[4] Grünfeld: Real-Encyclop., Bd. ii., p. 613.
[5] Centralblatt f. Harnk., 1897, p. 354.
[6] Art. Bubo, Quain's Dict.
[7] Ven. Dis., p. 479 (fourth edition).
[8] Rindfleisch: *Loc. cit.*, p. 172.

BUBO PLAGUE.—(Synonyms: The Pestilence, or Pest; the Black Death; the Plague of Egypt; the Oriental, Levantine, Indian, or Pali Plague [Máhámari]: Adeno-Nervous Fever, Typhus Pestilentialis, Malignant Polyadenitis, Pestis Bubonica, etc.)

DEFINITION.—The bubo plague, or more briefly, the plague, is a disease which at times is widely disseminated, and which consists of a single paroxysm of acute, infectious, and contagious, febrile disorder. It is characterized clinically by a sudden onset, short course, great mortality, and, specifically, by the occurrence of carbuncles, ecchymoses, and petechiæ upon the general surface, and occasionally by gangrenous inflammation of the lungs, more commonly by the development of glandular swellings, tending to suppurate, in the inguinal and axillary regions and exceptionally elsewhere in the body. The plague is endemic in certain localities, notably those bordering on the eastern shore of the Mediterranean Sea and in the Oriental countries adjacent thereto. Occasionally it extends widely as an epidemic, especially along the great paths of commerce to other parts of the world, even to the Arctic zone, thus becoming pandemic. It is apt to prevail particularly during certain seasons of the year.

Discovery of the Specific Cause in the Bacillus Pestis.—The plague bacillus was discovered by Kitasato in an investigation of an outbreak at Hong-Kong made by direction of the Japanese Government and published in 1894 under the auspices of the University of Tokio. Yersin and Roux, by independent research, which was made almost coincidently with that of Kitasato, also discovered the same micro-organism. The plague bacillus is a short bacterium or coccobacillus, almost as broad as long, measuring about 2 μ in its greatest diameter. As the bacteriological characters of the plague micro-organism have been discussed in the article on *Bacteria*, in Vol. I., it will be necessary here merely to call attention to a few facts of especial interest from the clinical standpoint. This bacillus pestis enters the human body with great facility, and rapidly multiplies after its introduction. It is found generally in the contents of the alimentary canal, in the blood, in the interior of organs, and especially in lymphatic glands, and in the discharges from buboes. While possessing extreme virulence in its action upon the animal organization, its own resisting power to chemical disinfectants is feeble. Carbolic acid in weak solution (one per cent.), or even lime water, will render it innocuous. Experiments made recently in the laboratory of the United States Marine Hospital Service at Washington, D. C., have demonstrated the fact that it is easily destroyed by all of the ordinary disinfectants. It dies in four days, if kept at a dry heat of 60° C. (140° F.), or in half an hour if subjected to a temperature of 80° C. (176° F.), and in a few minutes if subjected to a heat of 100° C. (212° F.). On the other hand, it develops easily in many culture media at the ordinary temperature—18° to 22° C. (64.4° to 71.6° F.). It loses its virulence by drying, and retains its virulence only when subject to the action of moderate heat and moisture. Dr. Walter Wyman, Surgeon-General of the Marine Hospital Service, in a recent official report on the bubonic plague, from which this statement is taken, gives a succinct account of the disease as it has come under the notice of his department. As regards its causation, he says: "The presence of organic matter, animal or vegetable, and in a state of decomposition, would seem to furnish the most favorable nidus for its growth, which will account for its more prolonged existence in Oriental countries and the comparative rarity of its appearance in Europe since the existence of modern and improved hygienic conditions. This does not mean, however, as was maintained by some at the Venice conference, that filth and crowding are alone responsible for the disease. The malady is pre-eminently of bacterial origin, and wherever the microbe is found, there the plague is likely to develop. The length of its life, when exposed to favorable conditions outside of the human body, has an important bearing upon the quarantine measures necessary to be enforced, particularly with regard to merchandise from an infected port." From a number of experiments made to determine the temperature and time required to kill the bacillus outside of the human body (according to the report of the German Plague Commission as quoted by Bowhill), "the longest time that infected material as lint, wadding, earth, etc., remained active was eight days. Sputum, from patients affected with the pneumonic form, kept in a vessel plugged with cotton wool, was no longer virulent in sixteen days. In ordinary drinking water the bacilli die in three days, in sterilized water in eight days, and in sterilized bilge water in five days. The bacilli are killed by drying at ordinary room temperatures in four days, according to Bowhill. The bacillus of plague is found in the dust of infected houses and in the soil, which has been contaminated by discharges from the body. It is also found in the bodies of domestic animals and vermin which dwell in infected houses and which die in great numbers during an epidemic. It is believed that mice, rats, dogs, beetles, flies are important factors in communicating contagion. The results of the study of the flagellate parasite of the rat's blood, the *trypanosoma*, by Rabinowitsch and Kempner,* establish the fact that fleas are the active agents of communication of this form of hæmatozoon infection. It is probable, in a similar manner, that fleas, especially in the Orient, convey the plague bacillus, especially as dogs and rats are so commonly infected at an early stage of the epidemic. In a recent paper, Professor Galli-Valerio, of the University of Lusonne, combats the idea that the particular flea, which is parasitic in the rat, can be instrumental in conveying the infection of bubonic plague directly to man. In experiments made upon himself, he was unable to obtain any evidence that this flea (*Typhlopsylla musculi*) will remain upon the body of a man unless under compulsion, or that it will puncture the skin of man. Surgeon-General Sternberg, U. S. Army, in a recent article in which this reference is found, says that "he admits, however, the possibility that plague might be transmitted from man to man by the well-known domestic flea (Pulex irritans)." As plague bacilli have been found in the intestinal contents of the rat's flea, it is possible that this parasite may after all play an active and important part in disseminating the plague among the rats and other inferior animals, and also contribute its quota toward causing infection of house dust which mingles with food and drink of man.

