



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

(Continued)

V. CHILE

Chile, with its 5,000,000 inhabitants, lies between the Andes mountains and the Pacific ocean (15°-55° S. Lat.; 70° W. Long.); it has an area of 289,810 square miles, a coast line of 2,800 miles, and an average width of about 100 miles. The country is mountainous, with several large fertile valleys, such as that between Santiago and Valparaíso. It may be divided into three geographical areas: the deserts of the north, the arable lands of the center, and the lake and forest country of the south. Still further south lie the Patagonian and Magellan regions, sparsely populated, and suitable mainly for sheep-raising. The climate is temperate, with the highest temperature, in the north, 91 F, and the lowest, in the south, 17 F; the average temperature in Santiago is 56 F. Rainfall varies greatly: La Serena, 6½ inches; Santiago, 16; Talca, 22; Concepción, 53; Puerto Montt, 104; and Valdivia, 112. The northern area from Arica to Iquique is rainless. Snow does not fall north of 36°S. except at altitudes of 200 to 300 meters (605 to 984 feet). Spring runs from September 21 to December 21; summer from December to March, autumn, March to June, and winter, June to September.

Plague in Chile was almost entirely confined to ports, and especially those of the northern, desert, saltpeter area. Its southern limit was Valdivia, just above the 40th parallel, where one case was reported in 1924; it is not known whether this was the only case or whether or not it was imported.¹ Altogether, four inland cities (Tacna,² 1904; Santiago, 1907; La Serena, 1915; Curicó, 1924) and at least 14 ports (Antofagasta, Arica, Caleta Buena, Chañaral, Concepción, Coquimbo, Iquique, Mejillones, Pisagua, Taltal, Tocopilla, Valdivia, Valparaíso, and Viña del Mar) have been infected.³ The last case of human plague was reported in 1931 in Santiago, and the last plague-infected rat was found in Antofagasta in 1932. The total number of cases in Chile may be estimated at about 5,200; of deaths, 2,150. (See below.)

Chile had its first real alarm about plague in 1902, when a suspicious case reached Valparaíso on board a ship which had made stops at Rio de Janeiro and Montevideo.⁴ Before this, however, a Chilean commission had been sent to Argentina, in February, 1900, shortly after

* See General Review.

¹ Valdivia lies at about the same latitude as the southern edge of the plague area in Argentina (La Pampa and Río Negro). Most Chilean plague, however, was north of Valparaíso (33d parallel).

² Now a part of Peru.

³ Ferrer, Pedro Lautaro: "Higiene y Asistencia Pública en Chile," 1911, p. 415; Macchiavello, Atilio: "Historia de la peste en Chile," 1932; and *Rev. Chil. Hig. & Med. Prev.*, I, No. 1, 1937, p. 69.

⁴ Report of the Chilean Delegate, Dr. Eduardo Moore, to the First International Sanitary Convention of the American Republics, Washington, 1902 ("Transactions," p. 33). The vessel, 11 days out of Rio de Janeiro and Montevideo, was refused entry at Punta Arenas and Coronel, but admitted at Valparaíso, where the ship and merchandise were disinfected and the patient removed to a floating hospital. There was apparently no repercussion from this case.

plague made its appearance there, to study the disease and control work.⁵

At the International Sanitary Convention held in Washington in 1902, the Chilean delegate mentioned plague as a disease unknown in his country, but expressed fears of its possible importation from Brazil or Argentina.⁶ When plague did strike, however, it was from the north. Peru had been invaded about April, 1903, and the disease soon reached a number of ports (Iquique, Pisagua, Antofagasta) in the center of the saltpeter area (Atacama desert) in northern Chile, a region of some 150,000 inhabitants, its ports isolated from each other and from the interior by the barren nature of the surrounding country.

The first case was diagnosed in Iquique May 25, 1903,⁷ and on May 27, the Iquique Council of Health declared that the disease, clinically and bacteriologically, was plague.⁸ The diagnosis was disputed, and the Government was asked to send a Commission from the Institute of Hygiene, which arrived June 1, and eventually sent in a confidential report that the disease was plague.^{7,8} Several vessels arriving in Iquique from March 7 to May 13 have been considered as possibly responsible, especially the *Colombia*, which touched at Iquique April 13 and arrived in Valparaíso April 18. (See General Review.) Up to July 20, 68 cases had appeared in Iquique in 11 foci and 7 outside the foci; the epidemic ended in September after 214 confirmed cases and

⁵ The members of the Commission were Drs. Alejandro del Rfo, Director of the Institute of Hygiene, Mamerto Cádiz, and Roberto Aguirre Luco. (Inst. de Higiene: "Higiene pública en Chile," 1903, p. 31.) The Commission was cordially received and its members were installed in the plague laboratory at Rosario, where they had an opportunity to make autopsies and to treat cases. On their return a number of precautions were recommended, including the establishment of a sanitary station at the Uspallata pass between Argentina and Chile (which, however, seems never to have been involved in the entry of plague into Chile, though it has been implied that the infection may have gone the other way. See Argentina); establishment of a sanitary station in Magallanes, organization of an anti-plague council, and stricter enforcement of existing sanitary regulations, but nothing much was done. (*Rev. Méd. Chile*, 1900, Feb. p. 75, Mar. p. 119, Apr. p. 159. Also Macchiavello: "Hist. de peste," p. 6; and Gallinatto, Valentín: "Contr. al estud. de la epidemiología de la peste bubónica en Chile," 1930, p. 24.)

⁶ I Int. San. Conv., 1902: "Transactions," p. 35. Yellow fever, leprosy, cholera, typhus, malaria, beriberi, yaws and glanders were also feared. This list is rather interesting in the light of past and present Chilean epidemiology. Yellow fever, leprosy, malaria and yaws have been practically absent from the country throughout its history. On the other hand, typhus fever has caused again and again most severe epidemics.

