.

²⁹ Wild rodents found in Brazil which have been studied in connection with plague include: the *mocó* (*Herodon rupestris*), which lives in cracks among rocks in the foothills and feeds on fruits, tubers and green herbs; and the *preá*, (*Cavia aperea*), which lives in the desert and hills; it is the *cuis* or wild guinea pig of Argentina, which was found naturally plague-infected in 1910. (Uriarte and González. See General

Iguatú, and Cedro, June, 1921.³⁰ Silva reported an extensive epizootic in rats and other rodents in 1934 and 1935 in various parts of Ceará, and stated that human cases had been reported in which there had been contact with a dead rat or *pred*.²⁹ Natural infection in *preds* was found by Oscar de Brito in Pesqueira, Pernambuco, in December, 1935; and by Silva in Ceará in November, 1936, and the experimental sensitivity of both *preds* and *mocós* has been demonstrated by Fialho and by Silva. Silva has also demonstrated the experimental sensitivity of the *rato de cana*, *rato de espinho*, *pixuna*, *punaré*, and *cotia*.²⁹ Two wild rats have been found plague-infected: *M. minusculus* and *M. silvaticus*; in Triunfo, Pernambuco, in 1927, 7.01% of *minusculus* and 3.27% of *silvaticus* were plague-infected.³¹ Maroja mentioned that in parts of Paraíba certain wild rodents—*punaré*, *pred*, *mocó*, *paca*, *cotia*—were hunted for food.³² The rôle of wild rodents in Brazilian plague, however, has not been definitely determined. The rat is so consistently present that both human and wild rodent infection have been considered as incidental to rat infection. Costa declared that the epidemiological data so far obtained were in favor of the domestic rat as the reservoir,³³ and the observations of Macchiavello³⁴ tend to minimize the importance of other rodents. The latter is also investigating the existence of non-plague epizootics among these animals.

Cats.—Sick and dead cats have been reported in connection with many plague outbreaks in Brazil, one of the earliest being in Campina Grande, Paraíba, in 1912. Gomes in 1918 reported seeing several cases of plague traced to cats³⁵ and noted that he and Aragão could find no other source of infection in the Mendes

Review and Argentina). According to Barros Barreto, Bica considers the *pred* an inseparable companion of the rat in paying tribute to plague. Epizootics in *preds* and *mocós* are sometimes very severe, with evidence of contact between the animals and positive human cases of plague. In Ceará, 1933, the animals died by hundreds, and the natives expressed the extent of the mortality by saying that there "weren't enough buzzards" to take care of the scavenging. In Bafa the periodicity of outbreaks is said to be explained by the appearance of wild rodents in dwellings during the harvest season (Schmidt and Serafim, Jr., cited by Barros Barreto.) Other wild rodents studied include the field rats *M. minusculus*, a grain-eater, and *M. silvaticus*, which feeds on roots, both found naturally plague-infected; *Cercomys laurentius*, known as *rato da cana*, *canoeiro* (cane rat), *rato vermelho* (red rat), and *rato do brejo* (swamp rat), which causes great destruction in cane fields, and also feeds on green swamp plants, living in groups in large nests of broken straw in the canals and marshes. It is migratory in habit, and is experimentally susceptible to plague. *Pizuna*, a wild mouse, lives under the same conditions as *Cercomys*, and is also sensitive to plague, as is the wild rat, *rato espinho* or spine rat. The *punaré*, *Holochilus sciurius*, a dark brown rat with a light ring around the eyes and a long, hairy tail, feeds on fruit and grain, and is sensitive to plague. It has few ecto-parasites. *Dasyprocta aguti*, the *cotia* or agouti, is also sensitive to plague.

²⁹ Cited by Fialho: *Rev. Hyg. & Saude Pùb.*, June 1935, p. 185.

³¹ De Brito, cited by Macchiavello, A.: *Estudios sobre la peste bubónica*, V. *Epidemiología de la peste bubónica en el nordeste brasileiro*, in press.

³² Maroja, Flavio: *Rev. Hyg. & Saude Pùb.*, June 1929, p. 591.

³³ Cited by Barros Barreto, J. de: *Bol. Of. San. Pan.*, Sept. 1940, p. 866.

³⁴ Macchiavello, A.: Unpublished studies.

