assume that the position which an air-ship ought to occupy should be such that its major axis may make with the line of the wind an angle of several degrees.

After the experiments we have just described, we stopped the motor, and the balloon passed over Mont-Valérien. Once, when it had taken the direction of the wind, we began again to turn the screw, proceeding this time with the current. The speed of the balloon was increased, and by means of the rudder we were now easily able to turn to the right or left from the line of the wind. We proved this by taking, as before, some point on the surface; and several spectators also verified it.

At thirty-five minutes past four we made the descent in a large plain near Croissy-sur-Seine. The operation of landing was conducted by my brother with great success. We left the balloon inflated over night, and the next day it had not lost the least gas. Painters and photographers were enabled to obtain views of our air-ship, which was surrounded by a numerous and sympathetic assembly which the novel sight had attracted from all sides.

We had intended to make a new ascent on this day: but, on account of the cold of the night, the bichromate of potassium in our ebonite tanks had crystallized; and the battery, which was by no means exhausted, was on this account, however, incapable of action. We drew the balloon to the shore of the Seine, near the bridge of Croissy; and there, to our great regret, we were obliged to discharge the gas, and to lose in a few instants what had required so much care in its preparation.

Without describing in greater detail our return, we have concluded from this first trial that, 1°, electricity furnishes a balloon with the most convenient power, the management of which in the car is remarkably easy; 2°, in our own case, when our screw, 2.8 metres in diameter, made a hundred and eighty revolutions per minute, we were able to keep head to a wind moving three metres per second, and, when proceeding with the current, to deviate from the line of the wind with great ease; 3°, the mode of suspension of a car from an elongated balloon by means of bands running obliquely, and supported by flexible side-shafts, insures perfect stability to the whole.

We ought to say that our ascent of Oct. 8 should be considered only as a preliminary trial, which will be repeated with the alterations which our experience commends. In addition, we would mention that there was in the car a considerable excess of ballast, and that eventually it will be possible for us to use a much more powerful motor. Aerial navigation will not be made practicable through a single attempt: it will require many trials and efforts and great perseverance under every ordeal.

(*To be continued.*)

THE DISCOVERY OF THE GERM OF SWINE-PLAGUE.

IN a communication read before the Paris academy of sciences, Nov. 26, 1883, by M. Pasteur, the following paragraph occurs: —

"As soon as I received his [Thuillier's] first letters from the commune of Peux, in the department of Vienne, it was certain that he had perceived in the blood and humors of the dead hogs a new microbion which it seemed should be the author of the disease. This microbion had escaped the observation of Dr. Klein of London, in the course of a long and remarkable account of autopsies and experiments published three years before in the report of the English sanitary office. Dr. Klein stated that a microbion was the cause of the affection; but he committed an error, for the microbion that he described has no connection with the cause of *rouget*. Thuillier by his observation had overcome the principal difficulty to a knowledge of this disease of the hog. Historic truth, however, obliges me to declare, that in 1882, and also in the month of March, the microbion of *rouget* was signalled at Chicago, in America, by Professor Detmers, in a paper which does great honor to its author. Thuillier could not have been acquainted with this paper, and I myself only learned of its existence very recently. The observation of the microbion of *rouget* of the hog by Thuillier dates from the 15th of March, 1882."[1]

It is so very seldom that investigations on this side of the water receive any notice whatever abroad, and particularly in France, that it seems a pity even to call attention to the very great injustice done to American work in the above statement, since any recognition at all is so much better than being quietly ignored. There is, however, so much of general interest in regard to the gradual development of our knowledge of the germ of this disease, so much of interest in the success and failures of those who have worked upon it, that, aside from our desire to see history correctly written, there is sufficient incentive for tracing the progress of this study, which commenced when the first real light was breaking upon the germ-theory of disease.

Dr. Klein deserves more credit for his share in the discovery of the micrococcus of swine-plague than M. Pasteur seems inclined to grant. In 1876 he published one of the first, if not the very first, reliable microscopic studies of this disease. The care and skill shown in this investigation are more apparent to-day than when the details were first published; and, although he subsequently made the unfortunate mistake of attributing the cause of the disease to a bacillus, this fact should not be allowed to weigh against his former and really valuable researches.[2]

In his account of the microscopic appearances of the intestine, the following sentence occurs: —

"From and even before the first signs of necrosis of the mucosa, viz., when the epithelium begins to break down and be shed from the surface, there are found masses of micrococci, which in some ulcers occupy a great portion of the *débris*."[3]

A little farther on he says, —

"There is one more point which I believe deserves careful attention. In the ulceration of the tongue just mentioned, and at a time when the superficial scab has not become removed, I have seen masses of micrococci situate chiefly in the tissue of the papillae, but at some places reaching as far deep as the inflam-

[1] *La vaccination du rouget des porcs à l'aide du virus mortel atténué de cette maladie.* PASTEUR et THUILLIER. *Comptes rendus*, xcvii. p. 1164.