Nosology and Clinical Forms.—The terms plague, pest, pestilence, the Black Death, la Grande Mortalité, and similar popular names have in the past been applied without discrimination to every form of epidemic disease attended by great mortality. In early times, therefore, epidemics of erysipelas, hemorrhagic or black measles, cerebro-spinal fever, typhus, and other infectious diseases, even leprosy, have been confused in the public mind and in the medical records with the bubo plague, and it is difficult, if not impossible, to declare at this late day, in some instances, exactly what form of infectious disease was responsible for the epidemic in question. By degrees, however, as knowledge of pathology and diagnosis increased, the term plague has, by exclusion, come to be understood as applying solely and only to the disease now under discussion. Therefore, whenever the word plague is used in this article it means the bubo plague, or malignant polyadenitis.

It has been observed and should be borne in mind that the clinical manifestations following infection with the plague bacillus may be modified to a certain extent by natural causes or attending circumstances, social as well as meteorological, so that the symptoms may not be identical in form in different countries or in different

* Zeit. für Hygiene u. Infektionskrank., 1899, xxxi., p. 251, and Journal Amer. Med. Assn., April 28th, 1900.

epidemics. Thus the black death, which ravaged Europe in the fourteenth century, presented features which, in the minds of some nosologists, create a doubt as to its really being an instance of the bubo plague. When we recall the sanitary, or rather horribly unsanitary condition of most European countries at that time, and the mode of living which then prevailed, we may find sufficient reason for some modification of the symptoms of the plague as known at the present day. Dr. J. C. Wilson,* from whose able summary of the literature of the plague this remark was extracted, also states that a like difference of opinion exists in regard to the relationship between the Indian or Pali plague, which has from time to time prevailed in Northwestern India during the present century, and the true plague. The black death of the fourteenth century and the Pali plague, though presenting many of the characteristics of bubo plague, differ from it, while they resemble each other in one important particular. Among the earlier and more common symptoms of note are those dependent upon gangrenous inflammation of the lungs, a lesion, according to Hirsch, extremely rare in bubo plague. This author informs us that recent observations have fully confirmed the early opinion that the Pali plague differs from that of the Levant chiefly in this modification, and cites Pearson and Francis as saying of the former disease that "the collective symptoms are more like those of plague than of any other known disease. . . . We believe it to be in all essential particulars identical with the plague of Egypt."

Clinically, the cases of plague have been grouped according to their severity into three classes: (1) The typical, ordinary, or grave cases. (2) The fulminating cases. (3) The abortive, or larval, cases.

Adopting the usual basis of classification by systematic writers, which is more in accordance with the semeiology and pathology, we have: 1. The bubonic or gangli-onic form. 2. The pneumonic form. 3. The septicæmic form.

"Of these forms," says Wyman, "the bubonic is the most common, the pneumonic the most fatal. The method of infection—that is to say, the point of entrance of the specific microbe—is a point still under active discussion, and is different not only for the various types and forms given, but also varies in different countries and in different sections of the same country. For example, in Hong-Kong, where the natives as a rule go barefooted, infection, in a large number of cases, has been traced to abrasions and wounds of the lower extremities. In India, some covering or protection for the foot is usually worn, but the natives suffer from the bites of insects and vermin; consequently the point of entrance of the infection has been largely upon the hands and arms. Infection through the intestinal tract, while admitted, is as yet largely unexplained; for in spite of the assertions of Wilm, some breach of continuity would seem to be necessary for the entrance of the micro-organism. As a rule, a small red spot marks the point of infection; this becomes successively a vesicle and a pustule, and in the ganglionic form, and in a large proportion of cases, a general redness, or a series of vesicles, marks the passage of the infection along a lymphatic tract or channel. These vesicles have been of very frequent occurrence in the Bombay epidemic."

