

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

(Continued)

## II. PLAGUE IN ARGENTINA

With the exception of the tropical and sub-tropical area of the provinces of Salta and Jujuy and the territory of Chaco, Argentina belongs to the temperate zone. The coast has an average temperature of 66 F; the central region, 61 F, with a range from 105 F in summer to low in winter; the Andean region has a greatly variable climate with fluctuations of 36 degrees within twenty-four hours not uncommon. Summer runs from November 1 to February 28; seasons north of 38° latitude alternate between dry (April-September) and rainy (October-March). In Corrientes, Santiago del Estero, Tucumán, part of Salta and part of the Chaco, the climate is hot during six months and mild the rest. Rainfall in the southern areas averages 16 inches a year; in the central region, from 20 to 39; in the northeast, from 40 to 60 inches. Dry months in the grain-growing area are May, June and July, with March usually having the heaviest rain.

Of Argentina's 24 provinces and territories, only the five territories of Chubut, Santa Cruz, and Tierra del Fuego in the extreme south; and Neuquén and Los Andes in the cordillera of the Andes have remained free from plague.

Plague reached Argentina five months after its initial appearance in Asunción, Paraguay in April, 1899,<sup>1</sup> the first cases being reported in dock workers in Rosario, Province of Santa Fe, September 1899. Rosario was then a city of 105,000 inhabitants, located on the Paraná river; a great shipping port, with large areas of unpaved ground covered with weeds, rubbish and garbage; high, rugged banks matted with creepers; and quantities of grain and scraps from the meals of laborers, fishermen, and other port frequenters scattered everywhere—an ideal haven for rats, since they could nest, eat, drink and go about their business even in broad daylight, hidden by the innumerable weeds. Facilities for the storage of grain were of flimsy construction, easily accessible to rats on all sides.<sup>2</sup>

The first cases of plague in Rosario went unrecognized, and it was not until January, 1900, that the existence of the disease was bacteriologically proven by a representative of the National Department of Health. Investigation of suspicious deaths occurring previously revealed that there were three cases toward the end of September 1899, which the attending physicians considered suspicious of plague; and other suspicious cases from then on, but as all diagnoses of plague were vigorously opposed by the authorities, the press, and the public, none

<sup>1</sup> See General Review.

<sup>2</sup> Albornoz, F.: *Bol. San., Arg.*, Jan. 1938, p. 4.

of the cases was definitely reported as plague. From 1900 to 1938 (last case, 1934) there were 703 cases of human plague in Rosario,<sup>2</sup> with 248 deaths (an average mortality of 35.27), the years 1901, 1918, 1931, 1932, and 1935-37 being the only ones free from plague. The greatest number of cases (105) occurred in 1900; the greatest mortality (66.67) in 1912. Some of the bubonic cases in the original 1899-1900 epidemic developed pulmonary complications,<sup>3</sup> but there were no true pneumonic cases until 1904.

The spread of plague to other ports has already been noted (General Review). From the ports, following the great grain-carrying arteries, the railroads, plague spread inward. The Provinces of Corrientes and Tucumán and the Territory of Formosa were infected in 1899; Córdoba in 1900 or 1901; Salta in 1904; Santiago del Estero in 1905; Misiones by 1908; Entre Ríos, 1912; Jujuy, 1913; Mendoza, 1914;<sup>4</sup> San Luis, 1916; La Pampa and Catamarca, 1920; Río Negro and the Chaco, 1927; La Rioja, 1928, and San Juan, 1931.

Four phenomena have characterized the course of plague in Argentina: first, the spread of plague to ports by river traffic; second, the spread of plague inland from ports by rail; third, the spread of plague from endemic foci in the interior to cause new outbreaks in ports, as in Bahía Blanca and Rosario;<sup>5</sup> and fourth, its dissemination by infection in wild rodents, in remote areas of the interior, far from railroads, as in La Pampa, Mendoza, Santiago del Estero, and Salta.<sup>6</sup> In one instance (Pampita epidemic, San Luis, 1932), the infection seems to have followed a highway;<sup>7</sup> it has been held that it was imported into Salta at least once, if not oftener, from Antofagasta, Chile, by mule trains crossing the Andes;<sup>8</sup> it has been thought that its introduction into Rosario may have been through rats carried in loads of Paraguayan wood.<sup>9</sup>

**Grain sacks.**—Bales of empty grain sacks have been implicated in the transmission of plague in Argentina since early times, but as late as 1921, at the time of the adoption of compulsory disinfection of grain sacks, it had not been determined whether the mode of transmission was through bacilli or through infected fleas, and disinfection methods were designed to destroy both. The measure has apparently been discontinued, since there is no reference to it in the legislation now in force.<sup>10</sup>

<sup>2</sup> Agote and Medina, *op. cit.*

<sup>4</sup> *An. Dep. Nac. Hig., Arg.*, Dec. 1916, p. 672, 1 C., 1 D., San Rafael, Province of Mendoza. According to later writers the first plague in Mendoza appeared in 1937, in connection with wild rodent epizootics. (Sussini, M.: *Bol. Of. San. Pan.*, June 1939, p. 510.)

<sup>5</sup> Bahía Blanca seems to have remained free from plague until 1913, when it was apparently infected by rail from La Pampa. Patients were brought to the port for treatment, and the first and only (two) autochthonous cases developed. The Rosario cases in 1933 were due to imported rats. ("Actas X Conf. San. Pan., 1938," p. 137.)

<sup>6</sup> Mujica, J. C. A.: *Geografía Médica, Bol. San., Arg.*, Feb. 1939, p. 63.

<sup>7</sup> Pardal, E.: *Rev. Inst. Bact., Arg.*, Nov. 1933, p. 18.

<sup>8</sup> Lozano, N.: *An. Dep. Nac. Hig., Arg.*, June-July 1907, p. 228; Rissotto, A.: *Ibid.*, Jan.-Feb. 1919.

<sup>9</sup> Uriarte, L.: *Epidémies de peste à l'Assomption, etc., Ann. Inst. Past.*, 1901.