³⁵ Gomes, Emilio: *Braz. Méd.*, Aug. 3, 1918, p. 245. A sick cat slept on a pile of sewing delivered to a seamstress; when the girl came to handle the material she was bitten by a number of fleas, and within a few days developed plague. At Mendes, a dead cat had been found, probably carried there in rags for the paper mill. There had been no rat epizootic. There were six or eight fatal cases of plague among the factory employees, and no plague since then. According to Autrán, Aragão also reported a case in Rio de Janeiro where the human infection was traced to a cat which, in turn, had frequented a stable where a rat epizootic had occurred. (Autrán, H.: *Bol. Sanitario*, May 1925, p. 17).

paper factory in September, 1912. Gomes also reported bacteriological confirmation of plague in four cats from the January 9, 1918 focus in Rio de Janeiro, and mentioned Garfield de Almeida's suggestion that "decatization" as well as "deratization" was necessary in plague control. However, Nery da Costa came to the defense of the felines, stating that while cats might be a danger in some well-sanitized localities, in Alagoas where the houses were already full of plague-susceptible rats, cats would do more good than harm.³⁶ Justa reported seeing in 1921, in Ceará, extensive feline epizootics; even the total disappearance of the cats of a given locality, noting, however, that "not every rat presenting a *vacuolated bacillus*, nor every cat with cervical or other adenitis and *cocco-bacilli* can be considered plague-infected," and mentioning the similarity of the plague organism to those of hemorrhagic septicemia and also to the bacteria of decomposition.³⁷ In 1924, dead cats were observed in Pernambuco, especially in Brejo Grande. Fialho, noting that sometimes feline epizootics occurred along with rat epizootics and sometimes alone, mentioned, in addition to the outbreaks in Cedro, Iguatú and Quixeramobim in 1921, those of Aracatí in 1934 and União in 1935, and said that Justa found bacteriological evidence of plague infection in a cat.³⁸ Fialho expressed the opinion that at least some of the feline epizootics were plague. Silva reported extensive feline epizootics in years and places in Ceará where there was neither human nor rat plague: Granja, Sobral, Russas, Aracatí, Quixada, 1934; Crato, V. Alegre, Joazeiro, 1935. There were also feline epizootics in Telha, Cangaty, and Coité in 1935 and in Tamboril in 1932. Camarra da Motta reported a feline epizootic in Campina Grande, Alagoa do Monteiro, S. Thomé, and Boi Velho, Paraíba, in 1935.³⁹ In studying the instances of human cases of probable feline origin in the May, 1935, epidemic, Silva observed cats carrying evidences of an old adenitis in the neck, the animals having survived the disease. He considered that the cats of Ceará were subject to two different diseases. One, with a mortality of or nearly 100%, spread with extraordinary rapidity, probably by direct contagion, attacked mainly the respiratory and gastro-intestinal systems, producing bilious vomit, green diarrhea, severe coryza, watery eyes, and killed the animal within 4 or 5 days, or less. It appeared in regions entirely free from plague, and was not plague, but some other disease, possibly infectious gastroenteritis. The second disease was more limited in its range of action, although sometimes it occurred coincident with the first; it appeared only in plague regions, preceding, accompanying, or following human or rat plague; it was characterized by buboes, generally in the cervical region, and was not always fatal. This was plague.⁴⁰ Macchiavello and Bezerra Coutinho recently completed a study of a feline epizootic in Crato and concluded that it was caused by a virus, and was not plague.⁴¹

Other animals.—In the 1934 and 1935 epizootics in Ceará the natives insisted that *raposas* (foxes), wild cats, *veados* (a kind of deer) and even cobras were affected. It was noted, however, that foxes were also found dead in periods when there had been no rodent epizootic. Silva was unable to produce plague in foxes experimentally, and he suggested that the fatal disease might be rabies, or some other disease common to the species.⁴²

Birds.—The theory of plague transmission by *urubús* (a kind of vulture or,

³⁶ Nery da Costa: *Rev. Med.-Cir. Brasil*, 1923, Nov., p. 523.

³⁷ Justa, A., *op. cit.*, p. 2.

³⁸ *Rev. Hyg. & Saúde Públ.*, June 1935, p. 199.

³⁹ Da Motta, C.: *Arch. Hyg.*, Rio, Mar. 1936, p. 187.

⁴⁰ Silva, M.: *Ibid.*, pp. 178-179.

⁴¹ Macchiavello, A., & Bezerra Coutinho, A.: *Adeno-mielo-enterosis de los gatos y epizootias felinas del Nordeste del Brasil*, I. 1930-40. In press.

⁴² Silva, M.: *Arch. Hyg.*, Rio, 1936, p. 177.

some say, of crow) in Brazil was presented by Agripino Barbosa to the VII Hygiene Congress in Bahia in January, 1928, and was accepted "in part" as a means of explaining the appearance of outbreaks of plague (beginning with epizootics) in places distant from other known foci and not easily reached from them. Barbosa felt that these birds might act as mechanical carriers of animals dead of plague. Alfredo Brito suggested that the birds might be "intestinal carriers," eliminating germs in the feces. Araujo, discounting the theory of mechanical transmission of plague over large areas on the ground that the birds do not usually fly very far with a burden, experimented with *urubús*, feeding them on meat containing large numbers of virulent plague bacilli. He was unable to recover the bacillus from the gastrointestinal contents two, three, and 15 days after feeding. *Urubús* were also insensitive to intramuscular injection of large doses of virulent plague bacilli.⁴³