Essential Character of the Disease.—At the present day, plague is classed as a contagious miasmatic disease (Liebermeister) in a group with enteric fever, cholera, epidemic dysentery, etc. Up to the seventeenth century, the plague was commonly ascribed to moral causes, as a visitation of the wrath of an offended higher power upon the people for their sins, or to some evil combination of the stars, which were supposed to preside over the health of man. It was Sydenham who first clearly pointed out the true nature of the disease and showed that it was like other disorders and therefore due to purely natural causes. In opposition to the ancient belief that the epidemic was produced by some atmospheric or meteorological condition, or hypothetical "epidemic constitution of the atmosphere," Sydenham acutely observed that infection either from a sick person or some fomites or infected clothing is an essential prerequisite to the outbreak. While maintaining the teachings of experience that changes of the atmosphere and the season of the year do affect the prevalence of epidemic diseases, and that, in point of fact, the plague itself is more apt to prevail in summer and the early fall in the temperate zone, and to diminish to a minimum in the winter, he insists that still something more is necessary. In his medical observations (chap. ii.) on the "Pestilential Fever and the Plague of the Years 1665 and 1666 as it Appeared in London," he remarks:* "I am far from denying that a statement made by several authors, as to the plague having originated during periods of the year other than that mentioned above, may be possible. The fact, however, is a rare one, and when it takes place, the ravages of the disease are less. . . . On the other hand, I have grave suspicions that the mere atmospheric condition, however much λοιμώδης (*loimodes*, Gr., from *loimo*, the plague), is by no means sufficient in and of itself to originate plague. Either the disease itself must continue to survive in some secret quarter, or else, either from some *fomes*, or from the introduction from pestilential localities of an infected person, it must have become extended. And, even in these cases, it cannot become epidemic, except with the conditions of a favorable atmospheric diathesis. Except upon this principle, I cannot comprehend how, of two towns near each other, and under the same conditions of climate, the one shall be grievously afflicted with the plague, the other be wholly free, and that by merely cutting off all communication between itself and the place infected. Yet this was done not many years ago, through the care and foresight of the Grand Duke Ferdinand II., who effectually stopped on the borders of Tuscany a plague that devastated nearly the whole of the remaining parts of Italy."

Former Epidemics.—It is probable that epidemics of plague raged prior to the dawn of history, since as far back as our records extend we meet with references to pestilences, which recall the features of this form of epidemic disease. Manetho, an Egyptian historian, who lived at the beginning of the third century B.C., described pestilences, resembling the plague, which ravaged the valley of the Nile during the reign of the most ancient Egyptian kings. The early Jewish writers of the Bible refer repeatedly to the plague as a visitation upon the people for various acts of disobedience. Zechariah (xiv. 12–18) refers, about 487 B.C., to a plague that shall "smite all the people who have fought against Jerusalem," and "the heathen that come not up to keep the Feast of Tabernacles"; but the description given does not agree with the clinical features of bubonic plague. "Their flesh shall consume away while they stand upon their feet, and their eyes shall consume away in their holes, and their tongue shall consume away in their mouths," which rather applies to an affection like leprosy than to an epidemic disease such as the plague. In fact, in Leviticus, the "plague of leprosy" receives a great deal of attention. Some confusion has arisen from the fact that the Hebrew word translated plague means "a smiting," and was applied to various kinds of disease without much discrimination, with either moral or medical signification. It has been recently stated,† with much appearance of probability, however, that the bubo plague is referred to in the Bible at a date more than eight hundred years previous to the hitherto accepted record, which has generally been dated 300 B.C. Drs. F. Tidswell and J. A. Dick, in a communication presented to the Royal Society of New South Wales, have furnished evidence to show that the plague of 1141 B.C., described in the First Book of Samuel (chaps. iv.–vi.), was true bubo plague. After the Philistines had captured the Ark of the Covenant, and taken

* "The Plague." Pepper's "System of Practical Medicine," by American Authors, Philadelphia, 1885, p. 771.

* Sydenham Society's edition of the works of Thomas Sydenham, M.D., London, 1848, p. 101.
† Nature, March 22d, 1900.

it to Ashdod, severe illness broke out among the people. "The hand of the Lord was heavy upon them of Ashdod, and he destroyed them and smote them with emerods." The Ark was afterward taken to Ekron, and here again we are told, "There was a deadly destruction throughout all the city, . . . and the men that died not were smitten with the emerods, and the cry of the city went up to heaven." The word "emerod," on account of similarity of spelling and sound, has usually been taken to mean hemorrhoids, but in the Revised Version of the Old Testament it is stated to mean "tumor," or "plague boil." The epidemic in Philistia occurred at the time of the regular plague season, and mice are mentioned in connection with it, which furnishes additional evidence that the epidemic was plague, for a connection has been clearly established between the death of rats and the plague, at Bombay and elsewhere, as has been already mentioned.

Thucydides described a plague which prevailed in Athens from 439 to 432 B.C., and reappeared again eighteen months later. Acron of Crotona is said to have dissipated the cause of this plague by means of fires kept burning in the streets. During this epidemic, Athens lost more than one-third of its population. Thucydides himself suffered with the disease, and Hippocrates noted it, in the aphorism, "All fevers complicated with buboes are bad, except ephemerals." Dr. Adams, the translator of the Sydenham Society's English edition of Hippocrates, mentions the curious omission of all allusion to the contagiousness of certain diseases by Hippocrates, although his contemporary, Thucydides, in describing the plague, expresses himself in such terms as put it beyond doubt that he regarded the disease as being of a contagious nature. Not the least reference to contagion, in any shape, is to be found in any of the Hippocratic treatises.