⁷ By Dr. O. Neill Roe, in a truck-driver. (Macchiavello, *supra*, p. 10.) Gallinatto (*supra*, p. 25) stated that the first case occurred May 17 and that by the 20th there were 9 clinically suspicious cases, the first bacteriological diagnosis being made May 25. According to Macchiavello, by the time the Government commission arrived (June 1) there were 9 cases, only one of them in a wharf-worker. He expresses the opinion that the infection had probably been spread among city rats through cargos sent to a warehouse or bakery, rather than by wharf rats, since little grain was kept on the Iquique wharves. Saltpeter and minerals were the chief exports. He notes that Iquique in those days offered very favorable conditions for rats—unpaved streets, houses of painted wood, without cement foundations, with wooden roofs, ceilings of wood or canvas, and patios full of trash and garbage. Other ports were similar. (*Supra*, p. 8.)

⁸ Pérez Canto: *Rev. Méd. Chile*, Jul. 1903, p. 269. He reported that according to the Provincial administration the first case was that of a laborer who had been unloading flour and rice from a vessel five days out of Callao; the man fell ill May 20th. Up to May 27th, when the diagnosis was announced, 8 cases with 7 deaths had been observed. He remarked that the "powers" of commerce, administration, and so on of the city—*alto comercio, altos magistrados, altos funcionarios, i otras altitudes*—denied the existence of plague, as did most of the press, and that a similar philosophy of *no debe haber peste y no la habrá*—there shouldn't be plague and there won't be—prevailed in Valparaíso. Unfortunately, plague, on the Chilean littoral as elsewhere in the world, failed to heed this firm mental opposition.

PLAGUE IN CHILE*

| YEAR | Tacna | | Arica ^{d,e} | | Pisagua ^d | | Iquique ^d | | Tocopilla | | Mejillones ^d | | Antofagasta ^b | | Antofagasta ^a | | Taltal | | Chañaral | | Serena | | Coquimbo | | Valparaíso ^f | | Santiago | | Curicó | | Concepción | | Valdivia | | TOTALS | | | | | | | | | |
|--------|-----------------|----|----------------------|-----|----------------------|-----------------|----------------------|-----------------|----------------|---|-------------------------|------------------|--------------------------|----------------|--------------------------|-----|--------|-----|-----------------|---|--------|---|----------|---|-------------------------|---|----------|---|--------|---|------------|---|--------------|-----|-----------|-----------|-----|-----------|-------|-------------------|-------------------|-------------------|-------------------|--|
| | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | C | D | Macchiavello | | | Gallinato | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | C | D | Mortality | C | D | Mortality | | | | | | |
| 1903 | | | | | | | 214 | 135 | | | | | | | | | | | | | | | | | | | | | | | | | | | 224 | 139 | 62% | 220 | 139 | 63.18% | | | | |
| 1904 | 8 | 6 | 28 | 9 | 310 | 97 ^a | 78 | 30 | | | | | 400 ^a | 115 | 185 | 43 | 33 | 14 | | | | | | | | | | | | | | | | 515 | 160 | 31 | 222 | 58 | 26.12 | | | | | |
| 1905 | 7 | 6 | 6 | 5 | | | 73 | 23 | | | | | 51 ^a | 32 | 51 | 19 | 13 | 5 | | | | | | | | | | | | | | | | 484 | 179 | 36.9 | 409 | 115 | 28.11 | | | | | |
| 1906 | | | 13 | 5 | | | 48 | 23 | 1 | ? | ? | | 75 ^a | 34 | 75 | 21 | 13 | 5 | | | | | | | | | | | | | | | | 174 | 65 | 38.6 | 151 | 54 | 35.76 | | | | | |
| 1907 | | | 35 | 16 | 105 | 47 ^a | 222 | 81 | ? | ? | ? | | 240 ^a | 90 | 240 | 95 | 231 | 110 | | | | | | | | | | | | | | | | 961 | 358 | 41.5 | 812 | 327 | 40.27 | | | | | |
| 1908 | | | 45 | 14 | | | 203 | 70 | 14 | ? | 4 | 300 ^a | 100 ^a | 173 | 105 | 226 | 81 | 20 | 9 ^f | | | | | | | | | | | | | | 814 | 329 | 40.0 | 567 | 205 | 36.15 | | | | | | |
| 1909 | | | 50 | 19 | | | 233 ^g | 79 | 1 | | | | 104 | 53 | 130 | 53 | 58 | 20 | | | | | | | | | | | | | | | | 626 | 232 | 37 | 516 | 161 | 31.20 | | | | | |
| 1910 | 6 | 4 | 33 | 16 | | | 169 | 64 | | | | | 177 | 61 | 10 | | | | | | | | | | | | | | | | | | 634 | 134 | 38.7 | 361 | 126 | 34.62 | | | | | | |
| 1911 | | | 97 | 29 | | | 82 | 38 | 1 | | | | 28 | 4 ^a | ? | 35 | 19 | 39 | 19 | | | | | | | | | | | | | | 229 | 94 | 41.2 | 227 | 93 | 41.4 | | | | | | |
| 1912 | | | | | | | 58 | 24 | | | | | 62 | 40 | 62 | 40 | 5 | 1 | | | | | | | | | | | | | | | | 125 | 65 | 38.7 | 125 | 65 | 44 | | | | | |
| 1913 | | | | | | | 53 | 25 | | | | | 43 | 31 | 120 | 38 | ? | ? | | | | | | | | | | | | | | | | 96 | 56 | 173 | 63 | 36.5 | | | | | | |
| 1914 | 21 | 6 | 11 | 4 | 2 | 1 | 39 ^a | 30 ^a | 3 ^a | | | | 96 | 54 | 96 | 54 | 20 | 8 | 13 ^a | | | | | | | | | | | | | | | 205 | 103 | 54.49 | 189 | 103 | 54.49 | | | | | |
| 1915 | 26 | 12 | | | | | | | | | | | 16 | 11 | 14 | 7 | | | | | | | | | | | | | | | | | | | 46 | 24 | 44 | 22 | 50 | | | | | |
| 1916 | 19 ^h | 19 | | | | | 77 | 7 ^a | | | | | 21 | 6 | 21 | 6 | | | | | | | | | | | | | | | | | | 48 | 33 | 96 | 33 | 34.37 | | | | | | |
| 1917 | 9 | 2 | | | | | 12 | 5 | | | | | 24 | 8 | 35 | 8 | | | | | | | | | | | | | | | | | | 45 | 15 | 56 | 15 | 26.78 | | | | | | |
| 1918 | 32 | 13 | | | | | 51 | 19 | | | | | 36 | 13 | 36 | 13 | | | | | | | | | | | | | | | | | | 120 | 46 | 38.3 | 467 | 46 | 38.3 | | | | | |
| 1919 | 13 | 5 | | | | | 39 | 16 | | | | | 29 | 7 | 29 | 7 | | | | | | | | | | | | | | | | | | 82 | 28 | 34.5 | 81 | 28 | 34.5 | | | | | |
| 1920 | | | | | | | 1 | 1 | | | | | 23 | 9 | 23 | 9 | | | | | | | | | | | | | | | | | | 24 | 10 | 41.6 | 24 | 10 | 41.6 | | | | | |
| 1921 | | | | | | | | | | | | | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | | | | | 2 | 0 | 16 | 10 | 62.5 | | | | | |
| 1922 | | | | | | | 17 | 1 | | | | | 2 | 2 | 2 | 2 | | | | | | | | | | | | | | | | | | | 3 | 1 | 0 | 3 | 1 | — | | | | |
| 1923 | | | | | | | | | | | | | 1 | 8 | | | | | | | | | | | | | | | | | | | | | 2 | 1 | 3 | 1 | — | | | | | |
| 1924 | | | | | | | | | | | | | 33 | | | | | | | | | | | | | | | | | | | | | | 39 | 13 | 35 | 10 | — | | | | | |
| 1925 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0 | 1 | 0 | — | | | | |
| 1926 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | — | — | — | | |
| 1927 | 17 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 17 | 1 | — | | | | |
| 1928 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | — | — | — | | |
| 1929 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | — | — | — | | |
| 1930 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 8 | 4 | — | |
| 1931 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | — | |
| Totals | 148 | 74 | 323 | 117 | 454 | 158 | 1584 | 671 | 20 | 4 | 609 | 171 | 1523 | 669 | | | 411 | 177 | 13 | 1 | | | | | | | | | | | | | | | | | | | | 5121 ^h | 2094 ^h | 4386 ^h | 1680 ^h | |