Parasites.—(See Tables 5 and 6). *X. brasiliensis* is the most prevalent flea in São Paulo city⁴⁴ (42.29% in 1939), *X. cheopis* in Santos (41.22–46.67) and in the State (53.84). Alves Meira found that in São Paulo city from June 1931 to June 1932, *C. musculi* was most prevalent from July to November; *X. brasiliensis* and *C. musculi* were almost equal in September (37.82% and 34.19% respectively) and *X. brasiliensis* predominated (65.3%) in December. The flea index for all the city rats was 9.5; for warehouse rats, 11.9; and for house rats, 4.4; the *cheopis* index 1.8, 2.5 and 0.3; the *brasiliensis* 4.3, 4.6, and 3.7; the *C. musculi* 3.2, 4.5, and 0.2. The highest incidence of *cheopis* was in January, when the index was 4. The greatest number of fleas found on any one rat was 275, all *brasiliensis*, found on a female *norvegicus* (house rat); 225 fleas, mostly *C. musculi*, (78%; *brasiliensis* 15.5; *cheopis* 5.7) were found on a warehouse rat, also *norvegicus*.⁴⁵ *Cheopis* predominates in ports: Salvador, 98%; Fortaleza, 85%; Maceió, 79%; Recife, 60%, with 38% *brasiliensis*; and Rio de Janeiro, 55.65%. The percentage varies with years and seasons: for instance, in Recife, in October, 1936, March and June, 1937, and April and June, 1938, *X. brasiliensis* exceeded *cheopis*, otherwise the predominating flea.⁴⁶ In Rio de Janeiro during 1936 the flea index varied from 2.3 in September to 4.0 in April; while *cheopis* was predominant in all but February and November, when *brasiliensis* exceeded it.⁴⁷ In the interior of Ceará, *cheopis* is the most common flea on domestic rats, followed by *brasiliensis*. In Triunfo, Pernambuco, *cheopis* predominates in the summer, *brasiliensis* in the winter. According to de Brito, in 1927–28, the greatest number of fleas in Pernambuco were found in July and August, when the temperature was 25–26 C (77–79 F) and the relative humidity 73–76%.⁴⁸ A recent study of fleas in relation to temperature, humidity, and plague in Northeastern Brazil, by Macchiavello, has not yet been published.⁴⁹ As to wild rodent parasites, little is known. Fialho reported finding on a *preá* a kind of louse, which was classified as *Heterogyropus heteronychus*, and Silva, in Ceará, found 31 *Rhopalopsyllus roberti* on 18 *ratos de*

⁴³ Araujo, Eduardo de: *Bahia Med.*, Aug. 1937, p. 155.

⁴⁴ *Brasiliensis* has been shown capable of transmitting plague, although in a lesser degree than *cheopis*. Prado, Jr. has stated (*Bol. Of. San. Pan.*, Oct. 1940) that *brasiliensis* is the chief plague vector in São Paulo, pointing out that a regular and even considerable increase in its numbers has been observed during local outbreaks. Alves Meira suggested that the sporadic nature of São Paulo plague might be due in part to the fact that while the flea index was over 5, the prevailing flea was not *cheopis*. (*Contrib. parasitol. para a epidemiologia da peste na cidade de S. Paulo: sobre as pulgas de rato, Ann. Paul. Med. & Cir.*, Aug. 1934, p. 143).

⁴⁵ Alves Meira, *supra*.

⁴⁶ Barros Barreto, J. de: "Actas, X. Conf. San. Pan.," p. 162.

⁴⁷ Barros Barreto, J. de: *Bol. Of. San. Pan.*, May 1937, p. 410.

⁴⁸ Cited by Parreiras, D.: *Arch. Hyg.*, Rio, 1935, No. 1, p. 45.

⁴⁹ A summary of these studies will appear in the *Bol. Of. San. Pan.*

canna. Alves Meira reported the finding of a *Rhopalopsyllus occidentalis* on a *R. norvegicus* caught on the grounds near the School of Medicine, São Paulo, and suggested that the parasite might have been accidentally acquired by the rat on a visit by the animal to the quarters of the laboratory animals which might well be infested by that species.

Seasonal distribution.—The majority of bubonic plague cases in São Paulo occur during the sultry days of summer, with the peak in January.⁵⁰ Alves Meira has pointed out that this period (December to March), in addition to being the plague season, is marked by the following coincidences: greatest percentage of rats with fleas; greatest number of fleas on a single host; highest *cheopis* index; highest percentage of *cheopis* on *rattus*, *alexandrinus* and *musculus*; predominance of *brasiliensis*; highest flea, *cheopis*, and *brasiliensis* indices; and greatest percentages of different hosts (*norvegicus*, *rattus*, *alexandrinus* and *musculus*) with fleas.