Plague was epidemic in Libya, according to Rufus of Ephesus, in the third century B.C. The great plague reported by Livy, who died 221 B.C., is said to have destroyed a million persons in Africa; no records remain, however, of its extension to Europe. The earliest account in the Christian era of a great epidemic of the plague is furnished by Procopius. This outbreak began in the year 542 in Egypt, from whence it extended to Palestine, Syria, and Persia; it then passed from Asia Minor into Europe, at Constantinople, where it carried off ten thousand victims in one day (543 A.D.). From this as a centre the plague, becoming pandemic, spread in all directions, carrying death and destruction in its train. It is estimated that shortly before the close of the sixth century fifty per cent. of the inhabitants of the Eastern empire had perished, either directly from the plague or indirectly from the destitution and disturbance of society incident upon the plague. This epidemic, known as the Justinian plague, is of historical importance, as the disease at this time established itself in Europe, where it maintained a foothold for more than a thousand years. In the seventh century it appeared in England. The fourteenth century again witnessed the spread of the plague from the East, whence it extended throughout Armenia, Asia Minor, Egypt, Northern Africa, and nearly the whole of Europe. In all the epidemics of this century, Hecker calculates that one-fourth of the entire population of Europe, or 25,000,000 persons, perished. R. B. Anderson ("America Not Discovered by Columbus") says that "the black plague reduced the population of Norway alone from 2,000,000 to 300,000." It was during this period that Venice took measures to check the spread of the plague and appointed three guardians of the public health charged with this duty. In 1403 there was opened the first quarantine establishment on a small island adjacent to Venice. In the fifteenth century the plague recurred frequently in nearly every part of Europe, the mortality being not less than 40,000. During the sixteenth century the epidemic continued. In 1572 50,000 died at Lyons, in 1576 Venice lost 70,000. In the seventeenth century occurred the great plague of London (1664 and 1665) of which Sydenham, Defoe, and Mr. Pepys wrote. It is said to have proved fatal to one-third of the population, or more than 68,000 inhabitants of this metropolis.

In 1656 it raged for five months in Naples, causing the death of 300,000 people. This, however, was the last extensive outbreak of the plague in Italy, as the great epidemic in London in 1665 was its final appearance in England previous to the occurrence of some isolated cases last year. In France, it still lingered in the provinces until 1668, although malignant epidemics had ceased several years before. In the early part of the eighteenth century two outbreaks occurred in Europe. The first spread from Turkey, through Hungary, to Russia, Norway, and Sweden, and thence along the Baltic to the Netherlands, coming to an end in 1714. Six years later, the last great outbreak on the European continent took place. It prevailed in Marseilles in virulent form, costing the lives of from 40,000 to 60,000 people in this one city alone. In 1721 it appeared in Toulon and spread over Provence, carrying off 87,000 out of a population of less than three times that number. In 1743 Sicily was attacked, the mortality at Messina being between 40,000 and 50,000. In 1771 nearly a quarter of the population of Moscow died of it, or more than 50,000 people. In the century just ended the plague has been confined principally to the East, although during the second and third decades repeated outbreaks occurred in the Balkan peninsula and the regions bordering on the lower Danube and the Black Sea. In 1815 it appeared on the Eastern coast of Italy, but was restricted to a small district. This was its final appearance in that country. A small epidemic was observed in Greece in 1828. The plague appeared in Malta in 1813, and in 1816 it extended to certain of the Ionian islands. Again, in 1820, the plague appeared at Majorca, whither it had been brought from the Barbary coast. Owing to favorable conditions on the coast of Northern Africa the plague has repeatedly appeared at Tunis and Algiers, and has generally shown a tendency to linger. The plague of 1784 lasted for fifteen years. Between the years 1816 and 1821 the disease again manifested itself in these cities, and again in epidemic form in 1836 and 1837. In 1835 there was an outbreak of such degree of severity in Cairo that the deaths equalled in number the entire adult population. Subsequent to this it ceased to prevail to any extent in Africa. It disappeared from Asia Minor, Syria, and Palestine in 1843, and from Egypt in 1844. Reports of the presence of the plague from time to time were made from Dalmatia (1840), Constantinople (1841), Canary Islands (1852). Since 1850 the disease has oscillated now east, now west, between the Red Sea and the Pacific, in China, India, Arabia, Persia, Mesopotamia, Russia, Caspian Sea, Afghanistan, Tripoli. There have been since 1850 but nineteen years when it was not recorded in one or the other of these countries.

For a short period, near the middle of the last century, nothing was heard of the plague, and it seemed unlikely that there would be any repetition of the periods of extensive prevalence, or pandemics, which had characterized the disease in former times. It is true that after a season of great scarcity of food in the northwestern provinces of India, the plague appeared in 1815 and continued until 1821, reappearing in 1836, and again in 1837 in Pali, and that, according to Hirsch, it has never disappeared entirely from the southern slopes of the Himalayas since 1823, where it has raged at an altitude of 16,300 feet. Its ravages in these mountain districts have been so great that some settlements have been wholly destroyed. The last outbreak to occur on European soil was that of 1878 and 1879, upon the banks of the Volga. Tropical Africa has never suffered from the plague.