* Table adapted from Macchiavello ("Hist. de peste," 1932, tables p. 40 and facing p. 40), with additional data from Ferrer (*op. cit.*), Gallinato ("Contr. al estudio," etc., 1930), Ríos (*op. cit.*). The figures for Iquique agree with those of Guajardo (*op. cit.*). The cities are given in geographical order, from north to south, showing the greater incidence of plague in the northern area.

- ^a Approximate figures only. (Macchiavello's note.)
- ^b Macchiavello's figures.
- ^c Gallinato's figures. He states that 35% should be added to those for 1904.
- ^d Gallinato's figures differ from these for several cities: Arica, 1905, 4 C 2 D; 1907, 15 D; 1909, 4 D; Concepción, 1916, 1 D, possibly an imported case; Iquique, 1906, no cases reported; 1907, 174 C 68 D; 1917, 9 C 2 D; Mejillones, 1909, 52 C 9 D; 1910, 28 C 2 D; Pisagua, 1905, 73 D.
- ^e Conrado Ríos gives nearly the same figures for Arica, except: 1904, 8 D; 1905, deaths are not given; 1908, 43 C 11 D; 1910, 13 D.
- ^f Ferrer gives 22 C in Valparaíso, 20 in Viña del Mar, for 1907; and 58 C 18 D for Taltal, 1908. Ríos gives 12 cases for Valparaíso, 1903.
- ^g Guajardo gives 223 cases.
- ^h Macchiavello has stated that 20% should be added to his totals to cover concealed or unidentified cases and deaths.
- ⁱ Including figures for 1930 and 1931 as given by Macchiavello.

135 deaths (63.0% mortality).⁹ It reappeared every year from 1904 through 1914, and thereafter in 1917-1920, 1922 and 1930. Despite the evidence of plague, vessels from Iquique were received in Valparaíso without special precautions, although foreign consuls gave those going abroad a foul bill of health.¹⁰

The first diagnosis of plague in Valparaíso is generally said to have been made June 10, 1903, in a servant of a marine accountant (*contador de marina*) who had apparently had no contact with rats or with ships' cargo.¹¹ There are reports of suspicious cases as early as April.¹² Only 4 additional cases were officially reported, the last August 14, and possibly there were not many more.¹³ Subsequent epidemics

⁹ At the Second International Sanitary Conference (1905, in an era when the fluctuations of plague were not yet well known), the Chilean Delegate, apparently impressed with the ending of the epidemics, stated that the disease was dying out very rapidly in the country. ("Transactions," p. 115.)

¹⁰ *Rev. Méd. Chile*, Jul. 1903, p. 268. However, the national authorities seem to have declared officially on May 28, 1903, that plague was present in Iquique, and a quarantine was placed on vessels from that port. (*Pub. Health Rep.*, U. S., Jul. 3, 1903, p. 1072; Aug. 7, p. 1309.) For an analysis of Iquique plague from 1903-1910, by cases, recoveries, deaths, ages, sex, nationality, patients treated at home and patients treated in the hospital, see Guajardo, Amador: "Memoria del desinfectorio público y del laboratorio químico municipal de Iquique, correspondiente a 1910," p. 19.

