China, .8 for India, and 1.7 for Egypt and Cyprus. This difference was undoubtedly due to the general dissemination of the disease among an unprotected native population. In our own army, for the thirteen years 1885–97, there occurred but 6 cases of smallpox, and in these instances the fact of previous vaccination could not be determined. In the year 1898, however, our troops on foreign service were brought into contact with an unvaccinated native class, and, furthermore, consisted largely of recruits hastily enrolled in an expanded army during the war with Spain. These men, examined largely by civilian physicians for enlistment, were less thoroughly protected against the disease by vaccination; and for that year the admission rate for the entire army was .40 per thousand. For 1898, from the troops in Porto Rico the admissions were 1.04 and the deaths .52 per thousand; in the Pacific islands the admissions were 5.51 and the deaths 2.07. For the entire military force, regulars and volunteers, May, 1898, to June, 1899 inclusive, the death rate from smallpox was .57 per thousand.

Manner of Infection.—In the great majority of cases the disease appears to be directly transmitted from the sick to the well through the medium of the atmosphere, and this power of aërial convection is one of the most striking characteristics of smallpox. Persons unprotected by vaccination apparently contract the disease by simply breathing the air of the space in which a smallpox patient is confined. There is no evidence for or against the transmission of the disease by food or drink or through wounds. Persons or things which may have been in contact with the patient are, however, capable of conveying the contagion. Power showed that the infectious agent could be carried by the air, particularly when a large number of cases were aggregated and the atmosphere was moist, for as much as a mile. This is a matter for consideration in the establishment of isolation hospitals. The incubation period of the disease is practically twelve days, and its period of infectiveness lasts at least six weeks in severe cases. The period of highest infectivity is believed to be during the stage of desquamation, when the morbific agent, whatever be its nature, is dispersed with the fine particles of epidermis that the patient sheds. The disease appears to be contagious at an early stage; after exposure to an infection the susceptible individual should be quarantined for a fortnight. A certain proportion of individuals, according to Notter and Firth about five per cent., appear to be naturally immune to the disease.

Soil and climate appear to have no influence on the occurrence of smallpox. Season appears to affect its prevalence, and in temperate climates the mortality curve is above the mean in the late winter and spring. In the tropics the disease is said to prevail chiefly during the hot season, the rains checking it to a great extent. The negro and colored races are especially susceptible to the disease, and these also suffer a heavy case mortality when vaccination has been imperfectly performed. During the Civil War the admissions among the white troops for variola and varioloid amounted to 5.5 per thousand strength, while the admissions of colored troops for the same cause amounted to 36.6 and the deaths to 12.2.

Prophylaxis.—For the prevention and eradication of smallpox, systematic vaccination is the measure of by far the greatest importance. When arm-to-arm vaccination was practised in armies, great difficulty was found in obtaining the necessary amount of virus, and it was also impossible to eliminate entirely the possibility of transmitting certain constitutional diseases. Animal vaccine disposes of this danger and places at the disposal of the military sanitarian as large quantities as may be desired. With improved virus and better technical methods, the proportion of successful vaccinations has steadily increased. In the Italian army, of 3,095,571 vaccinations and re-vaccinations made during the period 1867–97 inclusive, Livi states that the success increased from 260 per thousand in 1867 to 698 per thousand in 1897. In the last-named year, in the Belgian army, the number of successful primary vaccinations was 69.91 per cent.; of those previously vaccinated, 43.21 per cent.; of those said to have had smallpox, 20.50 per cent. In our service, Army Regulations require that as soon as a recruit joins any rendezvous, regiment, or post he shall be examined by a medical officer to ascertain whether vaccination is

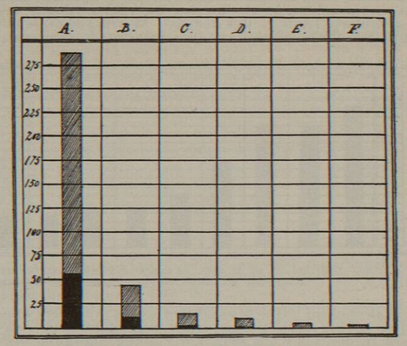

FIG. 1086.—The Influence of Vaccination on Smallpox in the Italian Army, Based on Figures for the Period 1867–97. *A*, Never had variola or been vaccinated in childhood and not yet vaccinated in the army; *B*, either had variola or been vaccinated in childhood and not yet vaccinated in the army; *C*, never had variola nor vaccinated in childhood and vaccinated in the army without success; *D*, never had variola nor vaccinated in childhood, and vaccinated in the army with success; *E*, had variola or was vaccinated in childhood, and vaccinated in the army without success; *F*, had variola or was vaccinated in childhood, and vaccinated in the army successfully. (After Livi.)