<sup>10</sup> Dessy (*Sem. Méd.*, May 23, 1901, p. 308) and Penna (*Ibid.*, Oct. 10, 1901, p. 628) considered the epi-

**Rats.**—The rôle of rats in the spread of plague in Argentina has long been recognized. *Norvegicus* is the predominating rat, invading the fields as well as inhabiting towns and villages; *R. rattus* is less prevalent, and *R. alexandrinus* least common, preferring the coast provinces. *Norvegicus* is also the most common port rat except in Rosario.<sup>11</sup> (See Table 4.)

**Rodent fleas.**—The study of rodent fleas in Argentina was begun in 1903. The flea picture in Buenos Aires has changed with the years, foreign fleas coming in, but *X. cheopis* is still predominant, although in a proportion of 65% instead of 95%. Of 30,389 rats examined from Buenos Aires during 1927–1932, 722 (2.37%) harbored fleas. (See Tables 5 and 6). The greatest number of fleas found on a single rat was 30 (on a *R. rattus* from Dársena Sud, B.A.), except for 47 on a sick female. Heavy infestation of sick rats has been noted.<sup>12</sup>

**Rural plague.**—With the gradual eradication of bubonic plague from Argentine ports, the problem of plague infection among wild rodents has received increasing attention. The first mention of the possibility of wild rodent infection seems to have occurred in 1905, when Dr. Carlos Malbrán, then President of the National Department of Health, went to investigate an outbreak of plague in Choya, Santiago del Estero. He reported that some dead *cuisés*, a kind of wild guinea pig found over nearly all of Argentina, had been found in the fields. No bacteriological examinations were made. References to similar phenomena were made in later years by sanitary inspectors, but despite all efforts, no dead animals were obtained for examination until 1919, when two *cuisés* were sent to the National Bacteriological Institute, one from Santiago del Estero and one from La Pampa. Plague was definitely proven in these two animals. Arata, in Córdoba, also reported finding plague-infected *cuisés* during the 1928–29 epidemic. In 1927 in Merou, Entre Ríos, Battaglia found dead *cuisés* in the vicinity of plague cases, but was unable to furnish animals for examination.<sup>13</sup> Bachmann, in a lecture before the Academy of Medicine in Buenos Aires, 1928, called attention to the dangers of rural infection.<sup>14</sup> In 1934, *cuisés* found in connection with a case of human plague in the Pampa were found to be infected.

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demic in San Nicolás de los Arroyos, Dec. 1900–Feb. 1901, to have been imported with grain sacks from Buenos Aires, Rosario or Calcutta. The first cases were among handlers, sewers or menders of such sacks; no more occurred after disinfection of the sacks (however, all persons coming into the infested area were vaccinated); and it was stated that no rats (Dessy) or hardly any rats (Penna) could be found. In 1920, Article 50 of Law 11,027 (General Budget for the Nation) authorized the Executive to charge half a centavo per sack for disinfection, the proceeds to be used for the sanitary defense of the country, and a Commission was appointed to study means of disinfection. No foreign references to the problem could be found, and the Committee eventually devised a method of disinfection and disinsectization by hot moving air. The Commission expressed the opinion that the sacks were contaminated by the plague rat. (Carbonell, M. V.: *Rev. Inst. Bact.*, Arg., Dec. 1922, p. 17; Informe de la Comisión, *An. Dep. Nac. Hig.*, Arg., May–June 1921, p. 105; Uriarte, L.: *Rev. Inst. Bact.*, Arg., July 1927, p. 767.)

<sup>11</sup> Office International d'Hygiène Publique: *Bol. Of. San. Pan.*, June 1933, p. 513.

<sup>12</sup> Uriarte, Calcagno, et al.: *Rev. Inst. Bact.*, Arg., March 1934, p. 57.

<sup>13</sup> Uriarte, L.: *Rev. Inst. Bact.*, Arg., Nov. 1936, p. 142. (However, Borzone reported proving plague in *cuisés* from Merou in 1927 by cultures and guinea pig inoculation, in the Bacteriological Laboratory of Entre Ríos. He also reported plague in *cuisés* from Rafaela and Santa Clara de Sagüier, date not given. *An. Soc. Cient. de Sta. Fe.*, III, p. 284.)

<sup>14</sup> Bachmann, Alois: "Peste bubónica," 1930.

In 1934 and 1935, intensive studies were made in La Pampa and Río Negro by de la Barrera.<sup>15</sup> The region affected by rodent plague includes a wooded area extending across 30° south latitude from Jujuy to Patagonia, characterized by poor, clayey, very stony soil, covered with drouth-resistant vegetation, in clumps of spiny bushes with small leaves, or leafless, and some large trees. Russian thistle is abundant and affords excellent harbors. Pasture is coarse and generally scarce; rainfall rarely exceeds 200 mm (7.87") annually, except in northern Salta, where it exceeds 1000 mm (39.37") annually. The temperature is high in summer and low in winter (maximum 42 C (107.6 F); minimum -10 C (14 F)). Industries of the region include sheep-raising in the almost deserted areas of the central and south Pampa; chiefly stock-raising north of the Río Negro; cultivation, stockraising and woodcutting north of the Pampa and Santiago del Estero; and cultivation in the unusually fertile irrigated zones of Mendoza, as far as the high tropical forest areas of northern Salta. The epizootics, always of great extent, develop during the winter and die out in the spring, often recrudescing the following winter. In wild rodents the disease is acute, causing death without the development of macroscopic anatomical lesions; chronic forms or lesions revealing a moderately long evolution of the disease are not found. Areas formerly abounding in *cuisés* or *graomys* have come entirely depopulated after an epizootic of plague.

The species most affected are: *Microcavia australis*, *Galea musteloides*, *Graomys griseoflavus*, and in a lesser degree, *Lepus europaeus*, *Hesperomys murillus*,<sup>16</sup> and *Sylvilagus brasiliensis*.<sup>17</sup>

<sup>15</sup> De la Barrera, J. M.: *Rev. Inst. Bact.*, Arg., March 1936, p. 439; *Bol. San.*, Arg., 1937, p. 452.