In the Northeast, the harvest season is the time when plague becomes intensified: May to June in Ceará; August to November in Pernambuco. In Ceará the majority of cases in 1935 and 1936 occurred from February to June (80% of those in 1936), which was the rainy season, during which humidity was greater (91.5 to 94.0% in 1935; 88 to 93% in 1936). The average temperature during the period was 19.7–20.8 C (66–69 F) and 19.5–21.4 C (66–70 F). Conditions, therefore, were favorable to *X. cheopis* activity. However, the few cases seen in 1938 and 1939 in this State appeared in August and September. In Pernambuco, the majority of cases in 1935 and 1936 were from July to October (80% of 1935 cases), when the temperature ranged from 19.2 to 21.4 C (66–70 F) in 1935 and 17.6–20.4 (62–68 F) in 1936 and the relative humidity from 77.2 to 92 and from 79.5–91. Of the 71 cases in this State in 1938, 85 percent were in the second half of the year.⁵¹ In Paraíba, plague has appeared in October (1927; and in dead rats 1935); November (1928, 1929); April (1932), and August–September (1927).⁵² In Rio de Janeiro the spring and late winter (September through January) were the months with the most plague (1900–1926).⁵³

Kinds of plague.—Most of the plague in Brazil has been bubonic, often with a low mortality. In 1935, Justa declared that “even 36 years ago plague was never as highly fatal or extensive as in Europe and Asia. All epidemiologists agree on this”;⁵⁴ and Barros Barreto in 1940 commented on the “relative mildness of the disease in Northeast Brazil.”⁵⁵ He pointed out, however, that severe and highly fatal outbreaks do occur. According to de Freitas, the 1902 epidemic in Recife was noted for the fewness and severity of cases.⁵⁶ (See Table 2 on Case mortality. Some of these percentages are probably higher than the actual mortality, due to the fact that sometimes only deaths appear

⁵⁰ Barros Barreto, J. de: *Bol. Of. San. Pan.*, Sept. 1940, p. 866.

⁵¹ Barros Barreto, *supra*, p. 866.

⁵² Camarra da Motta, *op. cit.*

⁵³ Rangel, E., *op. cit.*, p. 16.

⁵⁴ Justa, A.: *Ceará Méd.*, Jul.–Aug. 1936, p. 2.

⁵⁵ *Bol. Of. San. Pan.*, Sept. 1940, p. 866.

in the statistics.) Of 1,326 carefully studied cases in Rio de Janeiro from 1900 to 1926, 93.3% were bubonic; 4.8% septicemic, and 2% pneumonic. About 28 percent of the cases in São Paulo from 1926 to 1936 were pneumonic, with a death rate of 75%. Of the 37 pneumonic cases (out of a total of 129) in the State, 33 were in São Paulo city (10 in 1930; 23 in 1936, with 6 and 18 deaths), 1 fatal case in São Bernardo (1936) and 3 fatal cases in Parnaíba (1927-28).⁵⁷ There were three cases of pneumonic plague in São Paulo city in December, 1899, one confirmed bacteriologically and one at autopsy.⁵⁸ Other pneumonic cases in Brazil include 7, which recovered with serum-therapy, in Campos, State of Rio, 1906, and 20 deaths in Paranaguá, (Paraná) in 1926. There are few references to pneumonic plague in Northeast Brazil, among them that of E. Silva, who reported that in December 1935 and January 1936, in Baía, of 36 cases, 91.6% were bubonic, 5.5% pneumonic, and one case (2.7%) was mixed bubonic-pneumonic.⁵⁹ Of 7 cases in Campina Grande, Paraíba, in 1923, 2 were said to be pneumonic. Ten pneumonic cases (7 fatal) were reported among the 40 cases in the initial outbreak in Belem (Pará), Nov. 1903-Apr. 1904, and 2 more cases from Dec. 1904-Mar. 1905. Mattos stated that an extensive pneumonic outbreak such as those in Manchuria was not compatible with the Brazilian climate.⁶⁰

Septicemic plague has been reported in various parts of Brazil, including São Paulo (2 cases, São Paulo city, 1930); Rio de Janeiro; Pernambuco (August, 1939, Bom Conselho area);⁶¹ and Miguel Pereira, State of Rio de Janeiro (Nov.-Dec. 1938). Rare instances of ocular involvement, gastro-intestinal symptoms, and meningeal plague have been reported.⁶²

Febre do caroço.—One of the most interesting features of Brazilian plague is *febre do caroço*, or *ingua de frio*, a mild disease characterized by fever, chills, general discomfort, headaches, and a bubo, generally localized in the inguinal region. The name is thought in the former case to be derived from the nut-like appearance of the buboes; and in the latter either because the disease is accompanied by chills, or because it occurs in the cooler part of the year. It has been reported since the earliest appearance of plague (see the account of such a disease in Santos in 1899, above, and also the reports of *febre do caroço* in Ceará in 1900, and Campina Grande in 1912). It has often been reported in Northeast Brazil. It is more common in children than in adults; the majority of cases can be con-

⁵⁶ "Os nossos medicos," etc. 1904, p. 229.

⁵⁷ Oliveira, Waldomiro de, *op. cit.*

⁵⁸ *Braz. Méd.*, Jan. 8, 1900, p. 18.

⁵⁹ Silva, E. C.: *Bol. Of. San. Pan.*, Jan. 1937, p. 21.