¹¹ The Valparaíso Board of Health (*Arch. del Consejo de Hig. de Valparaíso*, 1904-1907, p. 21) implicated the *Colombia*, which had had two deaths of plague on board, and this view was accepted by Ferrer, Galinatto, and Macchiavello. Macchiavello, studying the situation in the light of subsequent experience, states that plague may have been introduced by that vessel on her arrival in April and have existed in rats, with possibly some unidentified human cases, until June. Pérez Canto (*Rev. Méd. Chile, supra*) reported that the diagnosis was confirmed by the Institute of Hygiene of Santiago on July 3, but that on the same date the administrator of the isolation hospital, a non-medical man, officially declared that the disease was not plague, and his opinion was accepted by the Valparaíso Board of Health. The Archives of the Board itself, published some years later, report that the diagnosis of the Institute bacteriologist (Cádiz) was accepted, but that there had not been any plague in Valparaíso before that case, and that there was no epidemic of plague, merely a case now and then. The Board had been discussing clean-up measures since May (when plague was reported in Callao), and had ordered plague serum from Buenos Aires and Paris. It also sent a physician (Durán) to study plague bacteriology in Santiago for three months at its expense. It is interesting to find one of the Board members originally most firm in his opposition to accepting the early cases as plague, without absolute bacteriologic confirmation, arguing the following year that once the existence of the disease in a locality was known and a few cases had been seen by local physicians, the clinical diagnosis was enough. (*Arch. Cons.*, etc., 1900 (2nd half)—1903, pp. 72-139; 1904-1907, p. 23.)

¹² On May 6, 1903, Dr. Ricardo Cannon, who had seen plague in Australia, reported to the *Consejo de Higiene* a suspicious case in the Matadero district, near the city railway station and garbage dump, and observed that eight days previously in this same house a person had died on the third day of a disease characterized by very high fever and glandular swellings, without seeing a physician. A later and more detailed report gives the onset of illness in the earlier case as April 19. Dead rats were found, but were attributed to the distribution of poison. Cannon had also heard reports of another similar case. The *Consejo de Higiene* investigated the case May 6, and decided that the disease was smallpox. On June 8 another suspicious case was reported, but the report was said to be unfounded. Swellings of the axillary glands were among the suspicious symptoms in both the cases reported by Dr. Cannon. (*Ibid.*, 1900-1903, pp. 72-80; 89-95.)

¹³ Macchiavello has suggested several reasons for the apparently small extent of the Valparaíso outbreaks, including a low *cheopsis* index. (In 1929, only 1% of Valparaíso fleas were *cheopsis*. See Fleas Below.) On the other hand, Pérez Canto (*supra*) apparently believed that many Valparaíso cases were being concealed. Ríos (Ríos, Conrado: "Árica en el presente i en el porvenir, su saneamiento," 1914, p. 37) reported 12 cases for Valparaíso in May and June. Valparaíso was much more alarmed over smallpox in these years. In 1904-05 she suffered her worst epidemic of smallpox since 1865. Apparently coming from Santiago, it began in 1903 with 4 cases 1 death, increasing in 1904 to 87 cases 29 deaths, and in 1905 to 11,089 cases 4,985 deaths (12,308 cases 5,630 deaths including Viña del Mar). Partly responsible was the poor quality of local vaccine during a certain period. (Carvalho, Daniel: "Epidemia de viruelas en Valparaíso, años 1904 y 1905," p. 15.)

were also fairly limited: 1904, introduced by the *Limari* in May,¹⁴ cases in Recreo, 4; 1906, Portales and Viña del Mar, 20-23 cases; 1907, 5 cases (Ferrer gives 22 for Valparaíso and 20 for Viña del Mar); 1908, 59; 1911, 1915, 1918, 1924, 1.

The history of plague in other localities may be given briefly.¹⁵ Plague gained its firmest foothold in Antofagasta, attacking this rapidly-growing port, with its flimsy wooden buildings, many with double walls and dead spaces under floors, its unpaved streets, and carelessly stored grain, early in 1904.¹⁶ When the isolation hospital was opened April 8 there were many cases throughout the city, and in a few days over 100 had been reported. The city suffered continuously until May, 1925, when there was a break until 1930. The total number of cases reported from 1908-1925 was 750; and of deaths, 1904-1930, 669. (See Below.)

Pisagua, a small saltpeter port, first infected in 1903,¹⁷ was doomed to suffer in 1905 an epidemic reminiscent of the days of the "black plague,"¹⁸ with 310 cases and 74 deaths reported officially in two months, and even more, according to private statements.¹⁹ The inhabitants fled to the interior, and part of the city was burned. In the first part of 1907 there was another epidemic, with 105 cases, 37-47 deaths; in 1909, 3 cases; 1910, 25 cases; 1911, 9 cases; 1914, 2 cases. The decline of the saltpeter industry since that date coincided with the apparent cessation of plague.

In Arica, plague appeared toward the end of June 1904, and every year thereafter through 1914, with a total of over 323 cases, 117 deaths.

Taltal had its first official cases in July, 1905, and the last in July, 1910, with apparently some cases in 1912 and 1914, and possibly 1913; Mejillones, over 300 cases in 1908; 1909, 177 cases; 1910, 28; 1911, 4-5; and none thereafter; Tocopilla,

¹⁴ The *Limari* arrived in Valparaíso in May 1904 concealing the fact that she had had cases and deaths of plague on board. The vessel had sailed from Callao April 18, taking on at that port a young student from Arica, on his way home from school in Lima. The lad fell ill and died of plague during the passage from Mollendo to Ilo, and was hastily buried at sea. The captain and physician did not report the death at Arica, in order to avoid the vessel's being declared infected. The truth came out when the boy's parents, alarmed at his failure to arrive at home, began to make investigations. (*Arch. Cons. Hig., Valparaíso, 1904-1907, p. 21.*)

¹⁵ Macchiavello, *supra*; Ferrer, *supra*; Gallinatto, *supra*; and supplementary data from other sources.