<sup>16</sup> *Cavia*, *Galea* and *Microcavia*, known as *cuis*, *conejo*, *apereá*, and *zogoná*, include various species and genera resembling the guinea pig; they are found over practically all of Argentina; live in colonies in burrows, or where vegetation is abundant, in tunnels in the weeds; are never seen in occupied houses, though sometimes in deserted ones; are not hunted for their meat or skin in the Pampa or Río Negro, although in the Chaco area their meat is eaten by the Indians. (In Media Agua, San Juan, 1931, and Frías, Santiago del Estero, 1934, dead *cuisés* had been observed and the human victims had eaten *cuisés*. However, material from dead *cuisés* proved negative for plague at Frías.) These animals have been found to be plague-infected both naturally and experimentally.

*Graomys* is a long-tailed rat, living in nests of birds and in holes in trees, and feeding on grain, herbs and fruit. It does not usually invade human dwellings but did so in the Loventuel epidemic, Pampa, 1935, nesting in straw roofs. Also found in the El Pucara, April, 1936 outbreak. Very sensitive to plague by scarification and ingestion; also found naturally infected.

*Lagostomus*, *Vizcachá* is very sensitive to plague, but natural infection of this species has not yet been proven bacteriologically.

*Ctenomys*, *tucu-tucu* is very sensitive to plague and epizootics have been noted in areas of human plague. Its timidity renders its contact with man less likely than that of other rodents. Some 40 species have been identified throughout Argentina.

*Lepus europaeus*, the European hare or *liebre*, has been found dead in La Pampa various times, and a dead plague-infected hare was found April, 1935, 200 m. north of Fortín Uno (Río Negro). Wild mice (*Akodon arenicola hunteri* Thos. and *Hesperomys*) of cannibalistic tendencies have been found very sensitive to plague; *Hesperomys* has been found infected in La Pampa. Other plague-sensitive species are *Reithrodon auritis*, *Oryzomys flavescens* W., and certain species of bats. (Yepes, J.: *Rev. Inst. Bact.*, Arg., Nov. 1935, p. 213; De la Barrera, J. M.: *Ibid.*, March 1936, p. 439.

<sup>17</sup> Two rabbits (*Sylvilagus*) were found plague-infected in northern Salta and southern Bolivia in June, 1933. (Comisión de Aseoramiento Técnico de la Peste: *Bol. San.*, Arg., May 1939, p. 405. Report of C. A. Alvarado.)

Rural plague is characterized by the scarcity of human cases (15 or 20 per year), despite the theoretically wide possibilities of infection, although this scarcity is compensated by the high pneumogenic affinity of the virus; and the type of human outbreak—cases of wild origin appear separately and unrelated, whereas outbreaks of murine origin are focal. Another factor of interest is the great proportion of children infected—undoubtedly from their habit of playing with dead animals. Of the 20 cases occurring in the Pampa from 1920 to 1935, 16 were children of from four to 15 years.

Wild rodent fleas.—Findings in regard to the parasites of *cuis*es and related animals have varied considerably. The index in the Pampa has been generally low, except in sick animals. The greatest number of parasites found was 40 in one plague-infected *cuis*; on the other hand, no fleas were found in 23 animals caught near a place where plague-infected *cuis*es had been discovered. In Quines, San Luis, no fleas were found in over 100 *cuis*es in 1932. In El Pucara, Salta, however, all *cuis*es found had at least 150 fleas. *Parapsyllus talis* (Jordan) made up 95.5% of 155 specimens of the first *Siphonaptera* found in La Pampa (see Table 5).<sup>18</sup> In Salta, Córdoba and Buenos Aires provinces up to 1934, the only parasites found on *cuis*es had been *Rhopalopsyllus*, except for two acarids of the type common on domestic rats, found on a *cuis* from Córdoba. *Rhopalopsyllus* was found by Weyemburg of Córdoba University in 1881 and classified at that time as *P. cavicola*. Various species, some Argentine, have been found of this genus, apparently native to America. Possible interchange of parasites was suggested by the finding of *X. cheopis* on a red weasel (*Lutreolina crassicaudata*) from Puente Alsina, Buenos Aires, and of *Craneopsylla wolffhugli* on *R. norvegicus* from Puerto Nuevo and Puente Alsina, Buenos Aires, the latter parasite, apparently belonging to field animals, having been found on *Hesperomys*, and on weasels (*comadreas*) and *Cricetidae*.<sup>19</sup> *P. irritans* has been found on various wild rodents, including the European hare, Zapallar region, San Luis; the vizcacha, *Lagostomus maximus*, from Loventuel, La Pampa; Quines area, San Luis; and Isca Yacu, Santiago del Estero; a *rata*, possibly *groomys griseoflavus*, from Victoria, La Pampa; a *zorro* (*pseudolopex* ?) from Fortín Uno, La Pampa, and Piquete, Salta; the *zorrito*, (*Mephitis* sp.) from Rivera, Buenos Aires; and on the *corzuela*, *Mazama nemorivagus*, from Piquete, Salta.<sup>20</sup>

In concluding his report, de la Barrera sums up the present status of rural plague in Argentina: Plague has appeared episodically in many species of wild and semi-domestic rodents of the country, without one being able to affirm that it is really endemic in them (that is, exhibiting chronic forms or minor plague). The well-studied epizootics have been in the winter (Lihuel Calel and Loventuel). The taxonomy of the ectoparasites of the infected rodents is incomplete, and the biology of such parasites has not been studied. The only experiments in the transmission of plague by flea bites from rodent to rodent were made at Fortín Uno and showed this mode of infection to play an unquestionable rôle; however, these experiments were made in plague-infected territory. The sensitivity of all these rodents to plague infection by mouth, and their frank cannibalism require that one not ignore this method of infection also. The origin of wild rodent infection dates back so far that no conclusions may be drawn concerning it. It is very

<sup>18</sup> Del Ponte, E., and Riesel, M. A.: *Rev. Inst. Bact., Arg.*, Jul. 1936, p. 696.

<sup>19</sup> Uriarte, Calcagno, et al., *op. cit.*

<sup>20</sup> Del Ponte & Riesel, *op. cit.*

possible that the wild and domestic species were infected by the rat at the beginning of the entrance of plague into the country. The unknown and most important factor is whether the infection has since maintained itself in the wild rodents or has been periodically transmitted to them by the rat, giving rise to epizootics.<sup>21</sup> If the domestic rat is the only permanent deposit of plague virus, its destruction would theoretically remove all danger; if plague exists endemically among wild rodents, the problem cannot be solved by rat destruction alone. Unfortunately, some discoveries made in normal periods, such as the finding of plague in the hare at Fortín Uno and of possible chronic forms in *Galea*, seem to strengthen the latter possibility in de la Barrera's opinion.