[2] Report on the so-called enteric or typhoid-fever of the pig, by DR. KLEIN. In Reports of the medical officer of the privy council and local government board. New series, No. VIII. Report to the Lords of the council on scientific investigations, etc., 1876, pp. 91–101.

[3] Loc. cit., p. 98.

mation extends. That they are micrococci was proved by their forming lumps of uniform granules; these lumps stain deep purple-blue in haematoxylin, and are thus very conspicuous, and besides resist the action of caustic potash, with which all the rest of the tissue disappears. These heaps of micrococci in locality correspond to the papillae, and are on the surface of the scab, but underneath the covering epithelium, some parts of this having changed into a dry, hard, discolored mass, others containing larger or smaller vesicles filled with fluid."[1]

In the examination of the respiratory organs we are given even stronger evidence for connecting these organisms with the cause of the disease. In the mucous membrane of the anterior surface of the epiglottis, which was only slightly inflamed in its submucous tissue, he found —

"Lymphatic vessels filled with micrococci. . . . In the infiltrated, firm, more or less disintegrating parts [of the lung] I find great masses of micrococci filling up capillaries and veins, and also contained in lymphatics around arteries.[2] . . . The pleura is much swollen, and contains great numbers, continuous layers, of lumps of micrococci. The free surface of the membrane is in many parts covered with them. The exudation fluid is also charged with them as has been mentioned above."[3]

We have here the record of the unbiassed *savant* seeking after the truth, and describing what he sees without any attempt to draw conclusions or build up theories. It was before Koch's brilliant investigations, identifying the Bacillus anthracis as the active principle in charbon virus, had seen the light. There was still the greatest doubt as to whether the contagia were essentially animal cells, vegetable organisms, or chemical poisons. It would have been premature to have presented the micrococci at that time as the cause of the disease, though it is evident from these observations that they existed in the tissues of the body before the death of the animal. We have consequently two questions to consider in an inquiry of this kind; viz., (1) Who is entitled to priority for discovering and demonstrating the presence of micrococci in the tissues and liquids of diseased animals? and (2) Who was first in proving the connection between the micrococci and the essential constituent of the virus?

It seems very evident that Dr. Klein discovered the micrococci as early as 1876, but it is equally evident that his investigations were not sufficient to show that this parasite was the cause of the disease. The fact that from later observations, of an entirely different nature, he attributed the cause to another organism, surely can at this day detract nothing from the merits of the paper from which I have just quoted; and it must consequently be acknowledged as a matter of historical truth, the data of which are fully recorded, that Klein discovered the micrococci of swine-plague long before they were seen by Pasteur and Thuillier.

We can now pass to a brief consideration of the investigations which were intended to connect certain organisms found in the tissues or liquids of diseased and dead animals with the cause of the disease.

In 1878 a second and very elaborate report was made by Dr. Klein,[4] in which he gives experiments that are supposed to demonstrate the pathogenic nature of a specific bacillus found in certain liquids of diseased hogs, and cultivated for several generations in the aqueous humor from rabbits' eyes. Coming so soon after the publication of Koch's remarkable studies of the life-history of the anthrax bacillus, and agreeing so closely with them in all important respects, it is scarcely to be doubted that the earlier conclusions had more or less influence in shaping the later ones. While it might be interesting to the specialist to enter into details in regard to the defective methods of cultivation used, the unsatisfactory results of the microscopic examination of the tissues and fresh liquids for the bacilli, and the still more unsatisfactory results of the inoculation experiments with the cultivated organisms, our space will not permit this at present. In behalf of a most indefatigable worker, however, I would call attention to the fact that this mistake of Klein's was not so extraordinary as it may appear to many to-day, because the methods of cultivating and studying disease-germs have to a large extent been perfected since that time.

In the same year a number of persons were appointed by the U. S. commissioner of agriculture to investigate the disease known in this country as hog-cholera. The greater part of these served but two months; but Dr. Detmers, having reported the discovery of the disease-germ, was allowed to continue his investigations. In his first report, Dr. Detmers stated that the disease was caused by a bacillus, which he named Bacillus suis, because the same, so far as he was able to learn, was peculiar to and characteristic of swine-plague.[1] He saw micrococci, but regarded them as bacillus germs: indeed, he states that he constantly observed one of these under the microscope while it "budded, and grew to double its length, in exactly two hours."[2]

This report of Dr. Detmers, coming so soon after Klein's, and attributing the virulence to a bacillus of substantially the same characters as that described by Klein, while the latter's micrococci were made to do duty as bacillus germs, — a relation which had been previously ascribed to them by the medical officer in his 'preliminary note,' though it was not suggested by the English investigator himself, — did much to confirm the bacillus theory, and to convince scientific men that the parasite of another contagious fever had actually been isolated, and its connection with the disease demonstrated.