¹⁶ Demaría and Gallinatto (*Rev. Inst. Bact. Chile, Dec. 1929, p. 35*) give the date of the first infection of Antofagasta as February 1904, as does Ferrer, *supra, p. 418*. Macchiavello (*supra, p. 25, citing Rev. Chil. Hig., 1905*) suggests that the original infection may have been imported on the *Gladstone* out of Calcutta with a cargo of empty sacks, which arrived in Antofagasta March, 1904. Three men engaged in unloading this cargo fell ill with plague.

¹⁷ *Pub. Health Rep., Sept. 25, 1903, p. 1610, information dated July 27.*

¹⁸ The disease appeared in January 1905 and spread rapidly throughout the city, accompanied by extensive rat mortality. The isolation hospital, lacking sufficient supplies and accommodations, with patients lying out-of-doors unprotected from the sun, for want of room, became merely a way-station on the road to the cemetery, and persons consequently attempted to conceal their illness for fear of being sent there. Many fell dead at work, or in the streets; others hid in their homes and were not found until their bodies had begun to decompose. The dead remained unburied for long periods for lack of people to bury them. The normal population of some 3,625 persons was reduced by March to around 400, of whom about 268 were in isolation at the plague hospitals. The local business men are said to have formed a commission to deal with the situation, and collected funds for an additional isolation hospital. The lack of supplies—serums, medicine, and general equipment—was disheartening; it was reported that two of the city's physicians finally left for that reason. Two others who remained themselves fell ill with plague. By March 21 the total number of known plague deaths was 133; and of patients discharged as cured, 45. (Report of a Pisagua merchant, as cited in a consular report of March 25, *Pub. Health Rep., May 5, 1905, p. 827.*) See also Ferrer, *supra, p. 417.*

¹⁹ At least 94 deaths, according to a local physician cited by Macchiavello (*supra, p. 34*), in addition to persons found dead in the street (apparently buried without diagnosis).

cases in 1906-1909, 1911; Caleta Buena and Junín, date unknown; Coquimbo, 1906; Serena (inland, 1915); Concepción, 1916; Curicó (inland, 1924); Valdivia, 1924; Tacna (inland, 1904-04, 1910, 1914-19, 1927 and possibly other years).²⁰

Santiago, most illogically, would seem to have been infected not from Valparaíso, with which it is most closely connected, but from Taltal, whence the disease was thought to have been brought by a group of *turcos* (peddlers).²¹ The first case was reported January 13, 1907, and there were 23 proved cases, disseminated throughout the city without concentrating in a focus. On April 5, 1910, another case appeared; in 1915, two more; 1919, one; and on October 25, 1931, an autopsy of a case of pneumonia revealed that it was undoubtedly plague. This was the last case in Chile.

Cyclic nature.—Studying the history of Chilean plague, Macchiavello has divided it into six cycles which reveal a steady decrease in the number of cases following the first year in each cycle:

| | | | | | |
|--------------|-----|-----|---------|-----|-----|
| First cycle: | C | D | Fourth: | C | D |
| 1904 | 515 | 160 | 1918 | 120 | 46 |
| 1905 | 484 | 179 | 1919 | 82 | 28 |
| 1906 | 174 | 68 | 1920 | 24 | 10 |
| | | | 1921 | 2 | 0 |
| Second: | C | D | 1922 | 3 | 1 |
| 1907 | 861 | 358 | 1923 | 2 | 1 |
| 1908 | 814 | 329 | | | |
| 1909 | 626 | 232 | Fifth: | C | D |
| 1910 | 346 | 134 | 1924 | 39 | 13 |
| 1911 | 229 | 94 | 1925 | 1 | 0 |
| 1912 | 125 | 65 | 1926 | ... | ... |
| 1913 | 96 | 56 | 1927 | 1 | 1 |
| | | | 1928 | ... | ... |
| Third: | C | D | 1929 | ... | ... |
| 1914 | 205 | 103 | | | |
| 1915 | 46 | 24 | Sixth: | C | D |
| 1916 | 48 | 33 | 1930 | 8 | 4 |
| 1917 | 45 | 15 | | | |

He has concluded that this cyclic nature of Chilean plague may be explained by relating it to two factors: foreign commerce and local residual plague in rats. According to this theory, the original large outbreaks in each cycle (which are said to have begun with severe, nearly always fatal septicemic cases, later followed by bubonic cases, in contrast to the situation in other years, when the first human cases were mild bubonic, sometimes ambulatory) were related to a reimportation of the disease, and it was carried on through succeeding years of the cycle by a reservoir in local rats, and tended to die out *in situ*. The foreign

²⁰ According to foreign reports, there were also cases in Chañaral and Copiapó in early 1905 (*Pub. Health Rep.*, 1905, Apr. 21, p. 712; Apr. 28, p. 774). That at Chañaral was later officially denied. Macchiavello gives plague for Chañaral in 1914.

²¹ Ferrer, *supra*, p. 420. In March 1905 antiplague measures had already been taken in Santiago, supposedly because cases had occurred there. (*Pub. Health Rep.*, Apr. 28, 1905, p. 771.)

factor, he suggests, may have been the introduction of infected fleas in cargos of jute-bags from India, as reported by Long and Mostajo in the case of the *Solafric* in Peru. (See General Review.)²²

Rats and mice.—(See also General Review and Table 4.) In 1931 in Antofagasta, 64% of the wharf rats were *norvegicus*, 30% *alexandrinus*, 6% *rattus*; in the commercial area, 38% were *alexandrinus*, and 30.8% each *norvegicus* and *rattus*; in the residential area, *rattus* represented 54.2%; *alexandrinus* 37%; and *norvegicus* 8.8%. The proportion of *norvegicus* and *alexandrinus* in the city decreased considerably during the succeeding ten years. In Iquique in 1930 (April-July) *rattus* (89.61%) was most common, followed by *alexandrinus* (9.44%) and a few *norvegicus* (0.95%).²³ While the rôle of rats in Valparaíso plague was unquestioned, there seem to be no studies in regard to the species. Macchiavello has found plague in Antofagasta mice, and cites Del Río (Iquique, 1903) who reported dead mice in houses of plague victims.²⁴