required. In such cases as present no evidence of successful vaccination within a reasonable period the operation is to be performed immediately. The date and result of the last vaccination are to be noted in the company descriptive and deposit book, and also on the descriptive list in case of transfer. This system is not sufficiently comprehensive and leaves too much to the discretion of the medical officer. It should be required that all young recruits be vaccinated immediately on enlistment, and that they be examined after ten days and re-vaccinated if the first operation has not been successful. In such as still prove refractory, the operation should be repeated at the end of three months. In time of epidemic the thorough vaccination of the whole command should be practised. For old soldiers, after being vaccinated on re-enlistment, no repetition of the vaccination, if unsuccessful, will ordinarily be necessary. The practice of simultaneously making several points of inoculation, as is done in European armies, has much to commend it as reducing liability to failure. In general, the total area of the cicatrices should not be less than half a square inch. The incubation of vaccinia being shorter than that of smallpox, it is possible to modify or even entirely prevent an attack of the latter, by vaccination performed some days after infection. This is especially the case with re-vaccination, the incubation of which is often shorter than primary vaccination. The operation, if successfully performed within three days after exposure to smallpox, will prevent the appearance of the symptoms, and in all likelihood the attack will be arrested or modified if vaccination be performed as late as the fifth day. The few attacks that occur between six and nine days after successful vaccination are mild, and practically none commence later. With regard to what may be accomplished in controlling smallpox, the recent work of army medical officers in the Philippines, Cuba and Porto Rico is a conspicuous example. In the latter island nearly a million people were vaccinated, and the disease was practically eradicated. In the Cuban epidemic at Holguin, where 12,000 cases of the disease were treated, not a single soldier of the well-vaccinated command contracted smallpox, though the men were constantly engaged in sanitary police and in guard duty at the lazarettos and infected points.

In addition to the prompt vaccination of all persons who may have come in contact with a smallpox case, the patient should be carefully isolated. All clothing and other articles exposed to contagion, which cannot be readily disinfected, should be burned. During the stage of desquamation, fixation of the contagious matter should be accomplished by smearing the skin with olive oil, vaseline, or carbolized glycerin. All discharges from the nose, mouth, and elsewhere should be received into vessels containing a disinfectant solution. The scabs which have fallen off should, as far as possible, be collected and burned. Isolation should be maintained until the last scab has disappeared. The surroundings of a case of smallpox should be carefully disinfected. No special precautions on the part of the attendants, provided they are thoroughly protected by vaccination, appear to be necessary.

In nearly all foreign armies, vaccine farms form part of the military establishment. In the French army there are five such farms, of which three are located in France and two in Tunis and Algeria. In our own service admirably managed vaccine stations have been established in Porto Rico and in the Philippines, since it was found to be a matter of both great difficulty and great expense to import active vaccine virus from the United States, Japan, or other countries. In the stations in the Philippines the young water buffalo or carabao has successfully filled the place of the calf for the production of vaccine virus.

TUBERCULOSIS.—*Occurrence.*—Tuberculosis is a disease which originates more frequently in garrison than among troops in active campaign; but, on the other hand, the arduous nature of the service required under the latter conditions is often responsible for the development of a previously latent infection. The disease is not uncommon among troops, a fact by no means strange when its great prevalence among the civil population is considered. It is probably true that a proportionally greater number of cases of tuberculosis occur among soldiers than among males of the military age in civil life, in spite of the former being physically sound men; but, on the other hand, the disease is of a somewhat chronic nature, not usually amenable to such treatment as can be given in the military service, and hence the early discharge of well-recognized cases does much to depress the rates for the army and raise those for civil life. Military service appears not only to afford greater facilities for contracting the disease, but also to more certainly develop an existing but latent infection.