**Cats.**—Cats have been implicated in several instances in Argentina, as in La Pampa, where reference has been made to the handling of dead cats by persons who later became infected, but plague infection has not been demonstrated. (See General Review, Wild rodents and other animals.)

**Seasonal incidence.**—See General Review.

**Human plague.**—The Provinces of Córdoba, Santa Fe, Salta, Buenos Aires, Santiago del Estero, Tucumán, San Luis and Entre Ríos have been the most affected by human plague. The most serious epidemic was that of 1919–20, when over 1,000 cases occurred in the Provinces of Santa Fe and Córdoba alone. The most common form has been bubonic, although outbreaks of pneumonic plague have occurred from very early times, and septicemic as well as other atypical forms have been observed (see Tables 1 and 2.) Sordelli has stated that in the few remaining endemic foci plague usually assumes a pneumonic type.<sup>22</sup> Plague has constantly declined in recent years, and in 1939 there were only 5 cases, all in the interior of the country.

**Pneumonic outbreaks.**—The first primary pneumonic plague reported in Rosario was in 1904, 3 deaths. In 1913 there were 6 deaths, in five nurses and a patient originally suffering from bubonic plague; the original pneumonic infection occurring in a case from San Genaro. The next and last pneumonic case in Rosario was in 1923. All were fatal. Other instances of pneumonic infection originating in a case from outside the city were Paraná, 1927 (2 deaths, illness contracted from a third fatal case from Merou, where there had been 23 fatal cases of pneumonic plague); and Santa Rosa, San Luis, 1934, 5 deaths, originating with a sixth fatal case from La Invernada. Other pneumonic outbreaks include: Córdoba Province: Río Seco, 1919, 18 deaths; Rafael García, December 1935, 1 death. Entre Ríos: Concordia, 1928, 1 death. Mendoza: Departments of Godoy Cruz and Rivadavia, 1937, 9 deaths (not confirmed bacteriologically). Salta: Los Molinos, El Pucara and El Carmen, 1932, 7 deaths; Tartagal, 1936, 4 deaths

<sup>21</sup> Uriarte seems to favor the latter view, noting that the extreme sensitivity of wild rodents to plague, which is highly fatal among them, renders chronic or latent forms less probable. (*Rev. Inst. Bact.*, Arg., Nov. 1936, p. 142).

<sup>22</sup> Sordelli, A.: "Actas IV Conf. Pan. de Dir. Nac. de San." (in press).

(pneumonic ?). San Juan: Media Agua, Lotes de Rossini and Department of Desamparados, 1931, 24 deaths. San Luis: Los Medanos and El Médano, 1936, 6 deaths; Pampita, 1932, 16 deaths. Santa Fe: Cañada Rosquín, Casas and Las Bandurrias, 1913, 45 deaths. Santiago del Estero: Colonia San Juan, 1937, 6 deaths; Departments of San Martín and Silípica, 1934, 11 deaths; Frías, 1934, 16 deaths; Cara Pugia, Larelo, La Banda, 1928, 8 deaths. Tucumán: Mascio, 1936, 6 deaths (5 suspicious); Tucumán city, Distrito Municipal, 1918, 10 deaths.

**Cutaneous and other atypical forms of plague.**—Instances of cutaneous plague, "plague carbuncle" and septicemia have been reported from various localities, including: cutaneous plague, Estación Perico, Jujuy, 1919, case; septicemic: La Silleta, 1917, and Tartagal, 1936, Salta; Santa Fe City, 1929, 1930, 1932, 1934; Rafael García, Córdoba, 1935, case; El Mirador, Mendoza, 1937, case ending in pneumonic plague. Enlarged glands of neck, recovered case, Tucumán city, 1918. Carbuncle: Rosario, 1934, cured case; Cañada Honda, Córdoba, 1928, case; San Nicolás, 1901, 3 cases (one of 70 and one of 55 days' duration).<sup>23</sup> In 1933 Paso stated that plague carbuncle was not particularly rare.<sup>24</sup> A detailed report of a case is given by Vivoli.<sup>25</sup> Penna reported a case of eruptive plague with 25 pustules on the limbs, back, stomach and forehead.<sup>26</sup> He also mentioned that he had observed at least 10 cases of minor plague, and reported a case of plague in a woman 8 months pregnant who recovered and gave birth to a healthy child, an interesting observation in view of the high mortality associated with plague under such conditions.

Cases of walking plague or plague of prolonged duration have been reported by Uriarte,<sup>26</sup> Borzone,<sup>27</sup> and Sordelli.<sup>28</sup>

**Plague control.**—After the appearance of plague in Argentina in 1899, attempts to combat it consisted of fumigation or disinfection of plague-infected dwellings, vaccination of contacts and even of most of the inhabitants of a given area, establishment of sanitary cordons<sup>29</sup> and patrols and destruction of rats on board ship and on shore. Unfortunately, most of the work was spasmodic, and undertaken only after plague had already appeared. At times nothing was done. There were not lacking far-sighted individuals who endeavored to secure adequate legislation, who proclaimed the necessity of continuous rat destruction work, who preached isolation of cases and contacts rather than the closing of public places and the establishment of sanitary

<sup>23</sup> Penna, J.: *Sem. Méd.*, Oct. 10, 1901, p. 628.

<sup>24</sup> Paso: *Sem. Méd.*, June 24, 1933, p. 642; Vivoli: *Ibid.*, Mar. 29, 1934, p. 974.

<sup>25</sup> *Sem. Méd.*, Jan. 31, 1901, p. 57.

<sup>26</sup> *C. R. Soc. Biol.*, Jul. 17, 1924, p. 1039. (Patient died three weeks after apparent recovery; autopsy revealed plague meningitis.) Also Uriarte, Morales V., and Anchezar: *Rev. Inst. Bact.*, Arg., July 1936, p. 705. (One month.)

<sup>27</sup> "La peste ambulatória en Santa Fe," *An. Soc. Cient. Sta. Fe.*, 1931, p. 234. (Vol. III). (Bacteriological study of glandular material from walking plague cases; number of cases and duration of illness not reported. Also mentions inapparent plague in rats.)