Other rodents.—In the original Iquique epidemic, human cases of plague which had been in contact with sick or dead rats, rabbits, and guinea pigs were reported. These were all evidently domesticated animals.²⁵

²² Macchiavello: *Rev. Chil. Hig. & Med. Prev.*, I, No. 1, 1937, p. 69. He cites a number of observations in support of his theory, such as the apparent cessation of plague in Taltal after trade with the outside world declined; the experience of Mejillones, representing a single four-year cycle with plague disappearing *in situ* (decline from 300 cases in 1908 to around 4 in 1911 and none thereafter); the reappearance of plague in Antofagasta in 1930 after an absence of five years; and the experience with the *Gladstone* in Antofagasta in 1904 (see Note 16). In January and February, 1929, he found 5 *X. astia* (an Asiatic flea which Demaria and Gallinatto had found no evidence of in Chile up to 1929) on Antofagasta rats. The first case of plague in that port since 1925 occurred January 21, 1930, in a wharf-worker, in an area where dead rats had been observed. And although cargoes of jute bags were not common in Antofagasta port statistics, 3,460 bales had been unloaded there in January 1929. He observes that on some occasions a number of Chilean ports experienced outbreaks of plague almost simultaneously, indicating the possibility of a single vessel being responsible. While nearby local ports may have been the source in some instances, he expresses the opinion that this does not explain all cases. As to the tendency of plague to disappear *in situ*, he suggests that this may be due to a decrease in the virulence of *B. pestis* and to the short plague season which results in a decrease in the number of chronic carriers left over from year to year. During the 1930 epidemic in Antofagasta, 87 murine and 7 human virulent strains were isolated, and after this period, several murine strains of decreased virulence were found in apparently healthy rats or rats with residual or chronic lesions. The paper concludes with a series of observations on the longevity of fleas. While the isolation of the northern Chilean ports by the surrounding desert, excluding influences not related to the port itself, provides ideal conditions for epidemiological study, the influence of outside factors would still appear difficult to evaluate, and in view of the continuous existence of plague on the West Coast of South America the rôle of coasting vessels in reinfections would seem to require thorough consideration. Macchiavello's studies are an interesting and valuable contribution to this question.

²³ Gallinatto: "Contr. al estudio," etc., 1930, p. 48. Macchiavello ("Hist. de peste," p. 43) suggests that this distribution may be one reason for the focal nature of the infection in Iquique, *rattus* being more of a house rat than *norvegicus*. In Antofagasta there seemed to be an epizootic among shore rats which later spread through the city, giving rise to scattered cases carried by *norvegicus*, in addition to the focal cases maintained by *rattus*. Incidentally, he was unable to find chronic plague in Iquique rats, but found it in Antofagasta rats. (*Ibid.*, p. 44; also *Rev. Inst. Bact. Chile*, III, No. 1, 1932, p. 39.)

²⁴ "Hist. de peste," p. 15; and *Rev. Chil. Hig. & Med. Prev.* I, No. 4-6, 1938, p. 184.

²⁵ Macchiavello: "Hist. de peste," p. 15. In one instance 24 rabbits died; in another, a child was bitten by a rabbit and got plague; and in another, a man who ate a rabbit and a child who cleaned the rabbit cages became ill.

Fleas and other parasites.—(See also Tables 5 and 6.) According to a study by Demaría and Gallinato,²⁶ the prevailing flea in Santiago in the summer of 1928-29 was *X. cheopis* (35.5-39.5%; index 4.47-5.55), followed by *Sarcopsyllidae* (28.8-26.7%), *L. musculi* (16.9-15.9), *P. irritans* (3.6-1.4) and *Ct. canis* (3.6-1.8); the flea index was 12.6-14.0. In Valparaíso in the autumn of 1929, Vidal found a flea index of 9.8 with 46.6% *C. fasciatus*, 42.9 *L. musculi*, 6.4 *P. irritans*, 3.1 *Sarcopsyllidae*, and 1.0 *cheopis*; this, however, was in the colder weather when the proportion of *cheopis* would naturally be low.²⁷ *Cheopis* was also found in Arica, Coquimbo, Iquique and Tocopilla; *L. musculi* in Coquimbo and Huasco, *C. fasciatus* in Coquimbo, and *Ct. canis* and *P. irritans* in Arica, these being merely specimens sent in for identification.²⁸ *C. fasciatus* predominates in Concepción.²⁹ The most extensive study has been that of Macchiavello on Antofagasta fleas and rats in relation to plague, temperature, and humidity. In 1928-1930 he found an average flea index of 15.74 with a maximum of 31.2 (Dec. 1928, summer) and a minimum of 5.6 (winter); an average *cheopis* index of 7.15 with a maximum of 19.9 (summer) and a minimum of 0.44 (winter, Aug. 1928). During a warm winter (1929) the proportion of *cheopis* remained high—in August it represented 64.5% of the flea population. The average proportion of *cheopis* for the period was 45.68%; maximum 66.77; minimum 7.9. The greatest number of fleas found on any one rat was 154 (87 *cheopis*), and practically all rats had fleas.³⁰ In view of the finding of plague in mice, the *cheopis* index for mice of 2.10 in Antofagasta (17% of their fleas) is of interest.³¹ On 5 rats, Macchiavello found a large number of bedbugs (*Cimex lectularius*, 43 on one rat), and in Jan.-Feb. 1929, he identified 5 *X. astia* on Antofagasta rats. He has mentioned the possibility of man-to-man plague transmission by human parasites, possibly *Cimex*, and especially the conditions offered by the custom of crowding together at wakes.³²