⁶⁰ *Arch. Hyg.*, Rio, 1927, pp. 125, 142. Experiences in both Argentina and Ecuador seem to bear this out. The scattered population may be a factor. Mattos mentions the freer circulation of air in warm countries and the lack of crowding as compared with cold regions.

⁶¹ Report of Macchiavello to the Pan American Sanitary Bureau.

⁶² Plague "ophthalmia," Neves, 1928. (Parreiras, D.: *Arch. Hyg.*, Rio, 1935, No. 1, p. 45.) Case with gastrointestinal and ocular symptoms, reported by Agripino Barbosa. (*Braz. Méd.*, Jan. 26, 1918, p. 28.) Godinho mentioned cutaneous symptoms (*Ibid.*, Jul. 15, 1900, p. 241) and also a child with meningeal plague (*Ibid.*, Aug. 15, 1903, p. 303).

sidered ambulatory. Most investigators consider the disease a light form of plague, although bacteriological examinations have been repeatedly negative. The recent studies of Macchiavello seem to affirm that the disease is plague.⁶³

Plague control.—To plague (and yellow fever) Brazil owes the development of public health work on a national scale. The limited authority of the national government—which was supposed to prevent the entry of exotic diseases, but could do little toward eradicating them once they slipped by inspections and quarantines—and the lack of funds or interest on the part of State and municipal governments were serious obstacles in the way of plague control in the early days of its invasion. Plague entered Brazil about the time that the demonstration of the mode of yellow fever transmission and the clean-up campaign in Habana showed the way to the eradication, from cities, at least, of this infection, which had ravaged many parts of Brazil during the 19th century. The joint struggle against the two diseases was a factor in the formation of the careers of such scientists as Oswaldo Cruz and Vital Brazil. It was Cruz who in 1903, as Director of Health, and with the backing of the President, secured for the health department the right to intervene on private property in the city of Rio, and in 1904 a law was passed reorganizing the department.⁶⁴ Previously the national authorities had had little to do except isolate the sick and make quarantine laws.⁶⁵ Under the new law, a General Directorate of Public Health was created, with authority over the public health of the national Capital and in the principal sea and river ports. As an antiplague measure, Article 101 of the Regulations required the construction of floors of impermeable material. This was carried out with particular vigor in plague foci, and some writers have attributed the reduction of plague in Rio de Janeiro especially to it.⁶⁶

The spread of plague into the interior, however, brought about a need for Federal intervention outside of ports. In 1919 a Rural Prevention Service was installed to combat epidemic diseases; it was abolished in 1930. In 1934 the present National Department of Health, in the Ministry of Education and Public Health, was established, and in 1936, through the efforts of João de Barros Barreto, Director of Health, the National Antiplague Service, with a regional type of organization, was created. This Service functions in Northeastern Brazil; plague control in São Paulo is carried on by the State, as previously noted.⁶⁷

⁶³ Report to the Pan American Sanitary Bureau.

⁶⁴ Law No. 1,151 of Jan. 5, 1904; Regulations of Mar. 8, 1904. (Torres, Theophilo: "La Campagne Sanitaire au Brésil," 1913. Also Autran, *op. cit.*)

⁶⁵ Prior to the administration of Cruz, in that of Nuno de Andrade, a law was passed requiring compulsory notification of plague, among other diseases, and giving the Federal Government control over the isolation hospitals in Rio de Janeiro. (Torres, *op. cit.*)

⁶⁶ Autran, H., *op. cit.*, p. 15.

⁶⁷ See São Paulo, above. Mention has also been made of the plague campaign in Santos in 1899 and thereafter, under the direction of Emilio Ribas, State Director of Health.

Northeastern Brazil has been divided into five sectors, and the sectors into districts, with trained personnel in charge. The campaign follows the classic lines of combating rats and their parasites, and, secondarily, immunization of susceptible individuals. Following a joint meeting of the Service personnel in Recife, in November, 1938, which Dr. J. D. Long of the Pan American Sanitary Bureau attended, detailed instructions were issued, covering the following points: (1) Collection of material for the diagnosis of plague in man and rodents, including in the former case viscerotomy,⁶⁸ and in the latter, bone fragments; (2) Technique of the bacteriological examination, with the differentiation when necessary of *P. pestis* and *pseudo-tuberculosis rodentium*; (3) Classification of fleas and calculation of indices; (4) Examination of rats and making of indices; (5) Division of human cases into: positive (confirmed by the laboratory); suspicious, not confirmed; and negative; (6) Deratization, through extensive use of poison in monthly, quarterly, or semi-annual cycles, according to whether plague was recent, six months previously, or more than a year previously, and with the use of arsenic recommended; (7) Use of traps to obtain rats for classification of fleas; (8) Fumigation of merchandise when plague occurs in a site connected with a port by rail, or when there are indications of plague in the vicinity, in order to prevent the transport by such merchandise of infected rats, or perhaps of infected fleas;⁶⁹ (9) Rat-proofing, a fundamental measure difficult of execution in the rural areas of Northeast Brazil, but the Plague Service aids where possible in the construction of rat-proof storehouses for food and material attractive to rats, and, with the help of the sanitary police, some results are being obtained in the disposal of garbage and the maintenance of an area from 100 to 200 M. around dwellings free from weeds and rubbish; (10) Care of the sick; (11) Immunization, using serum in the foci and vaccine in neighboring areas, without, however, neglecting rat destruction and rat-proofing for these measures.⁷⁰