The mortality from tuberculosis was extremely high among troops at the beginning of the present century, but has gradually decreased down to the present time as a result of more attention to their welfare. In our own service the admission rates for tuberculosis, during the Civil War, amounted to 6.22 per thousand strength; the death rate to 2.53. During the second year of the war the admission rate was 9.38 and the death rate 3.05. For the period of peace, 1868–84, the admissions amounted to 4.88 per thousand strength, and the deaths to 1.05. For the decade 1885–94 these rates fell to 3.39 and .59 respectively; and for the period 1895–98 they were still further reduced to 2.83 and .42. These rates are low as compared with those for other armies, and reflect credit upon the care given to our troops; but their existence, even at present figures, implies a certain laxity of sanitary administration. The death rate from this cause should be made to approximate zero through a more prompt and thorough elimination of those affected with tuberculosis, while a higher physical standard in respect to recruits would do much to reduce the future admissions to sick report from this disease. At present our rates are considerably raised by the military sanitarium for the tuberculous maintained at Fort Bayard. In foreign armies, figures with respect to the occurrence of tuberculosis, as given by Marvaud and contained in recent official reports, are as follows:

Country.	Period.	Admissions per 1,000 strength.
Germany	1873–79	4.3
	1881–91	5.7
	1891–97	2.57
Austria	1878–81	4.2
	1889–91	4.7
	1893–97	1.76
England	1870–83	6.1
	1885–90	3.5
	1888–97	3.7
Russia	1890–97	4.2
Italy	1875–81	3.16
	1882–91	3.82
Spain	1886–91	7.75

In the Russian and French armies the death rates are particularly high, being 1.6 and 1.10, respectively. The lowest death rate is given by the Belgian army, in which, as a result of careful elimination of the tuberculous, the rate was but .35 per thousand strength in 1898. For the year 1897 the death rate was .45 in the German army. Among the British troops on colonial service, during the decade 1888–97, the lowest rates of admission were given by Gibraltar, 1.9, and Bermuda, 2.4. The highest rates were given by the troops in India, 4.2, and in Ceylon, 4.1. For the Spanish army in Cuba, in 1897, the admission rate for tuberculosis was reported to be in excess of that for yellow fever, dysentery, or typhoid fever.

Dissemination and Infection.—Every tuberculous soldier is a source from which the disease may be propagated to his comrades. The particular manner in which the infectious material is thrown off depends upon the anatomical location of the tuberculous lesions. Undoubtedly the disease is most commonly disseminated by infected sputum, but this is merely because the specific bacilli more commonly find in the respiratory apparatus the conditions which are favorable to their development. It should not be overlooked that under certain conditions the urine, fæces, or discharges from superficial lesions may be proportionally as infectious as the sputum.

In the sputum of those affected with pulmonary tuberculosis the specific bacilli are usually found in enormous numbers. When such infected sputum is dried, pulverized, and disseminated as dust by air currents, the infectious material may be inhaled by those within its sphere of action, and, in susceptible individuals, may reproduce the disease. The same may also occur with tuberculous urine, fæces, and suppurative discharges. In the dried state the vitality of the bacillus is very great, and it has been shown to retain its virulence under these conditions for as long as from seven to ten months. In the wet state, its virulence is retained for about six weeks; but in this condition it is comparatively harmless, though not entirely so. Cornet found that the dust in rooms occupied by consumptives contained virulent tubercle bacilli in a large proportion of cases. Such dust, disturbed from cornices or out-of-the-way places, even after several months, is often capable of producing an infection, and to its agency the appearance of many cases of obscure origin may be attributed. In a study of consumption occurring in Philadelphia it was found that certain infected tenement houses were apparently responsible for a large proportion of cases; in some instances every family successively occupying these houses presenting one or more cases of the disease after an occupancy of any duration. These observations have a practical application to the military service in connection with the disinfection of barracks in which a case of this disease has occurred.

While the breath in consumptives does not appear to

convey the infection, fresh tuberculous material, after infection, may be transmitted to food or drink by unwashed hands or other agency, and give rise to the disease when taken into the alimentary tract. Vigoura, in ten examinations of the hands of hospital attendants in wards where consumption was being treated, found the tubercle bacilli present in two instances. In the same way, infected individuals who cough over food may also disseminate the affection. Flies feed greedily on tuberculous material, and their importance as carriers of the specific bacilli has only recently been appreciated. Much evidence on this point has lately been collected. Spillman and Haushalter examined the flies and fly excreta in a hospital ward and found tubercle bacilli in both. Hoffman examined the intestinal contents of flies taken from a room where a death from phthisis had recently occurred and found the bacilli in four out of six instances, as well as in the fly excreta on the walls and furniture. Guinea-pigs inoculated by him with fly intestine became tuberculous. Alessi fed flies with phthisical sputum and produced tuberculosis in rabbits inoculated with their dung. It is thus apparent that food may be readily contaminated by flies carrying infectious material. Tuberculous meat may also be a cause of the disease; and in civil life milk from diseased animals is not infrequently infected. Clothing or other articles, when infected, may convey the disease to those persons who handle them, and in such instances the disease appears to result from infection by way of the alimentary tract. Inoculation through a breach of the skin has often occurred, but such method of infection is not common in the military service. When it does occur, the process is usually localized at the site of infection. Direct infection from the sick is rare, but there appears to be evidence to the effect that the disease may be communicated by the sick to the well. In instances of this sort, however, the affected individuals can scarcely be said to have been free from the possibility of infection by indirect means also.