The Present Epidemic.—In 1892 the Chinese Government, in the course of some military operations, moved certain stores and materials by caravan, from Yunnan, which was the endemic focus of the disease, to Longtcheu. The disease made its appearance in the latter place in 1893, and was thence conveyed by trading junks to Canton and Hong-Kong, in which cities it was recognized as epidemic plague in 1894. From Hong-Kong it was conveyed by sea to Bombay, Kerachee, and Poonah. Wyman estimates that as a result of this epidemic outbreak there were 220,907 cases in Bombay presidency alone, with

the enormous mortality of 164,083. It also prevailed in Calcutta, Amoy, Formosa, Alexandria, and the port of Kobe in Japan. In 1899, Nieuchwang, in China, was invaded, and the epidemic soon gained a foothold, the domestic animals dying in great numbers and infecting the surroundings and the soil. It again made its appearance in Europe in Oporto, Portugal, in August, 1899. Some not well-authenticated cases at Plymouth and Southampton, England, have been reported within the past few months by the public press as having occurred, but through the vigilance of the sanitary authorities the disease has not been able to extend its influence outside of the small area directly connected with the shipping. There has been noticed, however, at Southampton an epidemic among dogs which was so fatal and infectious that in a short time the town was nearly cleared of its canine population. From this source the disease has since spread to many other parts of England, and the epidemic is receiving much attention from the veterinary physicians.* In October, 1899, the plague appeared at Santos, Brazil. This outbreak, as noted by Wyman, marks an important epoch in plague literature, as furnishing the first recorded instance of the occurrence of the disease in the Western hemisphere. The outbreak occurred after the arrival of a ship from the infected port of Oporto, which lay alongside the dock in Santos, and within a short time there was an extensive mortality in July and September among rats, preceding the appearance of cases among human beings. On the 18th of November, 1899, the British steamship *J. W. Taylor*, from Santos, arrived at the quarantine station, New York, with two cases of bubo plague on board, and reported having lost one man at sea from the same disease. Owing to the prompt and effective action of the United States quarantine officials in disinfecting the ship and cargo, no spread of the disease occurred. A few suspicious cases in the Chinese quarter have occurred at San Francisco, Cal., but as the sanitary authorities were alert and took the necessary steps to control the disease, no communication from these cases has been observed.†

The recent acquisition of the Hawaiian Islands and the Philippines by the United States, among other advantages, has given us the rather questionable one of having the first veritable epidemic of plague in territory under our flag. In the latter part of December, 1899, plague broke out in the Chinese quarter of the city of Honolulu. As a result of the most vigorous measures for its extinction, including the application of the torch (with the unexpected result of the destruction of a large portion of the city), the deportation of the population from the infected quarter, and the establishment of a cordon preventing all communication between them and those outside, the epidemic has not spread, and as a result of thorough disinfection comparatively few cases have since occurred. The plague subsequently broke out with decided virulence among the filthy huts of the Chinese quarter of Manila. The military authorities, however, at once adopted active measures to prevent its spreading and to limit its course. The St. Petersburg plague board reports recently that bubo plague is prevalent in Assyr, Mecca, and Jeddah, and that, accordingly, last year's Mussulman pilgrimage to Mesopotamia was prohibited. A report from Major Blair D. Taylor, United States Army, in regard to the progress of plague in Honolulu, dated January 15th, 1900, states that up to that date there had been 34 cases, with 27 deaths. The following week there were 12 new cases and 6 deaths. Plague has disappeared from Kobe, Japan, but is active in Osaka, taking the form of a lung disease which proves very fatal. At the present time the epidemic of 1899–1900 seems to be on the decline in the East and has gained no foothold in Europe or America. General Wyman believes that, with the rigid application of the ordinary principles of sanitary science and with the means now at our disposal for the prophylaxis and cure of the malady, it seems extremely doubtful if the plague will ever secure a decided foothold in the United States.

Accidental Propagation.—Incidental to the recent outbreaks of the plague was the unfortunate communication of the disease to several physicians who were engaged in making bacteriological investigations. The Japanese Commissioner Aoyama, who accompanied Kitasato to Hong-Kong in 1894 by direction of the Japanese Government, contracted the disease by inoculation incurred during a post-mortem examination, but fortunately recovered, although one of his assistants died of disease contracted in the same manner. More recently, in 1898, the disease appeared in Vienna, in Professor Weichselbaum's institute, in which inoculation experiments were carried on upon guinea-pigs with material obtained from Bombay by a commission appointed by the Imperial Academy of Sciences of Vienna. Dr. Müller, who was a member of the commission, unfortunately fell a victim to his zeal for science, and a laboratory attendant named Barisch also died; two nurses were also attacked by the disease. The commission was successful in restricting the spread of the disease by adopting extremely active measures. The *Lancet* for October 29th, 1898, states that "as soon as the first case of plague was clearly recognized, the plague commission permanently closed Professor Weichselbaum's institute. All the animals used for experiments were killed and cremated, and the drains of the institute were disinfected. Dr. Nothnagel's clinic was cleared and disinfected, and the medical men and nurses belonging to it were isolated; the public were refused access to the General Hospital; all the medical men and the nursing staff were kept indoors, and some supposed febrile cases were transferred, from the institute and Professor Nothnagel's clinic, to the Infectious Hospital. Barisch's wife and brother were also admitted to the Infectious Hospital and received prophylactic treatment." These measures were completely successful, and abruptly terminated an outbreak that had startled the entire civilized world.