⁶⁸ Securing a small piece of liver by use of the viscerotome, an instrument developed by Ferreiras and especially, Rickard, in Pernambuco, for use by the Yellow Fever Service (See *Bol. Of. San. Pan.*, Apr. 1931, pp. 517, 519; Apr. 1934, p. 375; Nov. 1934, p. 1025; and Sept. 1939, p. 862) and also found of value in plague. Unfortunately, fear of the use of this instrument has sometimes led surviving relatives to conceal their dead and bury them surreptitiously. (Silva, M.: *Arch. Hyg.*, Rio, Mar. 1936, p. 170.) Use of the instrument to obtain tissue for plague diagnosis has been mentioned in Ecuador (*Bol. Of. San. Pan.*, Jan. 1937, p. 49).

⁶⁹ Various writers have mentioned the possibility of transmission of plague through merchandise, such as rags, clothing, or empty sacks, with differing amounts of basis for the speculation. De Moura and Duprat seemed to consider that the bacillus might be brought in on merchandise, and infect local rats. The former felt that the Parnaíba outbreak, São Paulo, Dec. 1927-Jan. 1928, was probably due to the infection being carried in empty sacks, sacks of corn, or sacks of *farelo* (chaff), but did not state whether there had been any plague at the supposed source. The first case of plague had been in an employee who cleaned a warehouse in which this merchandise was stored, and who found dead rats there. (*Arq. Hig. & Saúde Púb.*, S. Paulo, Jan. 1940 p. 75.) Duprat, who discounted the idea of rats as a reservoir of plague in Rio Grande do Sul, felt that it was brought in with grain flour, or fodder from Argentina; he reported that in the Bazílio epidemic in 1913, rats were found dead among sacks in a warehouse storing Argentine flour. The rats were field, rather than city rats; no rats outside the storehouse got plague, and it never reappeared in Bazílio. (*Rev. Hyg. & Saúde Púb.*, May 1935, p. 164.) Fialho (*Ibid.*, June 1935, p. 192) considered that the transmission of plague through fleas in sacks of cotton from the interior where plague seems to be epizootic was entirely possible in Ceará. However, Mattos reported that "the spread of plague by means of infected articles was never observed" in Rio de Janeiro, the outbreaks being always traceable to sick or dead rats and cats in the focus. Man-to-man contagion was also not observed; no case was known which spread to the family or dwellers in a house when the original case had been contracted elsewhere, and there was no contagion in the Hospital. (*Arch. Hyg.*, 1927, p. 125.)

⁷⁰ Barros Barreto, J. de: *Bol. Of. San. Pan.*, Sept. 1940, p. 866. Mention might be made of the killing of rats with sticks, which some have considered an effective measure. (See for instance, Pinotti, et. al., *Arq. Hig.*, Rio, Feb. 1939, p. 117. These authors note, among other objections to the practice sometimes in vogue of paying rewards for dead rats, that during epizootics it brings children into contact with plague rats, and even adults may fail to exercise sufficient care. The cardinal obstacle to the practice is, of course, the possibility of rat breeding, or importation, by some individuals.) In drought areas promising

Plague control in ports includes rat destruction, sanitation, classification of fleas and rats, and a certain amount of rat-proofing, especially in old plague foci. Ships are deratized in Rio de Janeiro, Santos and Manaos. The Clayton system was the most used in 1938, but hydrocyanic acid was being increasingly employed; its adoption was hindered by the difficulty of obtaining the materials.⁷¹

Serum treatment.—Serum has been used in the treatment of plague in Brazil from the earliest times, with much success⁷² (See Table 3). Two great Brazilian research centers were originally established for the manufacture of plague serum and vaccine—the Butantan Institute of São Paulo and the Manguinhos (now Oswaldo Cruz) Institute in Rio de Janeiro.⁷³ Oswaldo Cruz reported that the use of serum reduced plague mortality 50 percent.⁷⁴ De Freitas observed in Recife in 1902 that “all remedies were useless until the arrival of the first shipments of plague serum from the Federal Capital.”⁷⁵ Godinho has reported a mortality rate of as low as 9.09 in serum-treated cases, and a rate of 13 percent was reported for cases treated in the Paula Candido Hospital, Rio de Janeiro, April–June, 1900, but both these figures were reached by excluding persons in an advanced stage of the disease upon beginning treatment, such as those dying in less than 48 hours after arrival at the hospital. The total mortality in Godinho’s cases, including those arriving in a moribund condition, was 37.5%.⁷⁶ And Ferrari reported a mortality of 7.2 in 68 cases in 1906 and 1907.⁷⁶ Camargo Penteado of the Butantan Institute concluded in 1907 that serum was the only satis-

results have been secured by shutting out water supplies from access by rats and then placing poisoned water and salty foods within reach. (Barros Barreto, J. de: “Actas III Conf. Pan. Dir. Nac. San.,” 1936, p. 235.)