<sup>28</sup> VIII Conf. San. Pan., Lima, 1927, p. 159. (Two cases, one six to 12 months, one three months.)

<sup>29</sup> Perhaps the extreme example was the attempt to isolate the city of Rosario in 1901, and this at a time when plague had already reached Buenos Aires and other towns. (Penna, J.: *Sem. Méd.*, Oct. 10, 1901, p. 620. The Decree is quoted.)

cordons, who warned against attempting to substitute vaccination for rat destruction, who advocated rat-proofing,<sup>30</sup> but the apathy of the public, the unwillingness to incur expense both on the part of authorities and of private firms such as grain dealers and railroads, and perhaps most of all, the lack of national authority to intervene in health matters in the provinces, combined to nullify their efforts.

In Buenos Aires, Dr. José Penna, as Director of Health Administration (Director de Administración Sanitaria) had passed the first anti-rat ordinance of Argentina, a municipal ordinance making compulsory the rat-proofing of new buildings.<sup>31</sup> Unfortunately the law was limited and incomplete, and was allowed to lapse. In 1914 as President of the National Department of Health, Dr. Penna succeeded in installing permanent deratization services in the Port of Buenos Aires, and they have since functioned permanently, although not always with sufficient intensity.<sup>31,32,33</sup> A plague section was organized in the Bacteriological Institute in 1916, with Dr. Uriarte as Chief, and captured rats have been examined daily since that time.<sup>34</sup> Vaccine and serum are also prepared by this Section.

**Legislation.**—Seeking to solve through “Argentine” methods the problem of plague in Argentina with its special national features,<sup>35</sup> health authorities finally secured the passage of a national law, Ley No. 11,843 of June 20, 1934 and its Regulations (Oct. 21, 1936). On the basis of rat destruction, rat-proofing, and fumigation of vessels it outlines a national program which is carried out under the supervision of the Permanent Plague Control Commission (Comisión Permanente de Asesoramiento Técnico de la Peste) (Resolution of March 17, 1937, authorized by Ley No. 11, 843 Article 49.)<sup>36</sup> Incorporated in Ley No. 11,843 are many older provisions, such as the Decrees of Nov. 19, 1928, on rat-proofing of buildings and constructions used in the grain traffic, in ports and railway zones; May 27, 1929, requiring deratization of vessels and railway cars; Nov. 11, 1928, requiring vessels to stay at a distance from wharves; and Nov. 25, 1931, requiring compulsory fumigation of vessels and railway cars.<sup>37</sup> Supplementary legislation

<sup>30</sup> Men such as Bachmann, Battaglia, Capurro, Penna, and Uriarte. In 1908 Arana Zelis presented a draft of regulations on constructions in the Port of Buenos Aires, requiring cement or asphalt floors and other precautions. In 1915 a national law on compulsory deratization was recommended by the Plague division of the National Department of Health. In 1919 a law on compulsory deratization was sent to Congress. (*An. Dep. Nac. Hig., Arg.*, Aug. 1908, p. 347; Jul.-Aug. 1919, p. 9; Nov.-Dec. 1919.)

<sup>31</sup> Uriarte, L.: *Rev. Inst. Bact., Arg.*, Nov. 1927.

<sup>32</sup> Uriarte, L., and Morales, V., N.: *Rev. Inst. Bact., Arg.*, Mar. 1928, p. 149.

<sup>33</sup> Regulations for the Sanitation of the Port of the Capital, May 28, 1914, *An. Dept. Nac. Hig., Arg.*, Sept.-Oct. 1914, p. 417.

<sup>34</sup> *An. Dep. Nac. Hig., Arg.*, Aug. 1916, p. 405. Rats are examined, classified and autopsied, and guinea pig inoculations made.

<sup>35</sup> Sussini, M.: “Actas III Conf. Pan. Nac. Dir. San.”, p. 201.

<sup>36</sup> “Recopilación de Leyes, Reglamentaciones, Decretos y Resoluciones en Vigencia,” Tomo I, 1938. Suplemento Especial, *Bol. San., Arg.*, 1938, p. 253 & ff.

<sup>37</sup> *An. Dep. Nac. Hig., Arg.*, 1931, p. 117, 120, “Actas IX Conferencia Sanitaria Panamericana,” June 1935, p. 515.

in force includes the Resolutions of June 24, 1937, establishing administrative zones, June 13, 1937 assigning plague work to malaria control officer in the Northern zone; Dec. 2, 1931, incorporating the Plague section into the internal health services; March 16, 1927, requiring health officers to send in rats for examination; Nov. 11, 1928, Mar. 24, 1931, May 17, 1932, Jan. 16, 1933, Apr. 25, 1933 and Nov. 12, 1937, regarding cyanide fumigation and fumigation in general; April 18, 1933, certificates of fumigation and exemption and May 20, 1938, on raticides.<sup>36</sup>

**Control in ports.**—By 1930 the anti-plague campaign in all the ports of the Republic was organized in a permanent and well-disciplined manner, and the work is still continued. Argentine ports offer special difficulties due to their great extent, their continuous growth, and the products exported, consisting largely of grains. The plague campaign has three objectives: (1) deratization; (2) sanitation (prevention of rat harbors and destruction of nests); and (3) sanitation and rat-proofing (preventing access to food); and is carried out under the following principles: Permanent deratization, employment of trained personnel, permanent personnel in each zone rather than traveling crews; permanent sanitation; and rat-proofing in sheds and warehouses under the supervision of trained inspectors. In each port there is a Chief Medical Officer of the Anti-plague campaign, aided by inspectors, foremen and laborers. Private enterprises, under the supervision of the Sanitary authorities, carry out work within their own establishments, with permanent personnel. All known methods of rat destruction and sanitation are used: fumigation and destruction of burrows (Nocetti machines, cartridges, and rat dogs); use of traps (guillotine); distribution of poisoned food and bait;<sup>38</sup> clearing the area of thickets, weeds, wastes, and rubbish, piling on saw-horses 0.80 m (31.49 in.) high of all material or substance which might serve as rat harbors; rat-proofing of sheds and warehouses.<sup>39</sup> The poison used is white arsenic, and the bait is varied, using fresh fish, fresh fruit, blood, salt pork, tomatoes, flour, meat, and water. Poisoning is carried out systematically in wharves, breakwaters, uncultivated lands, and grain warehouses. Captured rodents are sent to the Bacteriological Institute, properly identified so that a plague

<sup>38</sup> A measure which for some time enjoyed considerable popularity was the use of the "Virus Danyz" or "Suero Danyz," an artificial culture of a microbe pathogenic to rats; in 1913 it was furnished free by the National Department of Health, through municipal authorities (*An. Dep. Nac. Hig.*, Sept.-Oct. 1913, p. 1225). It was eventually abandoned, as failing in practice to kill rats in any large number and tending to set up a chronic rather than a fatal infection. Barium carbonate poisoning has also been tried in Argentina. (Savino, E.: *Sem. Méd.*, No. 14, 1934.)