Predisposing Causes.—The disease occurs in all countries and climates, but is especially prevalent where sudden changes of temperature and damp atmosphere favor the occurrence of bronchial irritation, the tuberculous element being thus engrafted upon a simple benign affection. A dry, equable, sunny climate does much to prevent the occurrence of this disease, and the same may be said with respect to altitude. Of the greatest importance in determining the occurrence of this disease is the so-called tuberculous diathesis. There seems to be no doubt that certain individuals present a hereditary susceptibility to this disease, and this predisposition may generally be recognized by the well-known physical signs. Among these chest capacity is important, and it is of interest to know that, in the German army, where the chest of a soldier does not properly develop under physical training, the man is regarded as predisposed to phthisis and returned to civil life.

Race exerts a considerable influence on the occurrence of tuberculosis, though no race is exempt. The negro and Indian are especially predisposed to this disease. Among the Apache Indian prisoners removed from Arizona to Alabama a few years since, the annual death rates per thousand, for five years, were 55, 51, 110, 146, 110—almost wholly from tuberculosis. For the white race, nativity seems to be not without influence in modifying susceptibility. In the United States army, for the seven years 1890–96, the admission rates for tuberculosis, per thousand strength, were 3.33 for American whites, 2.97 for soldiers born in Ireland, and but 1.49 for those of German birth. In the examination of 501,068 recruits, during the Civil War, Baxter states that rejections for tuberculosis were more frequent in blonds than in men of dark complexion; and that the proportion of rejections increased directly with the height. Age is a factor of great importance in the occurrence of the disease. For the period 1890–96 the admissions for tuberculosis in our army, per thousand of each class, were proportioned as follows:

Period.	Admissions.
19 years and under	5.03
20 to 24	3.44
25 to 29	3.09
30 to 34	2.69
35 to 39	2.70
40 to 44	1.87

The rates for infantry are slightly higher than for cavalry and artillery, and nearly three times as high as those for the Medical Department; the latter showing the beneficent effect of lessened exposure and overcrowding. For the period 1890–96 the admissions were about two-thirds as frequent among officers, 1.98, as among enlisted men, 2.96.

Nothing is better established with regard to tuberculosis than its relation to overcrowding and bad ventilation. As long ago as 1858 it was shown in the British army that the troops which suffered the most from overcrowding presented the greatest amount of tuberculosis. The custom of living in common, as in barracks, greatly favors the occurrence of tuberculosis, since where an infection of the building has occurred all the occupants are equally exposed to the danger of contracting the disease. Casemates, from their dampness, defective ventilation, and want of sunshine, particularly favor the occurrence of tuberculosis among troops quartered in them. No more striking example of the influence of habitations on the frequency of tuberculosis has been given than that reported by Davy, in 1862, as witnessed by him at Fort Clarence, in England. At this post, converted into a military lunatic asylum, the deaths from tuberculosis among officers and among soldiers' wives, these being lodged in ordinary houses, furnished 19 and 18 per cent. respectively of the mortality from all causes. Among the soldiers quartered in casemates, tuberculosis caused 39 per cent. of all deaths. A susceptibility to tuberculosis may be acquired by individuals, ordinarily resistant to the disease, through insufficient and improper food, want of exercise, poor ventilation, and uncleanliness of the person and surroundings. As in other diseases, any circumstance which tends to lower the powers of vital resistance favors infection.

Prophylaxis.—In the military service the prevention of tuberculosis depends largely upon the careful selection of recruits and the avoidance of enlisting such as appear to have a predisposition to this disease. If such have been enlisted, they should be discharged. All soldiers affected with the disease should be promptly discharged from the service, as their retention is a menace to others.