⁷¹ Barros Barreto, J. de: “Actas X Conf. San.,” 1938, p. 161. In 1937 a Brazilian health officer was sent to the United States, through the good offices of the Pan American Sanitary Bureau, to study ship inspection methods. On his return systematic ship inspection for rat infestation was begun.

⁷² Brazil observed that one of the greatest obstacles in the way of effective plague treatment when the disease first appeared in Santos, was the lack of serum, which could not be procured immediately, due to the heavy demands on available sources such as the Pasteur Institute in Paris. At the opportune moment, a French steamer arrived in Santos, and Ribas, the Director of Health, succeeded in talking the *commandant* out of a good supply of the serum which he had on board for preventive purposes. The effects of the serum were said to have been very favorable. (Brazil, Vital: *Arch. Hyg. & Saúde Púb.*, S. Paulo, Jun. 1936, p. 8.)

⁷³ The efficiency of the Brazilian serum as proven in Ecuador has been emphasized by Trujillo (*Bol. Of. San. Pan.*, Sept. 1938, p. 820).

⁷⁴ Cruz, Oswaldo: Report of Brazil to the III International Sanitary Conference, Mexico, Dec. 2-7, 1907, “Transactions,” p. 143.

⁷⁵ “Os nossos medicos, etc.,” p. 238.

⁷⁶ Godinho, V.: *Braz. Méd.*, Aug. 15, 1903, p. 303. According to the Hospital Paula Candido report, *Braz. Méd.*, 1900, p. 217, of 36 known cases treated at home or without medical care, all died. According to Ferrari, Godinho stated that “serum almost always cures the bubonic type in adults if used before the third day; it is often effective after the fourth day, and sometimes even after the fifth.” (Ferrari, A.: *Rev. Med.-Cíur.* *Braz.*, 1908, p. 14.) Surgical removal of the buboes, together with serum, was a routine procedure of Camillo Terni, who had been brought from Italy by the Brazilian Government in 1900, but it was abandoned by Brazilian physicians. Ribeiro de Almeida reported that mortality dropped from 40% to 32, 27, and 19% after abandonment of the surgical measure, and both he and Tavares de Macedo considered it undesirable except in cases of necrosis. (Ribeiro: *Ibid.*, p. 411.)

factory treatment for plague.⁷⁷ Godinho has reported two instances of recovery of pregnant women after serum treatment.⁷⁸ Serum has also been used preventively, especially in the case of contacts.

Vaccination.—Vaccination against plague has also been practised in Brazil since the early days. Instances in which all but one person in a focus were vaccinated and that one person contracted plague, have been reported.⁷⁹ In 1931, Albuquerque reported that he had secured "magnificent results" with vaccine in Maranhão.⁸⁰ Large-scale vaccination has been tried in northeastern Brazil in recent years: 1937, more than 5,000 vaccinations; 1938, almost 27,000; 1939, around 5,000. In 1938 in Serra da Inveja, 4,000 persons were immunized with vaccine from the Laboratory of the National Department of Health, and there was only one case among them, and that not fatal.⁸¹ However, vaccination is regarded as auxiliary to other measures and in no case as a substitute for them.

Research.—Early research in Brazil was directed mainly at improving plague vaccine and serum. Cruz, Vasconcellos, and Fontes at the Manguinhos Institute; Terni at the Jurujuba Hospital; and Brazil, Godinho, Ferrari, Pentecado, and others, in Santos and São Paulo, experimented with various methods and doses.⁸² At Jurujuba and the Butantan Institute, burros were used instead of horses in

⁷⁷ Camargo Pentecado, Dorival de: *Tratamento da Peste*, "Collectanea de Trabalhos," Instituto Butantan, 1901-17, pp. 83-105.

⁷⁸ In one instance, a woman ill with plague, who had a miscarriage at 3½ months, was treated with serum and recovered. (*Braz. Méd.*, Jul. 15, 1900, p. 246.) Another woman gave birth to a healthy child while under treatment for plague; however, another patient entered the hospital the day following a premature delivery, with puerperal infection; she died 69 days later showing nervous system alterations. (*Ibid.*, Aug. 15, 1903, p. 303.)

⁷⁹ For instance, E. Gomes (*Braz. Méd.*, 1902, p. 126) reporting results with the Terni-Haffkine vaccine, said that there was no more plague among policemen or firemen after those groups had been vaccinated; and that in a certain pharmacy all but one person were vaccinated, and that person contracted plague; in a house in which dead rats were found, the inhabitants were vaccinated and no one became ill; and of 20,000 persons vaccinated, most of them in plague foci, only 4 got plague. According to Tavares de Macedo (cited by Machado, O.: "Etiologia e prophylaxia da peste," Rio, 1901, p. 89), all the personnel of the Jurujuba (plague isolation) hospital in Rio de Janeiro were vaccinated, with the exception of a laundress who refused vaccination; she contracted plague and died.