<sup>39</sup> Uriarte has long argued for rat-proofing of grain deposits, and similar constructions. (Uriarte, L.: *Rev. Inst. Bact.*, Argentina, Nov. 1927, and many other papers.) Since his first experience with plague in the original outbreak in Asunción, 1899, he has emphasized the important rôle of rats in plague and warned repeatedly of the danger of neglecting rat destruction for other measures such as vaccination. . . . Not the least of Uriarte's contributions to the study of plague in Argentina has been his effort to induce other investigators to publish the results of their work and thus make the information available for research.

rat may be traced to the warehouse or region from which it came.<sup>40</sup> Rats are shipped in metal drums with double walls permitting the use of ice, and sent by rail. The capacity of the drums ranges from 20 to 200 rats.<sup>41</sup>

An interesting study of plague in Rosario, Santa Fe, including the relation of the movement of grain to the number of rats and an analysis of the effects of various control methods, has been published by Albornoz.<sup>42</sup> The first panic was followed by a period of "expectation" during which little was done, although anti-rat measures were occasionally suggested. There were 257 cases of human plague. From 1910 to 1919 some deratization and disinfection was done. (Deratization, 1913-14; 1918-19.) There were 225 human cases. From 1920-1929 rat work was done in all years, intensively during epidemics and haphazardly between them; disinfection of empty grain sacks and antiplague vaccination were also employed. The author feels that they merely diverted attention from the really necessary rat work. There were 207 cases of plague. From 1930 to 1937 vaccination and disinfection of sacks were abandoned; anti-rat work was organized on a permanent basis with personnel maintained at the expense of each grain firm, enterprise, and railway, under the direction of the National Department of Health. The program included daily deratization, rigorous sanitation of all premises, laboratory control of captured rats, intense and periodic poisoning, study of parasite indices, and classification of trapped rats. Human plague decreased and disappeared, and the last case of rodent plague was in 1932. During the 8 years of this campaign there were 14 human cases, 10 of them during the first semester of 1930 before the campaign was well under way, so that only 4 cases occurred after it began, and there was a reasonable suspicion that these four originated in infected rats brought from outside the port. Prior to 1931 practically all cases could be traced to the port. The last human case was in 1934.<sup>43</sup>

**Prevention of railway propagation of plague.**—Railway propagation of plague is another problem which has received considerable attention in Argentina. The destruction of weeds around railway property, the cleaning of ditches, destruction of waste and rat-proofing of warehouses, ticket offices and homes of personnel, have been required, and in general the railway companies have cooperated with the work, at least in recent years.<sup>44</sup> Poison, and to a lesser extent, trapping, have been

<sup>40</sup> In the 13 principal ports of Argentina, 69,605 rats were destroyed in 1936; 72,291 in 1935; and 41,921 rats were examined in 1936 as against 32,092 in 1935. Seven plague rats were found in Buenos Aires in 1936 (port); 15 in Santa Fe and 2 in Bahía Blanca in 1935. (Off. Int. Hyg. Pub.: *Bol. Of. San Pan.*, June, 1938, p. 513.)

<sup>41</sup> Report of the Argentine delegation to the X Pan American Sanitary Conference, September, 1938.

<sup>42</sup> Albornoz F.: *Bol. San., Arg.*, 1938, p. 4.

<sup>43</sup> In connection with rat destruction, Albornoz has noted that the apparent absence of dead rats need not mean there are none. In an outbreak of plague in Rosario in 1928, in a warehouse where 12 cases had occurred, no dead rats could be found, but in 1938 in tearing down the double wall of an office in the warehouse, a large number of dead, dried up rats were discovered. In Santa Fe two years previously, after many investigations, 16 dead rats of various periods were found in a double wall. With this focus destroyed, plague disappeared from the city. (*Bol. San., Arg.*, 1938, p. 472.)

<sup>44</sup> Legislation was necessary; Uriarte in 1928 (Sobre profilaxis antipestosa y rat-proof, *Rev. Inst. Bact.* Mar. 1928, p. 198) noted the need for cooperation of grain and railroad companies; the fact that the most prosperous ports and localities had the most plague; that great and wealthy enterprises had never been required to undertake sanitation work in their sheds and warehouses, whereas poor urban householders have had to make costly improvements in the name of "public health." He suggested that plague was

used for the destruction of rodents, as has fumigation. Some lines have equipped a special railway car with all the elements necessary to carry out deratization, and have organized a trained crew for the work. Where requirements of the National Department of Health were not complied with, warehouses would be closed and/or fines imposed, according to the circumstances.<sup>45</sup> An intensive campaign of popular education was carried on in 1937, with distribution of material, investigation of towns, collection of information as to number of warehouses, sheds, rodents, inhabitants, physicians, pharmacies and hospitals, and inspection of warehouses and other buildings.<sup>46</sup>

**Plague in the interior.**—Plague control in the interior involves a war on rats guided by detailed maps of plague foci in which the location, type of construction, purpose, and means of communication of each building within a given district (of from 100 to 150 houses) are noted. Rat control brigades make periodic visits, leaving poison and traps, with directions for their distribution, collecting and classifying trapped animals and sending the spleens to the Bacteriological Institute, and determining flea indices. Prevention of wild-rodent borne plague rests largely on education of the inhabitants concerning the danger of handling sick or dead animals, destruction of rats to prevent their acting as a connecting link in the infection, and clearing of areas around dwellings to lessen the possibilities of contact.<sup>47</sup>