During the ten years of the Antofagasta study, notable changes have occurred. In 1928 and 1929 the flea index was more than 20 per rat, with *X. cheopis* predominating, and 100% of the rats had fleas; in 1937 the flea and *cheopis* indexes were less than 8 and 3 respectively; no longer were all rats flea-infested, and *C. lectularius*, *Lyponissus bacoti* and *Laelaps echidninus* were no longer being found on rodents. Parasites, abscesses, salmonella infection and other non-plague pathology had almost completely disappeared from rats.³³

Seasonal distribution.—Chilean epidemics have occurred mainly during the summer and autumn (December to June). The area from the northern boundary to Valparaíso is favorable to flea activity during that period (temperature between 15 and 28 C, 59.0-82.4 F and humidity around 70). The 1903 epidemic in Iquique ended in September. In Antofagasta 38.5% of the cases occurred during the first quarter of the year, 50% during the second, and 7.5% during the third.³⁴

²⁶ *Op. cit.* The first figure is that given by these authors in their 1929 paper; the second, that of Gallinato ("Contr. al estudio," 1930, p. 83), who also gives the number of fleas and rats; the former paper contains only percentages. *Sarcopsylla* was considered by them a new species.

²⁷ Vidal, M., cited by Demaría and Gallinato, *op. cit.*, p. 36. Gallinato in 1930 gives slightly different percentages: 0.6% *cheopis*; 0.2% *Ct. canis*; flea index 8.60, *cheopis* index 0.04 (*supra*, p. 83).

²⁸ Gallinato, *supra*.

²⁹ Ruiz del Río, A.: "Contr. al estud. de enferm. parasitarias humanas transmitidas por las ratas en Concepción," 1938.

³⁰ Macchiavello: *Rev. Inst. Bact. Chile*, II, No. 2, 1931, p. 1.

³¹ *Ibid.*: *Rev. Chil. Hig. & Med. Prev.*, I, No. 4-6, p. 184.

³² *Ibid.*: "Hist. de peste," pp. 15, 44.

³³ *Ibid.*: Report to X Pan American Sanitary Conference, *Actas*, 1938, p. 166; *Rev. Chil. Hig. & Med. Prev.*, II, No. 1-3, 1939, p. 69.

³⁴ *Ibid.*: "Hist. de peste," p. 41.

Kinds of plague.—The majority of Chilean plague was bubonic. In Iquique in 1903, of 214 cases studied, 15.5% were septicemic, 9.5% ambulatory, 4.4% secondary pneumonic, and 70.6% bubonic. Bubonic, gastric, and septicemic plague were most common in Antofagasta, in that order; some ambulatory cases were reported at the beginning of epidemics. Pneumonic cases were only 1 to 2% and always secondary.

In Pisagua, severe septicemic and "fulminating" plague were observed, the latter killing apparently healthy individuals in a few hours. Pneumonic plague was more common than in Iquique, but whether or not it was primary is not known. Apparently the only specific references to pneumonic plague in Chile are the October, 1931 case in Santiago,³⁵ and the two cases reported by Rivera Tapia in connection with the 1903 epidemic in Iquique.³⁶ Two cases of plague carbuncle were reported in Iquique in 1903; in Antofagasta there was a case of plague with 18 buboes. Macchiavello has noted that the early cases in Valparaíso resembled the "viruela pestosa" of Ecuador.³⁷ The most common location for the bubo in Iquique and Antofagasta was the groin. Sanhueza reported that attenuated forms of plague had been seen in Iquique, Antofagasta, and Taltal. He also reported a fatal case of meningial plague in Antofagasta.³⁸

Prevalence.—In 1911, Ferrer stated that some 4,000 cases of plague had been reported from 1903 to 1910. Since this figure included only patients treated at isolation hospitals or by physicians, he thought that 35% should be added for a truer estimate. Macchiavello brings the total up to 5,200 cases, 2,150 deaths for 1903–1930, and has stated that 20% should be added to his figures, giving at least 6,200 cases. The morbidity per 100,000 inhabitants fluctuated greatly, ranging from 25 in 1907 to 0.13 in 1930, although, as Macchiavello has pointed out, the lack of accurate statistics makes such estimates of little value. He notes, however, that even in years of severe plague epidemics the cities of the northern (plague) region generally had a lower death-rate than the plague-free cities of central Chile.³⁹

Death rate.—Ferrer (1911) gives 63.8% as the death rate for the first year (1903), and about 33% in following years. Macchiavello computes the death rate 1903–1930 at from 40–42%; maximum annual mortality, 62% (1903); minimum 30–46% (although in Antofagasta the mortality ranged from 70% in 1915 to 28% in 1906); greatest number of cases and deaths, 1907: 861 and 358.³⁹

³⁵ *Ibid.*, p. 38.

³⁶ Manuscript data given by him to Macchiavello ("Hist. de peste," p. 12). A Sister of Charity in the isolation hospital became fatally ill with pneumonic plague after caring for a patient, and the Mother Superior, in caring for the Sister, contracted the disease herself and died.

³⁷ "Hist. de peste," p. 16, footnote.

³⁸ Sanhueza, A. C.: *Rev. Méd. Chile*, May 1907, p. 129. He also told of a case in Iquique which for a month had shown only light fever, loss of weight, and small glandular swellings, when suddenly he became seriously ill, recovering after energetic serum-therapy; another instance of the non-benign nature of "benign" plague.

³⁹ Ferrar, *supra*; Macchiavello, *supra*, p. 39; the latter also cites Gallinato's totals: 4,437 cases, 1,678 deaths, mortality 37.8%, to 1927.