The Disease in Lower Animals, and their Agency in Spreading the Plague.—Concerning the matter of the part played by the lower animals in spreading the epidemic, our knowledge is still incomplete. Dr. Sticker, of the Vienna Commission, states that rats and mice are active carriers of the contagion. Preliminary experiments have shown that pigeons, hens, geese, and swine are insusceptible to the disease, while dogs, cats, sheep, goats, cows, and horses react to the infection by at least a transitory morbid state that ends in recovery. Monkeys are highly susceptible, especially the so-called sacred ape, and they may play an important part in the epidemics of India. Surgeon-General Sternberg, in reference to this subject, says: "We have learned that certain of the lower animals, including rats and mice, are very susceptible to infection, and that they play an important part in the propagation of the disease, also that the germs are found not only in the blood and in pus from suppurating buboes, but also in the discharges from the bowels of infected individuals. This being the case, it can readily be seen how important a strict sanitary police is in arresting the spread of an epidemic. As in other filth diseases in which the germ is present in the excreta of the sick, insects, and especially fleas and house flies, probably play an important part in the spread of the disease."*

Modifying and Predisposing Agencies.—Poverty, filth, physical and social wretchedness have become so generally recognized as predisposing causes to the plague that Cabiadis termed it *miseriæ morbus*, thus perpetuating a name given to the plague of 1665, in London, which was called "the poor's plague" (Wilson). The bad hygiene observed in the poorer class of dwellings, especially in tropical countries, not only favors the propagation of the epidemic by vermin, as already mentioned, but it also lowers the vital resistance of the individual and renders him more liable to infection than if he belonged to a grade

* Journal of the Amer. Med. Assn., March 3d, 1900, p. 568.
† *Ibid.*, March 24th, 1900, p. 763.

* "History and Etiology of the Bubonic Plague," Philadelphia Med. Journ., April 7th, 1900.

higher in the social scale. The season of the year has some influence upon the development and course of the plague, but it has been remarked that the influence is not the same in different countries. The epidemics in London reached their height in midsummer and declined in the fall months. In Constantinople also the disease becomes dormant in winter and becomes active as the summer heat increases. In the epidemics of extreme Northern Europe, the disease has been equally prevalent in winter and in summer, while they lasted. Egypt and Mesopotamia, however, follow a different course; in Cairo the epidemics have always ceased upon the recurrence of the hot weather of June.

A marshy soil is favorable to the spread of plague, repeated outbreaks having occurred in the valley of the Nile, the marshy regions of the lower Euphrates and along the Caspian and Black seas; but dampness and low elevation are not essential, since it has flourished in the mountainous districts of Arabia and on the slopes of the Himalayas, at a great elevation. Both sexes and all ages are liable to the infection, although young adults furnish the greater number of victims. Depressing influences, especially debilitating diseases, increase the individual susceptibility. Occupation has little influence, although it has been observed that oil carriers, dealers in oils and fats, and, to a less degree, water carriers and bath attendants are less liable to contract the disease than others. It is noted by Dr. N. F. Arnold, U. S. N., that those inhabitants of Chinese cities in which epidemics are in progress who live in boats suffer little. This is probably due to the fact that communication between the rats and other animals inhabiting them and those of the land is not easy (*Philadelphia Med. Journ.*, April 7th, 1900, p. 789). The plague is to a certain extent self-protective; second attacks, if they occur, are of less severity than were the first.

Incubation Period.—The period of time which elapses between exposure to infection and the development of the disease is comparatively short. Prus, in a report drawn up for the French Academy of Medicine in 1844, declared that the plague had never shown itself among compromised persons after an isolation of eight days. It appears that from three to six days is about the rule. Cabiadis sets the incubation stage at three days, but occasionally it lasts only twenty-four hours. Hirsch, from observations on the Astrakhan epidemic, concluded that the average period was five days, very short or very long periods being seldom observed. Recent observations by Haffkine and Simond agree in showing that the incubatory period may be as short as twelve hours, but, on the other hand, that, in a number of cases observed in a detention camp, over six per cent. occurred as late as the ninth day, and 1.73 per cent. as late as the eleventh day. Wyman justly remarks that this point has an important bearing on quarantine measures at ports of arrival, for it does not bear out the theory that the period of incubation is such that all cases which are to occur will occur on the voyage, since a fair proportion of the cases developed in a period which exceeds the average duration of a trans-Atlantic passage in these days of fast ships.

Relative Danger of Propagation by Fomites and Merchandise.—With regard to the transmission of the disease by fomites and the dangers of spreading an epidemic by merchandise from an infected locality or from a ship having plague on board, it is fortunate that the vitality of the bacillus, apart from the animal body, is limited, its virulence being rapidly lost under conditions of heat, light, exposure to sun and to the air. In fact, this is in accord with every-day laboratory experience, where the greatest difficulty is found in keeping cultures of the plague bacillus in virulent condition. Wyman further says that "under ordinary conditions of laboratory growth, in the presence of uniform temperature, on favorable nutrient media, and kept from the influence of strong light, a culture of the plague bacillus, virulent to rabbits, will in two or three days so deteriorate that it is no longer pathogenic for the very susceptible mouse. Passage through the bodies of animals, repeated at short intervals, seems to be necessary to preserve the virulence of the bacillus. These conditions removed, its viability is short, and it either perishes altogether or becomes a saprophytic organism. It therefore would seem justifiable, in the present state of our knowledge, to assert that the relative danger from merchandise as a carrier of infection is slight, and that the greatest danger is to be apprehended from mild cases of the disease, unrecognized, little dangerous in themselves to the person having it, but as capable of spreading virulent contagion as is mild varioloid of communicating and imparting a virulent, fatal type of smallpox."