Among other measures of prevention may be mentioned the location of barracks on dry, elevated, sunny sites; the provision of sufficient cubic space, and thorough ventilation; the avoidance of sharp corners or projecting ledges upon which dust can collect, and the rendering of floors impermeable with paraffin. Spitting on the floor and walls, aside from its being an offence against neatness and decency, should be prohibited for sanitary reasons. Metallic spittoons of a pattern readily cleansed should be provided, and should contain a small quantity of some odorless disinfectant solution so as to keep the sputum in a moist condition. These receptacles should be cleansed and scalded daily. Box spittoons containing sawdust, as too often found, should never be employed. They are not only a danger to health, but are often ignited by cigar and cigarette stubs. It should not be forgotten that a squad room which has contained a case of tuberculosis is not safe for occupancy until disinfected. In the routine cleaning of barrack rooms the use of dusters should be avoided, and all dust should be removed from shelves and projecting ledges by means of damp cloths. Meat from tuberculous animals should be rejected for issue. An abundant diet containing a considerable amount of fat appears to be of value in the prevention as well as treatment of this disease. Chilling and exposure, which favor bronchitis and pleurisy, predispose to tuberculosis and should be avoided. Exercise in the open air, especially such exercise as increases the mobility and capacity of the chest, is desirable.

With reference to the measures to be applied to the affected individual, the disinfection of the sputum and other discharges from persons suffering from various manifestations of the disease is of the most importance. The patient should be impressed with the fact that he is a possible source of infection, and that it is quite within his power to control the spread of the disease to others by attention to a few simple details that in no way interfere with his comfort. Special spit-cups should always be provided for the sick; since otherwise while endeavoring to use those on the floor they will frequently cause its contamination. When the spit-cups cannot be used, clean rags or rice-paper napkins may be employed, and these subsequently destroyed by fire. Bed or body clothing, soiled with tuberculous material, should be at once removed and disinfected. The bedding of the tuberculous should never be used by the well. All blankets should be frequently sunned, and great care taken to prevent their being shaken under circumstances which would allow the dust to be inhaled, or become a means of infection to others. The tuberculous individual should be provided with separate eating utensils, and these disinfected after use. The uneaten portions of food should be burned. All personal contact between the sick and the well is to be avoided.

Typhoid Fever. — *Occurrence.* —The history of typhoid fever, as a disease of soldiers, scarcely extends over a period of fifty years, it being previously confused with several other affections. About half a century ago the disease was differentiated from typhus fever by Murchison, both previously being classed together by medical officers as "spotted fever"; and undoubtedly much of the fatality which prior to this time had been regarded as due to typhus was in reality due to typhoid infection. In addition, no distinction was long made between enteric fever and the continued malarial fevers. Shortly before and during the Civil War, however, medical officers were forced to recognize the different characteristics of typical cases of these diseases, and about the same time the term "typho-malarial" was adopted to cover that class of cases which, while they presented some of the clinical symptoms of both diseases, were apparently identical with neither. Later, the fact that most of these cases of typho-malarial fever were in reality typhoid infections was strongly suspected; but it was not until Laveran, of the French army, discovered the malarial parasite that the differentiation between enteric and malarial fevers was definitely made. In the French army the official recognition of the existence of a disease intermediate between malaria and typhoid was withdrawn in 1888, and about the same time the term typho-malarial was discontinued in our own medical nomenclature. This example has since been followed in all the more important armies, and military statistics for this disease, for the past ten years, may be regarded as much more accurate. In the Russian army, however, even as late as 1897, no small proportion of the continued fevers were classed as "undetermined" in nature. It is obvious, therefore, from the difficulty which has until recently existed in the recognition of typhoid fever, that statistics for the periods prior to the past decade are of little value for purposes of comparison between different armies, and even for the same service they are not free from error. For our own army it may safely be assumed, from a better knowledge of the nature of the typhoid infection, that cases which have been recorded as typho-malarial are in reality largely cases of enteric fever.

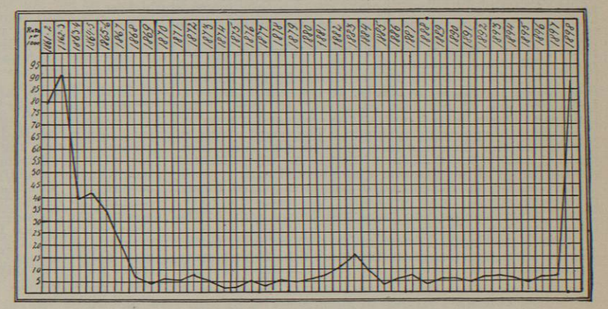

Fig. 1087.—Admissions for Typhoid and "Typho-Malarial" Fevers, per Thousand Strength, Occurring in the United States Army During the Period 1861–98, Excluding the Year 1867.