**Ships.**—Fumigation of ships has long been carried out in Argentina, but its orientation has changed from the practice of fumigating vessels on which plague has occurred, to the preventive work of fumigating vessels in order to keep down the rat population. The national plague prevention law provides for the periodic fumigation (every three months if by direct combustion of sulfurous anhydride; every six months if by the Clayton system of sulfurous anhydride or hydrocyanic acid) of vessels in the national coasting trade; and for the fumigation of foreign vessels whose certificates of fumigation or exemption have expired, or on which evidence of the presence of a considerable number of rats on board is found after inspection, even though the vessel's papers may be

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just as much an "accident of work" or occupational disease as anthrax, although not so recognized by law. He also noted that strict compliance with the law stopping grain traffic at the appearance of plague might perhaps cause the recalcitrant to see the light. He pointed out the need for educational work directed at industrial officials as well as at the general public. . . Battaglia told him that in Puerto Bryan 450 rats were killed in one grain deposit (*estiba*) and that in another, at a railway station at Alto de Chipi6n, C6rdoba, 800 rats were exterminated.

<sup>45</sup> Report of Argentina, "Actas," 10th Pan American Sanitary Conference, 1938.

<sup>46</sup> In two months and 20 days, two inspectors, making six trips, covered 930 stations in Buenos Aires, Santa Fe, San Luis, Mendoza, San Juan, C6rdoba, Santiago del Estero, Tucum6n, Entre R6os, Corrientes, La Pampa and Misiones, distributing and posting 23,750 notices, 1,021 copies of the antiplague law, 12,000 pieces of rat poison; inspecting 148 stations (finding 133 warehouses with a large number of rats); and filled out 799 descriptive blanks on cities. The 930 stations are one third of the nation's railway stations. The railways cooperated most effectively with the work. Many requests for poison, literature and advice were received as a result of the campaign. (*Bol. San., Arg., 1937*, pp. 736, 793, 835, 837.)

<sup>47</sup> Sussini, M.: "Actas III Conf. Pan. de Dir. Nac. de San.," p. 199.

in order. At the end of 1934, after the training of special personnel for the work, investigations were begun directed against vessels which were suspicious because of their origin, their exemption from fumigation, or because they came to load grain, with the result that rats were found in many of them in open contradiction of the statements on their certificates of fumigation or exemption.<sup>48</sup> An intensive application of this system has had three interesting results: some vessels wish to be fumigated in Argentine ports, confident of an efficient operation; some, formerly notorious for their poor hygienic conditions, now arrive in Argentine ports in good condition; and others adopt all sorts of schemes and subterfuges to deceive the scientific personnel assigned to the work.<sup>48</sup>

**Serum treatment.**—The efficiency of serum treatment in plague has long been recognized in Argentina (see Table 3). It was used in the Rosario outbreak in 1899, although on a small scale due to lack of sufficient supplies.<sup>49</sup> It has been manufactured by the Bacteriological Institute since the organization of the Plague Section in 1916, as well as previously.

**Vaccination.**—Plague vaccination has had a constant vogue in Argentina, and has been considered effective by some observers.<sup>50</sup> Others have considered that its preventive value was apt to be overrated at the expense of such imperative measures as rat destruction (Uriarte, Albornoz.). The present tendency, in contrast to the former *en masse* vaccination of as many persons as could be induced to be vaccinated (or in some instances, as clamored to be vaccinated), is to limit vaccination to plague workers and contacts and trust to isolation of cases and contacts and intense deratization to protect the rest of the population.

**Research.**—Research work in Argentina has included investigation of the conservation of the vitality and virulence of the plague bacillus (Uriarte and

<sup>48</sup> During the first year (1935), 97 foreign vessels were fumigated in Argentine ports, 52 of which held unexpired certificates of exemption or fumigation, and on these 52 ships, 2,371 rats or 55 per vessel were found. (1420 rats or 83 per vessel on the 23 with exemption certificates; 960 rats (56 per vessel) on the 17 which had been fumigated with sulfur within six months; and 491 rats (41 per vessel) on the 12 which had been fumigated with cyanide within the stated period.) During the same year 3,757 routine fumigations were made on domestic and 45 on foreign ships, with 3,959 rats recovered, slightly more than one rat each for the 3,802 fumigations. From 55 vessels fumigated extemporaneously in 1936, 2,491 rats were recovered, an average of 45 rats per vessel. From the 19 of these ships which possessed certificates of exemption, 628 rats, or 33 per vessel were recovered; from the 18 with certificates of sulfur fumigation, 920 rats, or 52 rats per vessel; and from the 18 with cyanide fumigation, 934 rats or 52 rats per vessel. In 1937, 2,890 rats were recovered from 57 extemporaneously fumigated vessels, or 51 rats each. From the 28 vessels with certificates of exemption, 1,211 rats (43 per vessel) were recovered; from the 9 with sulfur fumigation, 665 rats (74 each); and from the 19 with cyanide fumigation, 972 rats (51 each). One vessel's status was not specified; she had 42 rats. In 1938, 857 rats were recovered from 18 vessels (48 each), of which 376 were from 7 exempt vessels (54 each); 101 from 3 sulfur-fumigated vessels (34 each); and 380 from 8 cyanide-fumigated vessels (47 each). In 1939, 902 rats were recovered from 11 vessels (82 each), of which 92 were from 2 exempt vessels (41 each); 215 from 4 sulfur-fumigated vessels (54 each) and 595 from 5 cyanide-fumigated vessels (119 each). It may be noted that from 1936 through 1939 the average length of time between the previous cyanide fumigation and the extemporaneous fumigation was 4.4 months; between the last sulfur fumigation and the extemporaneous fumigation, 3.9 months. All the extemporaneous fumigations were by cyanide. For the tabulated reports, 1936 through 1939, see the transactions of the IV Pan American Conference of National Directors of Health. (Actas, III Conf. Pan. Dir. Nac. San., p. 221; *Bol. Of. San. Pan.*, June 1938, pp. 513 and 553; tables, 1935-37, pp. 554-555.)