In January, 1880, M. Mégnin published the results of a microscopic examination of the blood in this disease, in which he described and figured a micrococcus.[3] This organism existed in single granules, and also in clusters and chains, and agreed so closely with one subsequently studied by me that I reproduced the drawings of it in connection with my report written the following December.[4]

[1] Loc. cit., p. 99. [2] *Ibid.*, p. 100. [3] *Ibid.*, p. 101.

[4] Report on infectious pneumo-enteritis of the pig (so-called pig-typhoid), by Dr. E. Klein, F.R.S. Report of the medical officer of the local government board. London, 1877 and 1878, pp. 169-290.

[1] Department of agriculture. Special report, No. 12, 1879, p. 42.

[2] Loc. cit., p. 53.

[3] Recueil de médecine vétérinaire, 1880, pp. 36, 37.

[4] Department of agriculture. Special report, No. 34, pp. 80, 81, plate IX.

In his second report,[1] Dr. Detmers does not seem to have materially modified the views referred to above, though he had been studying the disease during the whole of another year. In discussing accepted classifications in his supplemental report, he says, —

"All, however, seem to agree, that those Schizomycetes classed by them under the name of 'Bacillus' do not form clusters or colonies (rasen, zoogloca-masses, gliacoccus, orcocoglia), and do not undergo metamorphoses from globular to rod-shaped Schizomycetes, two things decidedly characteristic of the microscopic parasites of the Schizomycetes family as found in swine-plague; consequently the name adopted, Bacillus, was not well chosen and is not suitable."[2]

As I have shown elsewhere,[3] the two points referred to would not exclude an organism from the genus Bacillus. The best-known bacilli certainly develop from resting spores of an oval form, as seen under the microscope: some of these spores approach very closely to the globular; and, if they should be perfect spheres, the classification would not be affected in the least. The other point — that an organism, multiplying as a micrococcus, after a time develops into a rod-shaped body — is an idea, that, although it is persistently pressed in some quarters, has never been accepted by the best authorities, and is no more true of the organism in question than of other forms of micrococci, as I have assured myself by long series of cultivations. The fact of greatest importance to the present inquiry is, that up to this time Dr. Detmers considered the organism of swine-plague to be rod-shaped in its developed form. This supplemental report, in which the first doubts are expressed in regard to the organism being a real bacillus, was dated six weeks after the appearance of Mégnin's paper, and was not distributed for seven or eight months subsequent to this. It is to be remembered, also, that in none of the above investigations were any sufficient precautions taken to exclude atmospheric germs from the liquids examined, and no pure cultivations were made. It was therefore a matter of considerable doubt whether the organisms described were really in the blood as it circulated in the living animal, or whether they were introduced *post mortem*.

The third report of Dr. Detmers bears the date of Dec. 4, 1880.[4] In this it was stated that the "swine-plague Schizophytae present themselves in different shape and form." The simplest form is that of a micrococcus. The second form is bispherical: the spherical cell has grown and become contracted, or indented in the middle, forming two united granules.

"These bispherical Schizophytae are always more or less numerous, are either at rest or moving, and usually provided at one end with a flagellum or post-flagellum, which, however, is so exceedingly fine that I have never seen it except with the $\frac{1}{15}$ homogeneous immersion objective of Tolles, and an amplification of over 1,500 diameters, and then only while the Schizophytae was moving."[5]

[1] Department of agriculture. Special report, No. 22, pp. 13-67.
[2] Loc. cit., p. 60. [3] Special report, No. 34, p. 68.
[4] Special report, No. 34, pp. 153-195. [5] Loc. cit., p. 187.

He then goes on to describe the formation of a chain of bispherical elements, and mentions the existence of zoogloea masses as well. He had not yet given up the rod or bacillus form: for he states that in the blood and pleural exudation, when a day or two old, and sometimes while yet fresh, rod-shaped bacteria can be observed; and it appears probable that the same constitute another form of the swine-plague Schizophytae.[1]

The same volume contained a report of mine in which are detailed certain experiments and observations on the schizophytes peculiar to this disease. In this report was given a description of the first successful attempts, as I believe, to demonstrate what micro-organisms, if any, existed in the blood and other liquids of living hogs sick with swine-plague. To keep the liquids to be examined free from all suspicion of contamination, vacuum tubes were prepared by drawing to a point the two ends of a small piece of glass tubing about a fifth of an inch in diameter. A drop or two of water was then aspirated into this tube, boiled to secure a vacuum, and the ends immediately sealed. The tube was now heated to redness to destroy any bacteria spores that might still be in it, and it was ready for filling with the virulent liquid. In use, a very sick hog was killed, a vein laid bare, sometimes before the animal was quite dead, the vacuum tube was passed through the flame of an alcohol lamp, the finely drawn-out end forced into the vein and broken across its walls, when it would immediately fill, and was sealed in the lamp as soon as withdrawn.[2] It is plain that such tubes could be preserved indefinitely for examination without any suspicion of atmospheric contamination. The only change that could occur would be due to a continued multiplication, — a kind of cultivation of the organisms which had existed in the blood of the living animal.