Typhoid fever at the present time is the most important disease affecting soldiers. While it prevails to some extent among troops in garrison, it is among soldiers in the field, and especially those in camps of more or less permanency, that it makes its greatest ravages. In this country, as in all temperate or tropical regions, enteric fever is so prevalent and its specific cause so widely disseminated that no camp of any size or permanency can be expected to remain free from its infection. In the camps of our army during the war with Spain not a single regiment escaped its ravages. According to the board appointed to investigate the epidemics of typhoid fever during this war, nearly all the regular troops and ninety per cent. of the volunteer regiments developed typhoid fever within eight weeks after going into camp; in the northern equally as much as in the southern parts of the country. This condition, far from being unusual, is what has commonly prevailed among all troops in active service; and Davies particularly notes a number of instances of epidemics occurring early in successive British military expeditions. The recent Anglo-Boer War in South Africa was no exception to this rule. It has been repeatedly observed, especially in the camps of 1898, that while troops in camp are heavily scourged, the surrounding civil population may remain wholly unaffected. The conclusion is inevitable that conditions ordinarily found in military encampments or governing troops in the field are extremely favorable to the propagation of this disease; and this fact is abundantly demonstrated by figures for our own service. During the Civil War period, 1861–66, the admissions for typhoid and typho-malarial fever amounted to 57.71 per thousand strength, while for the sixteen years following the war, 1868–84, the admissions for the same cause were only 6.29 per thousand strength. Again, in 1898, during the war with Spain, the admissions for typhoid fever amounted to 88.55 per thousand strength; during the year 1897 they amounted to 6.25, and during the decade 1885–94 they were only 5.51 per thousand strength. Throughout the period of peace, 1868–97, the rates for typhoid fever showed no very great variation except for the years 1882 and 1883, when sharp localized outbreaks of the disease occurred, and for the years 1874 and 1875, when the rates fell much below the normal. Of late years the disease has shown a tendency to become slightly more prevalent among our troops, in spite of the much improved sanitary conditions under which the soldier now lives. It is possible that the reduction in the period of enlistment from five to three years, through the greater proportion of more susceptible material in the army which is thus maintained, has had an effect in neutralizing sanitary im-

provements as far as their influence on enteric fever has been concerned. The relative prevalence of typhoid fever in our army, since the year 1860, together with the remarkable increase induced by camp life, is shown by the accompanying diagram (see Fig. 1087).

During time of peace the mortality from typhoid is not high in our army as compared with the country at large. For the year 1896 the death rate was .48 per thousand; this being lower than the typhoid mortality rates in most of our large cities, such as Washington, Chicago, Pittsburg and Philadelphia, notwithstanding the great susceptibility of men of the military age to this disease. In the French army, however, Coustan states that the relative amount of sickness due to typhoid fever is constantly five or six times greater than among the civilian population. During time of peace there has been no great epidemic of this disease in our army, the highest rates of admission being given in the years 1882 and 1883, when the admissions per thousand, for the entire army, amounted to 11.23 and 15.06, respectively. The rates are undoubtedly kept low through the fact that our troops have in the past been scattered in small commands over a large area, and that an infection of an individual water supply was therefore not able to affect a large number of troops at once, as is often the case in foreign armies. A considerable proportion of those exposed to the infection have at times contracted the disease. Viry and Coustan cite epidemics in the French army, in 1875, in which 10 per cent. of those exposed contracted the disease at Nanly, 18 per cent. of those at Saratory, and 25 per cent. at Brest. In 1889, of the troops at Dinan, 60 per cent. of the command contracted typhoid during a single epidemic. The board which investigated this disease during the war with Spain concluded that not less than one-fifth of all the troops located at the camps of mobilization were affected with typhoid fever, either in recognized or in unrecognized forms. It also stated that in all probability the deaths due to typhoid fever amounted to more than 80 per cent. of the mortality from all causes.

With regard to the occurrence of typhoid fever in foreign armies, Coustan gives the rate in the French army as follows:

Period.	Admissions per 1,000 strength.	Deaths per 1,000 strength.
Before 1888	From 12 to 31	2.5
1888	13.2	1.7
1889	11.6	1.6
1890	10.5	1.71
1891	10.77	1.95
1892	12.12	1.54
1893	9.59	

Before 1888, typhoid fevers and continued fevers were classed together. Up to 1893, typhoid was the cause of about one-third of all the deaths occurring in the French army. Marvaud gives the case mortality for the period 1878–90 as about sixteen per cent.

In the German army reports the rates of admission and death for typhoid fever, per thousand strength, are given as follows:

Period.	Admissions per 1,000 strength.	Deaths per 1,000 strength.
1881–82 to 1885–86	5.6	0.46
1886–87 to 1890–91	3.6	.28
1891–92 to 1895–96	2	.21
Year 1895–96	1.7	.19
Year 1896–97	1.3	.16

The small proportion of cases of this disease, together with the reduction which has steadily gone on, shows most forcibly the admirable sanitary condition of the German army.