<sup>49</sup> Agote & Medina, *op. cit.*

<sup>50</sup> Sordelli:<sup>3</sup> Report of the Argentine Delegation, 10th Pan American Sanitary Conference, p. 171. None of 800 persons vaccinated in San Nicolás in 1901 contracted plague although two unvaccinated children in the same locality did. (Penna, *Sem. Méd.*, Oct. 10, 1901, p. 619.)

Morales Villazón have kept original strains of plague bacilli with their original virulence for periods longer than two years, without resowing or reinoculation);<sup>51</sup> investigation of the course of experimental infection with certain strains;<sup>52</sup> techniques in diagnosis and differentiation of the bacillus (including an investigation of the value of the "ganglion puncture");<sup>53</sup> the culture of plague in peptone water with glucose and neutral red;<sup>54</sup> culture of plague in peptone water with rhamnose and litmus or bromocresol purple in order to differentiate it from *B. pseudotuberculosis rodentium*;<sup>55</sup> discovery of a non-plague but plague-like *pasteurella* in rats (1928, 1934, 1935) and experiments with other organisms;<sup>56</sup> experimental vaccination with living bacteria;<sup>56</sup> use of scrapings from the bone marrow to secure living plague bacilli in dead animals.<sup>57</sup> Degenerative forms of the plague bacillus were described by Uriarte in 1899.<sup>58</sup> The sensitivity of various animals to plague has been studied.<sup>59</sup> The classification of wild rodents<sup>60</sup> and of fleas<sup>61, 62</sup> has been undertaken. A study of the attraction of mate for rats led to the conclusion that except for the fresh seeds it has no particular appeal.<sup>63</sup> The use of fish as a bait in poison packets is a successful Argentine innovation.<sup>64</sup>

<sup>51</sup> Uriarte, L., & Morales Villazón, N.: Conservación de la vitalidad y virulencia del *B. pestis*, *Rev. Inst. Bact.*, Arg., Nov. 1936, p. 5.

<sup>52</sup> Anchezar, B. V.: Estudio bacteriológico y anatomopatológico de la infección experimental con *P. pestis* (Cepa E. V. avirulenta de Girard), *Rev. Inst. Bact.*, Arg., Aug. 1938. Also published, with a comparison with experimental virulent plague infection, as a thesis. Universidad Nacional de Buenos Aires, 1938, 60 pp.

<sup>53</sup> Uriarte, L.: "La ponction ganglionnaire dans la peste bubonique," *C. R. Soc. Biol.*, Dec. 4, 1924, XCII, p. 901.

<sup>54</sup> Uriarte, L., & Morales Villazón, N.: "Acerca de la diferenciación del bacilo pestoso," *Rev. Inst. Bact.*, Arg., Nov. 1935, p. 287; "Procedé de culture pour differencier le B. de la peste," *C. R. Soc. Biol.*, 1924, XCI, p. 1041.

<sup>55</sup> Uriarte, L., & Morales Villazón, N.: "Un cocabacilo similipestoso en las ratas de Buenos Aires," *Rev. Inst. Bact.*, Jul. 1935, p. 91. The *B. pseudotuberculosis rodentium* has never been found in autopsies at the Institute (210,906 autopsies in 20 years); the strains used are from the Pasteur Institute. Savino, E.; Aldao, A., & Anchezar, B.: "Los microorganismos del género *pasteurella*: I. Los caracteres de cultivo," *Rev. Inst. Bact.*, Arg., Dec. 1939, p. 110; Savino, E.; Morales V., N. & Anchezar, B.: "Bacterias del grupo *coli-anaerogenes* y *Brucella bronchiseptica* en ratas grises," *Rev. Inst. Bact.*, Dec. 1939, p. 142; Presencia de *Pasteurella* sp. incert. en ratas grises, *Rev. Inst. Bact.*, Dec. 1939, p. 146. See General Review, Note 6.

<sup>56</sup> Savino, E., & Anchezar, B.: "Vacunación antipestosa experimental con bacterias vivas," *Rev. Inst. Bact.*, Arg., Dec. 1939, p. 122.

<sup>57</sup> A method used by Pons in Saigon in 1926, inspired by Truche's procedure in infections of birds, and developed independently by Uriarte, Morales Villazón and Anchezar in Argentina in 1932 as an extension of the common practice of veterinarians in investigating anthrax in animals. It has also been used for the diagnosis of plague in human bodies (scrapings from the ribs). (Uriarte, L.; Morales V., N., & Anchezar, B.: "Un procedimiento para investigación de la peste en los roedores," *Rev. Inst. Bact.*, Arg., July, 1935, p. 1.)

<sup>58</sup> Uriarte, L., & Morales Villazón, N.: "La profilaxis de la peste bubónica: Un decenio de investigaciones en las ratas," *Rev. Inst. Bact.*, Arg., Mar., 1928, p. 149.

<sup>59</sup> Uriarte, L., & Morales V., N.: "Sensibilidad e insensibilidad a la peste de algunos animales," *Rev. Inst. Bact.*, Arg., Jul. 1936, p. 721.

<sup>60</sup> Yepes, José: "Epítome de la sistemática de los roedores argentinos," *Rev. Inst. Bact.*, Nov. 1935, p. 213.

<sup>61</sup> Del Ponte, E., & Riessel, M. A.: "Notas sobre *siphonaptera* argentinos," *Rev. Inst. Bact. Arg.*, Jul. 1936, p. 696. *P. irritans* en animales salvajes, *Fol. Biol.*, Sept.-Dec. 1936, p. 287.

<sup>62</sup> Uriarte, L.: "Pulicidas des rats de Buenos Aires," *C. R. Soc. Biol.*, Sept. 4, Oct. 2, 1924, XCII, p. 831. *Rev. Asoc. Méd. Arg. XXXVIII*, Sesión Oct. 2, 1924, Vol. V. Uriarte, L., Calcagno, B., et al.: "Pulicidas murinos de Buenos Aires," *Fol. Biol.*, June-Aug. 1934, p. 173.

<sup>63</sup> *Bol. San.*, 1937, p. 606.

<sup>64</sup> Sussini, M.: "Actas III Conf. Pan. Dir. Nac. San.," p. 203) credits Albornoz with the idea of using fish in bait, and notes that it has also been used with success by Long in Guayaquil, Ecuador.

(To be continued)