Control.—Probably the most effective agents in the control, or rather, the limitation, of early Chilean plague, were geography and meteorology. The climate south of Valparaíso seems to be unfavorable to *X. cheopis*; and in the northern area, the ports are surrounded by the dry, desert-like Pampa, with a temperature varying perhaps 50° in a single day and night; with few rats, and no fleas,⁴⁰ so that plague did not spread to the interior. The early preventive measures were mostly on paper, and included a provision for the compulsory reporting of plague, among other diseases (Law of February 7, 1899); installation of sanitary stations at Arica and Agua Fresca and elsewhere (which installations remained largely in the debating stage); inspection of vessels, and so on. After plague arrived, little systematic work seems to have been done until about 1928.⁴¹ In that year, several cities began to consider systematic deratization.⁴² Antofagasta led the way:⁴³ in July 1928 the classification and study of rodents and fleas and control work including trapping, poisoning and house inspection, were begun; by the end of the year a rat-flea study was undertaken in Santiago,⁴⁴ but interrupted; in the autumn of 1929 Vidal made a study of Valparaíso fleas; in February 1930 deratization was begun in Iquique, and in 1931, flea and rodent studies were started.⁴⁵ In July, 1932, the newly-created National Antiplague Service took over the direction of the plague campaigns. Under it studies of rats and their parasites, and deratization work have been continued in Antofagasta and Iquique.⁴⁶ Rat-proofing is encouraged, but economic conditions and the poor construction of many buildings make renovation a difficult task. Favorable results with gas fumigation have been reported, but again, poor construction prevents its extensive use.⁴⁷ Although there has been no human plague in Chile since 1931 and no rat plague has been found since 1932, anti-rat work is still maintained as a precaution against re-infection.

⁴⁰ Macchiavello: "Hist. de peste," p. 44.

⁴¹ One obstacle was the lack of centralized responsibility, as pointed out by Guerrero Bascuñan and Córdova in 1908. They observed that in directing antiplague work in Iquique and other cities the national administration was exceeding its specific powers, and that it had to base its intervention on the failure of the municipalities to handle the situation (due partly to lack of funds). On the other hand, the national authorities sometimes interfered in matters of a more local nature, such as disinfection and water supplies, again exceeding their authority. The lack of a settled national policy in public health matters, and of a definite legal responsibility, made the handling of such problems as plague depend on the attitude of the head of the government at any given time. (Guerrero Bascuñan, Mariano, and Córdova, Lucio: "La administración sanitaria en Chile i en el extranjero," 1908, p. 704.)

⁴² Macchiavello, *supra*; and El Servicio Nacional Antipestoso, *Rev. Chil. Hig. & Med. Prev.*, I, No. 2-3, 1938, p. 112; Diez años de lucha antipestosa, 1928-1937, *Ibid.*, I, No. 4-6, 1938, p. 183.

⁴³ Under Dr. Antonio Tirado, Chief Provincial Health Officer, and following him, Dr. Contreras.

⁴⁴ Demaría and Gallinatto, *op. cit.*; and Gallinatto, *supra*.

⁴⁵ By Tannenbaum. (Macchiavello: Diez años, etc., *supra*.)

⁴⁶ The house inspection has had favorable results in keeping premises in such condition as to offer less attraction to rats and parasites, and has even raised the standard of living, or at least of cleanliness, as indicated indirectly by the finding of fewer *C. lectularius*, *L. echidninus*, etc., on rats. (Macchiavello.)

⁴⁷ Macchiavello: "Diez años, etc.," *supra*.

Vaccination and serum-therapy.—Serum therapy and preventive inoculation with serum have long been favored in Chile; as to vaccination itself, little can be stated, since the term seems to be used for preventive serum inoculations as well as for the use of plague vaccines.⁴⁸ It was noted that the members of the Chilean Commission to Argentina (Rosario) in 1900 were vaccinated and none contracted plague, whereas three members of the unvaccinated Argentine Commission to Paraguay in 1899 became ill.⁴⁹ Most, if not all, the cases coming to the isolation hospitals received serum treatment if available. In Iquique it was noted in 1903 that the mortality in the few serum-treated cases up to August had been 26%. Montero reported a 6.0% mortality in Antofagasta in 1904; Cruzat, 5.5% in Chañaral, and Del Río and Zegers, Iquique, 1903, 44.70%.⁵⁰ It might be mentioned that excellent results with Chilean serum have recently been reported in Bolivia.⁵¹

Research.—Chilean plague research has been mainly but not wholly epidemiological. The studies of Gallinatto and Demaria, of Vidal, Tannenbaum, and Ruiz del Río on rats and fleas have already been mentioned in various parts of this article, as have the extensive investigations, bacteriological as well as epidemiological and historical, of Macchiavello on rat and flea incidence, rodent pathology, and plague in relation to parasites, rodents, meteorological factors, and foreign commerce (including the possible rôle of jute bags). The work included a study of 18,154 autopsies of rats, 88 of them plague rats, made in connection with his research in the Antofagasta plague laboratory since 1928. In the course of these autopsies, plague was discovered, by the use of cultures and the microscope, in 19 rats which presented no visible plague lesions.⁵²

⁴⁸ Ferrer, in Mejillones in 1909, used Yersin serum followed 3 days later by Hoffkine vaccine. Public health workers and the families of plague cases were inoculated, with "brilliant" results. (Ferrer, *supra*, p. 419.)

⁴⁹ *Rev. Méd. Chile*, June 1903, p. 214.

⁵⁰ Dujardin-Beaumetz: *Bull. Inst. Pasteur*, June 15, 1906, p. 473.

⁵¹ *Bol. Min. Hig. Salub.*, Bolivia, Dec. 1938, p. 22. On the other hand, Siles, the President of the Superior Board of Health of Bolivia (*Rev. San. Mil.*, Bolivia, No. 7, 1940, p. 881), shows himself decidedly skeptical as to the efficiency of all serums and vaccines.

⁵² Macchiavello: *Anatomía patológica de la peste murina en Antofagasta*, *Rev. Chil. Hig. & Med. Prev.*, II, No. 1-3, 1939, p. 50; *Breves consid. sobre anatomía patológica de la peste murina en Antofagasta*, *Bol. Of. San. Pan.*, Aug. 1933, p. 799.