SYMPTOMS.—Of the three varieties or clinical forms of the plague which are usually recognized, (1) the bubonic, (2) the pneumonic, and (3) the septicæmic, the former is the most frequent and may be considered as the type. In cases of this ordinary grave or *bubonic form* we have present a highly contagious fever, setting in suddenly, attended with constipation, with a rapid, feeble pulse, with dizziness and delirium, with injected eyes, with a dry tongue, with noises in the ears and deafness, with defective urinary secretion, with starting of the tendons, with watchfulness or stupor, and with red patches and purple spots scattered over the surface of the body. Such is the graphic language used in describing the disease by Da Costa, to which he adds (as distinguishing it from typhus), nausea and vomiting, a pale face, an alarmed despairing look of the countenance, hæmoptysis, and, above all, the buboes and carbuncles in different parts of the body, and the clearing mind when they manifest themselves. Moreover, the disease is of much shorter duration than typhus. Death generally takes place between the third and the fifth day, or convalescence sets in on the sixth or the seventh day, or early in the second week. It may, however, be protracted by a long-continuing suppuration of buboes.

J. C. Wilson divides the course of the attack into four stages: (1) invasion, (2) intense fever, (3) fully developed localizations, (4) convalescence. The first stage is ushered in by a feeling of lassitude with pains in the loins and extremities. Extreme bodily debility, fulness and throbbing pain in the head, with dizziness and mental weakness, are complained of. The patient's expression is dull and stupid, and he responds but slowly or awkwardly to questions. His face is pale, eyes languid, his gait weak and staggering, as if inebriated. No distinct rigor is noticed, but shivering occurs, and nausea, vomiting, and diarrhœa may appear early. This stage begins suddenly and may last from a few hours to a day or more. It is followed by the febrile stage, which may be ushered in by a chill, more or less severe but commonly the latter. The lassitude and headache now become more marked. The temperature rises to 102°–104° F., or, exceptionally, to 107.6° F. The pulse is rapid, 120 to 130, the skin hot and dry, and the patient complains of fever and thirst. The eyes become sunken and injected as the case continues, the tongue is coated with a grayish pasty mass, the teeth and lips are covered with sordes, the vomiting often continues. Active and noisy delirium, with great restlessness, or mild delirium, tending to stupor or coma, now appears. Bloody crusts collect on lips and nostrils. The pulse grows feeble, small, often very irregular, the lips become bluish, the extremities cold, and there is impending collapse. The enlargement of glands may now be noticed, with tenderness and swelling of the superficial lymphatic vessels. A sudden fall of temperature, often to several degrees below the normal, now occurs, frequently attended by a profuse, strong-smelling sweat. The pulse falls to 100 or below, and the mind clears.

The third stage is characterized by suppuration and great enlargement of the glands of the groin, or upper part of the thighs, less frequently in the axilla or near the angle of the jaw. As this usually does not occur in fatal cases, suppuration is looked upon as favorable. The buboes may appear as early as the second day, sometimes as late as the fifth day, exceptionally they are absent altogether. Carbuncles, though less common than buboes, are also likely to appear at this stage, especially

on the legs, buttocks, or the back of the neck, but they are not necessarily fatal, as the slough may soon separate, the gangrene being of limited extent. Boils also are occasionally seen. The appearance of petechiæ is regarded as unfavorable; they may be detected only in the neighborhood of the buboes, or may appear in great numbers all over the body, giving the cadaver a livid hue (from which character the name black death probably was derived). Extensive ecchymoses may also appear just before death.

The fourth stage, that of convalescence, begins about from the sixth to the tenth day, and may be delayed by prolonged suppuration or by relapses. Among special features to be noted among this class of cases is the matter rejected from the stomach, which at first is simply gastric mucus with bile or later a coffee-colored fluid; hæmatemesis may occur. Bleedings from the nose, lungs, bowels, vagina, and bladder have also been observed. Such cases generally terminate fatally. The urine may contain albumin and blood, hyaline and granular casts are commonly found; it also frequently contains indican; the quantity voided is diminished or suppressed in grave cases. The temperature record is not characteristic: it remains at 102–103.5° F. for about three days; it then becomes nearly normal or subnormal, and may rise again, if septic processes supervene. The blood becomes leucocythæmic, but the red cells are not diminished in number. The blood contains the plague bacillus, in the great majority of cases. In some, especially early in the epidemic, the disease progresses with such intensity and rapidity that the characteristic symptoms have not time to develop; the whole duration of the attack is only a few hours. In this, which is called the fulminant form, convulsions and coma, with the rapid formation of petechiæ and vibices, precede the fatal termination. This form is most likely to occur in the aged.