In the Russian and Austrian armies the admission rates have of late years been as follows:

Year.	Russian army per 1,000 strength.	Austrian army per 1,000 strength.
1890	9.6	
1891	7.9	
1892	7.6	5.7
1893	7.2	14.0
1894	6.7	3.7
1895	7.7	3.1
1896	7.9	3.5
1897	8.4	3.8

In 1897 the death rate for the Russian army was 1.37.

The admission rates for the British army, at home and on foreign service, are given elsewhere in this section. In the Spanish army, according to Coustan, the admission rate for the year 1886 was twelve per thousand.

For the Italian army the mortality from typhoid has recently been as follows:

Year.	Deaths per 1,000 strength.
1893	1.12
1894	.84
1895	1.15
1896	1.10
1897	.98

In the Belgian army, for 1898, the death rate from typhoid was .28 per thousand strength.

Elimination of Infectious Material by the Sick.—It has long been recognized that the fæcal discharges of typhoid patients contain the specific bacillus and are a potent factor in the dissemination of the disease. The enteric bacilli are not usually found in the stools earlier than the seventh day, although the latter are probably infective during the incubation period and certainly during the onset of the disease—and they ordinarily disappear soon after convalescence is established. In some cases, however, the bacilli have been found as late as forty-one days after defervescence. The stools appear to gain in infectivity for several days after discharge from the sick person, but the reasons for the increase in virulence are not as yet understood.

The elimination of typhoid bacilli by the kidneys affords a ready means of spread which has not sufficiently engaged the attention of medical officers; and in investigating the cause of typhoid fever in military camps this mode of dissemination is too often overlooked. Enormous numbers of the bacilli are frequently, though apparently not invariably, present in the urine. When they do occur, it is late in the disease and during convalescence. In 38 cases, Richardson found the bacilli present in 9; always in large numbers and practically in pure cultures. They appeared only in the later stages of the disease and persisted far into convalescence. Smith found them present in 3 out of 7 cases examined by him, and observed that they may be present in sufficient numbers to render the urine turbid. Petruschky found typhoid bacilli in urine two months after the temperature had become normal, and calculated that in one instance the urine contained 170,000,000 typhoid germs in each cubic centimetre. In many cases the urine in convalescence has been found to be swarming with typhoid bacilli, while none could be detected in the fæces. In certain instances this condition has been found to persist for years. Richardson has reported an old case of cystitis in which the bacillus was found in pure culture in the urine five years after the attack; and similar results have been obtained by Houston and others. Horton-Smith finds that the specific bacilli are present in the urine in one-fourth of the cases of the disease, and, when present, occur in far greater quantity than in the fæces. In comparing the two as to the most dangerous and frequent cause of the disease, he concludes that this is "the urine, and this partly on account of the enormous numbers of bacilli which may occur in it, and partly on account of the excretion itself. Thus the stools by their color and odor at once attract attention, so that the slightest soiling of the linen is at once noticed and the damage rectified; but the same cannot be said of the urine." It can readily be seen how a convalescent from typhoid fever, prematurely returned to duty, may infect the soil of his company camp by urine surreptitiously passed at night; where such contamination by fæcal matter would be scarcely possible, and if it occurred would be readily detected and measures promptly taken to limit its evil effects.

It has recently been questioned whether the sputum in typhoid fever may not be infectious. Investigation on this point by Williams and others has given positive results in a number of instances. How early the bacilli may appear and how long they may persist are matters which have not as yet been determined.

Methods of Dissemination among Troops.—The typhoid bacillus undoubtedly obtains entrance into the system by being swallowed either with the water or with the food, or by drawing into the mouth or pharynx the germs suspended in the air, or by placing in it some specifically contaminated object.