⁸⁰ "Actas, II Conf. Dir. Nac. de San.," Washington, 1931, p. 98.

⁸¹ Barros Barreto, J. de: *Bol. Of. San. Pan.*, Sept. 1940, p. 866. In 1939 the Oswaldo Cruz Institute was preparing a vaccine using 2 cc. of a culture in glycerinated agar, killed by heat at a temperature of 65° during one hour. A. de Assis, of the Laboratory of the National Department of Health, prepared a vaccine using peptonated gelose (pH 7.4) at laboratory temperature. At the end of 48 hours culture, the bacterial suspension was treated by formaldehyde (to obtain a final concentration of 1:2,000 of formalin) and dried in a water bath for an hour at 50 C. The suspensions are kept at a low temperature (4 C) and diluted in physiologic solution (phenicized at 4%) to secure a concentration of 1,000 bacteria per cc. Two inoculations are made at 7-day intervals. According to Barros Barreto, results with the latter vaccine seemed to be the more satisfactory.

⁸² Cruz, O.: "A vacinação anti-pestosa," 1901; "A vacina anti-pestosa," 1901; "Le vaccin contre la peste," 1902; Instituto Oswaldo Cruz. Also *Braz. Méd.*, Dec. 1, 1901, p. 443; May 22, 1901, p. 195. Fontes, A. C.: "Vacinação e soroterapia antipestosas," Inst. O. Cruz, 1903; Vasconcellos, H. F. de: O soro anti-pestoso, *Ibid.*, "Memorias," vol. I, No. 1, 1909, p. 14. Terni used intraperitoneal injection in rabbits or guinea pigs in the preparation of vaccine, but other investigators felt that it was difficult to control the potency with this method. (Terni, J. C., & Bandi, J.: *Braz. Méd.*, Apr. 1, 1900, p. 112; Terni, *Ibid.*, May 1, 1900, p. 143; Machado, O., *supra*, Note 79.) Ferreira de Aguiar ("Da soroterapia na peste," Rio, 1905) described the different methods of preparation in use at Manguinhos, Jurujuba and Butantan. Pentecado, D. de C.: *Tratamento da peste*, *Rev. Méd. S. Paulo*, Mar., 1908, p. 89; also "Col. Tr. Inst. Butantan," 1918, p. 86. Ferrari, A.: A soroterapia na peste, *Rev. Méd. S. Paulo*, Dec. 1907, p. 491.

the preparation of serum. Cruz and Meirelles studied the characteristics of the plague bacillus;⁸³ Moses, immunity in plague;⁸⁴ Aben-Athar and Vampré prognosis in certain cases;⁸⁵ while clinical reports are numerous. Fialho experimented with the survival of the plague bacillus in dead guinea pigs, finding positive evidence of plague up to and including 72 hours after death; after 4 days, no evidence of plague was found.⁸⁶ The importance of regular study of captured rats was pointed out by Gomes, who described the finding of plague in rats during routine examinations while no epidemic or epizootic was known to be present; investigation of the locality from which the rats came revealed cases of plague.⁸⁷ Plague research has received new emphasis with the extensive epidemiological studies which have been undertaken in recent years, including those of Alves Meira and Prado on São Paulo rats and their parasites; of Fialho, Silva, Macchiavello, Pinotti, de Brito, Araujo, and others on rural epizootics, plague in wild rodents, *febre do carçoço*, and the effect of climatological conditions; the bacteriological investigations of Macchiavello in regard to Northeastern plague, plague-like pasteurellae in rats and wild rodents, *carçoço* fever, and (with Bezerra Coutinho) feline epizootics; all of which have often been referred to in this paper,⁸⁸ and show the attention given the problem and its solution.

(To be continued)

⁸³ Machado, O., *supra* (Note 79). Meirelles, Eduardo: *Braz. Méd.*, Dec. 8, 1900, p. 409.

⁸⁴ Moses, Arthur: *Mem. Inst. O. Cruz.*, 1914, Tom. 6, p. 100.

⁸⁵ Aben-Athar, Jayme: "As oscilações do complemento do soro dos pestosos e seu valor prognóstico," *Inst. O. Cruz*, 1907; Vampré, E.: *Prog. na peste bubônica: a nota bulbar da peste*, *Rev. Clin. S. Paulo*, Sept. 1937, p. 77.

⁸⁶ *Arch. Hyg.*, Rio, 1928, p. 17.

⁸⁷ *Braz. Méd.*, June 1, 1918, p. 173.

⁸⁸ See sections on São Paulo, Plague in the Northeast, Rats, Wild Rodents, Cats, Birds, Parasites, Seasonal Distribution, and *Febre do Carçoço*.