The *pneumonic form* of plague occurs principally in India. Whereas, in the ordinary bubonic form, the infection apparently enters the body by means of some wound, abrasion, or bite of an insect, in this form the lungs appear to be the door of entrance. Pneumonic plague cases occurring during an ordinary epidemic, according to Harris and Arnold,* are all fatal, usually within the first four days, and without any other symptoms than fever, cough, bloody expectoration, pain in the chest, and the symptoms of the digestive and circulatory disturbance noted above.

The *pneumonic form* was prominent in the epidemic known as the black death. Dr. Calmette reports that he has observed it in the recent epidemic in the city of Oporto, Portugal, and that in pulmonary plague there are no buboes, but the cases are marked at the outset by a profound depression of the vital powers, by violent vomiting, cadaveric paleness, a rapidly failing pulse, and death within a few hours. W. C. Hossack, in the *British Medical Journal*, February 10th, 1900, described a peculiar form of plague pneumonia. Its onset is insidious, and at the end of five or ten days the symptoms may be very little marked, while the physical signs are scarcely recognizable. Intelligence is unaffected, head symptoms are wanting, and death, when it comes, is apt to be quite unexpected. The pulse is the most important diagnostic point; it is disproportionately quick and feeble. As a rule, there are no enlarged glands, unless late in the disease, and every case proves fatal. They are recognized, by Hossack, as a form of pneumonic plague. What has been termed the *septicæmic form* is regarded, by Sternberg and others, as a secondary phenomenon, which occurs only in very severe and usually fatal cases. Arnold says that a bare ten per cent. of all cases will reach the septicæmic stage. Such cases as present no buboes have probably received infection either through the respiratory, genito-urinary, or digestive passages. The same observer reports having seen several cases that presented conclusive evidence of the last mode of inoculation.

* "Bubonic Plague with Clinical Notes," Philadelphia Med. Journ., April 7th, 1900.

In cases of the ordinary type an early symptom is the presence of pain and tenderness on pressure in the inguinal region. The onset is often marked by convulsive tremor or shivering, without sensation of cold, a staggering gait, confusion of mind, dizziness and headache, with a dull expression of countenance, great prostration, and rapid appearance of typhoid state. In children, cervical adenitis is more common than inguinal.

From personal observation of the plague in London in 1665 and 1666, Dr. Sydenham furnished the following clinical description:

"The first attack is almost invariably ushered in by chills and rigors (such being also the accession of intermittent fevers), which are followed by violent vomiting, by pain in the region of the stomach, like that of the pressure of a screw, burning fever, and its usual crowd of concurrent symptoms. These affect the patient without intermission, until either death itself or else the favorable breaking out of buboes or of parotid abscesses. Hereby the morbific matter becomes eliminated, and relieves them from the appalling crises.

"Occasionally it happens that the disease lights upon the patient without any premonitory signs of fever whatsoever, so that, even whilst engaged in his common business, a man may be suddenly struck down,—an eruption of crimson blotches being the only forerunner of his quickly coming death. It is important, however, to remark that death, thus sudden, rarely happens, except during the beginning of epidemics of more than ordinary severity. In years when the disease has been sporadic, and during its remissions and decline, they have never been observed. It happens also that at times tumors may break out without either fever or any other important symptom as their precursors; although I suspect, for my own part, that chills or shivers, in some slight degree or other, and more or less perceptible, invariably precede. Those to whom this happens may walk about in public as usual, and attend to the common duties of life like healthy men, taking no thought of regimen."

The German National Board of Health has issued recently a circular to physicians, containing official instructions regarding the plague, from which the following graphic description is extracted:*

The outbreak of the disease proper is preceded by lassitude, depression, pains in the lumbar region, increased thirst, and diminished appetite. It frequently begins quite suddenly. Stinging, burning, or dull pains at the point which corresponds then or later to the bubo, the inflammation of the glands or the pneumonia, may be the first manifestations of the disease, soon accompanied by chilliness amounting to a rigor, and consecutive fever. The latter may exist for several hours or days before the local manifestations develop. The commencement of the disease is almost invariably accompanied by a sensation of vertigo in the head, which may increase to resemble a severe intoxication, with the external indications of extreme stupor, and loss of control over the limbs, and then pass away. Nausea or vomiting frequently accompanies the vertigo. When the patient reaches the physician the clinical picture in severe cases is usually fully developed. The patient produces the impression of a drunken man: the vacant stare; the face bloated, flabby, expressionless; the extremely bloodshot eyes; the thick, stammering speech, and uncertain, staggering gait. This impression is enhanced by the abrasions and bumps caused by the stumbles and falls of the patient. The tongue looks as if it were whitewashed with lime, or is occasionally red and knobby like a raspberry. The skin is dry over the entire body and burning hot, or it is merely hot on the face and trunk, while the pulseless limbs are already cold and covered with a sticky sweat. The respiration is labored or sighing; the heart beat is much accelerated; the arteries are relaxed; the radial pulse is dicrotic, full or already thready, near extinction, while the heart beat is still vigorous. Put to bed, the patient lies dormant in extreme ex-

* Münchener med. Woch., January 2d, and Journal Am. Med. Assn., February 3d, 1900.