In the epidemics of towns or large garrisons, water usually serves as the vehicle for the infective agent; but in military camps there are many modes of infection, and in the typhoid epidemics of 1898 contaminated water was one of the least important factors. Vaughan says: "There probably were local water supplies that became specifically infected with the typhoid-fever bacillus, but infected water was not the great factor in the causation of this disease," and this opinion will be shared by those who had experience in field service during the period named. At Jacksonville, Lexington, and Knoxville, the troops used the same water supply as the adjacent civil population, yet one class had typhoid and the other had not. At Jacksonville there were only a few sporadic cases in the city, while in the adjoining camp, with about the same population, the admissions to hospital for typhoid fever were 60 or 70 per day. In Knoxville not a case occurred among the citizens at a time when there were hundreds of cases among the soldiers. In time of peace, however, the part played by drinking-water in the occurrence of typhoid is very great. Instances might be multiplied indefinitely to prove this point, and among these instances perhaps the best examples have occurred in the military service, and particularly in the French army. For the year 1886, among the French troops, the number of cases of typhoid fever amounted to somewhat over 14 per thousand strength. In 1894 it had been reduced to slightly less than 6 per thousand strength; the result being obtained by an almost progressive yearly decrease. In 1895 the Minister of War reported that in 29 garrisons formerly extremely subject to typhoid fever, in each of which an uncontaminated supply of drinking-water had been provided, there had followed an almost total disappearance of this disease, and the few isolated cases which occurred were shown to have originated outside the barracks. In those cases in which a new water supply had been provided and the water was drunk unfiltered, epidemics followed from time to time on the contamination of the source and disappeared after the introduction of Pasteur filters. At Avesnes, after the installation of these filters, 105 cases in 1891 became, for the next three years, only 1 annually. At Auxerre, 129 cases in 1892 were reduced to 1 each in 1893 and 1894. At Melun, 122 cases in 1889 fell to 7.4 for the following five years. At this last post, in February, 1895, 28 dragoons were suddenly attacked, the infantry battalion in the same barracks having not a case. Investigation showed that the Pasteur filters had been allowed to freeze, and the soldiers had been ordered to drink only the weak infusion of tea, in which the water had been boiled, furnished them. While the infantry had obeyed, the dragoons had not, and had helped themselves to the Seine water from the hydrants.

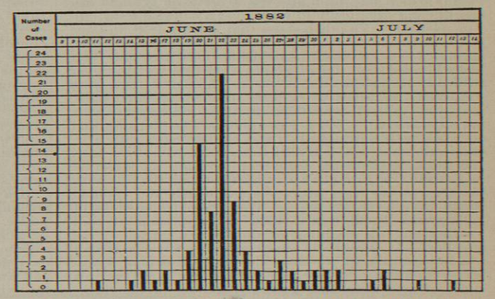

FIG. 1088.—Course of Typical Water-Borne Epidemic of Typhoid Fever, Occurring in the Garrison at Wittenberg, Germany. (After Gaffky.)

At Cherbourg, with a previous annual average of 114.5 cases, the installation of Pasteur filters in 1890 reduced the cases to 28, 8, 11, 3, and 3 in the succeeding five years. At Dinan, with a previous annual average of 278 cases, the installation of Pasteur filters in 1890 reduced the number of cases to 1, 2, 3, and 1 respectively during the next four years. At Lorient, until 1889, there was a yearly average of 170 cases of typhoid fever among the garrison. In 1890 filters were set up, with the result of a decrease to 58 in that year, while the three following years numbered 2, 1, and 1 respectively. In 1894 water was brought into the barracks at this station from a spring supposed to be pure, and 11 cases of typhoid shortly appeared. On examination the water was found to be contaminated, and the disease practically ceased to exist among the garrison upon its disuse. Viry states that of 194 epidemics of typhoid fever occurring in garrisons of the French army during the period January 1st, 1887, to January 1st, 1890, no less than 187 of them could be directly associated with a "defective, doubtful, mediocre, or infected water supply." Many instances of the relation of typhoid fever to drinking-water of bad quality have occurred in our own army. At Jefferson Barracks the typhoid which prevailed endemically at that station diminished greatly when a purer supply was substituted.

Except in rare instances, examination of a water supply during an epidemic of typhoid has failed to reveal the specific germ of this disease. It has, however, usually determined the presence of the bacillus coli communis, showing the probability of infection with typhoid discharges. In character, an epidemic of typhoid due to an infected water supply will be marked by the suddenness of the outbreak and the simultaneous occurrence of a large number of cases. The accompanying diagram (Fig. 1088) typically illustrates the course of a water-borne epidemic. As in most places the water supply soon regains its purity, no increase subsequently may be anticipated unless a second infection of the water supply occurs. In typhoid spread by other means than water, as in camp epidemics, the onset of the epidemic is gradual. With each case additional sources of infection are developed, and the prevalence of the disease steadily increases as long as efficient preventive measures are not taken and there is an abundance of susceptible material.

Among articles of food, milk is not infrequently contaminated with typhoid germs from infected water which may have been added to it or used to wash the dairy utensils. Many other articles of food which are eaten uncooked are liable to spread the disease, especially vegetables. Recently an epidemic of typhoid fever occurred in the Insane Asylum at Northampton, Mass.,