Three separate outbreaks of swine-plague at widely separated points were investigated; and in every one, I found, by the method of study just referred to, that the virulent liquids contained micrococci, single, and in chains and clusters, but never rod forms, except in those cases where the tubes did not fill well, or where they were imperfectly sealed. And blood from the most perfect of these tubes, which contained no visible organisms but micrococci, produced unmistakable and severe cases of swine-plague in inoculated animals.[3] These were the first experiments in which the virulent material, preserved free from suspicion of atmospheric contamination, was shown to contain but a single species of schizophytes; and they were consequently the first which indicated any connection between the micrococci and the essential cause of this disease.

In his fourth report, Dr. Detmers states positively that some of the swine-plague organisms develop a lasting spore, and are changed into a helobacterium.[4] But there is no account of any measures adopted to decide which of the forms observed in the impure liquids examined had existed in the body of the

[1] Loc. cit., p. 188. [2] *Ibid.*, p. 22. [3] *Ibid.*, pp. 23, 24.
[4] Department of agriculture. Annual report, 1881 and 1882.

living animal; nor was there any substantial reason given for considering the helobacterium as belonging to the same species as the micrococci, or, if they happened to be different, which, if either, was able to cause the disease.

The same volume contains my report bearing the date of Jan. 27, 1882. In this are details of successful inoculation experiments with the sixth pure cultivation of micrococci which had been obtained and cultivated with every precaution known to science at the present day.[1] It was the first real evidence of the pathogenic action of these organisms. It was equally satisfactory with the experiments of MM. Pasteur and Thuillier; and the inoculations were made Jan. 17, 1881, or fourteen months before the discovery of this same organism by these gentlemen.

The communication of Dr. Detmers, referred to by M. Pasteur, appeared in the *American naturalist* for March and April, 1882, and was a *résumé* of his studies for the department of agriculture. In this article he still thinks there is just cause to suppose that the organism of swine-plague has a helobacterium, or rod form, and a resting spore. There are, however, no new observations or experiments referred to, there is no additional proof that the micrococci seen by him were not the result of atmospheric contamination, — nothing to show that a pure cultivation of these would produce the disease. On the other hand, the organism which he describes possesses a flagellum, and a moving stage or period, neither of which have I been able to observe with the true germ of this disease, nor with the closely allied micrococcus which causes fowl-cholera.

It is a matter of record, therefore, that the organism which constitutes the cause of swine-plague was first discovered by Klein in 1876, but that he failed to connect it in any way with the virus of the disease, and afterwards concluded that it depended upon a very different schizophyte. It is also a matter of record that I was the first to demonstrate by satisfactory methods that this micrococcus exists in the blood during the life of the animal, that it can be cultivated in flasks, and that the sixth successive cultivation, made in considerable quantities of liquid, and which contained no other form than micrococcus, still produced the disease. Neither Pasteur and Thuillier, nor any other investigators that I am aware of, have added one particle of evidence, except by way of confirmation, to that previously advanced by me. M. Pasteur is usually very particular in giving credit, but he does not seem to be keeping up with the progress of American science. D. E. SALMON.

MIGRATION OF BIRDS IN ENGLAND.[2]

THE general report of the committee of the British association, of which this is in fact an abstract, comprises the observations taken at lighthouses and lightvessels, and a few special land-stations, on the east and west coasts of England and Scotland, the coasts of Ireland, Isle of Man, Channel Islands, Orkney, and Shetland Isles, the Hebrides, Faroes, Iceland, and Heligoland, and one Baltic station (Stevns Fyr, on Stevns Klint, Zealand), for which the committee is indebted to Professor Lütken of Copenhagen. Altogether, a hundred and ninety-six stations have been supplied with schedules and printed instructions for registering observations, and returns have been received from about a hundred and twenty-three, — a result which is very satisfactory, showing, as it does, the general interest taken in the work, and the ready co-operation given by the lightkeepers in assisting the committee.

As in preceding years, the line of autumn migration has been a broad stream from east to west, or from points south of east to north of west, and covering the whole of the east coast. In 1880, to judge from the returned schedules, a large proportion of the immigrants came in at the more southern stations; in 1881 they covered the whole of the east coast in tolerably equal proportions; but in 1882 the stations north of the Humber showed a marked preponderance of arrivals. Altogether, a vast migration took place this year upon our east coast; the heaviest waves breaking upon the mouth of the Humber, Flamborough Head, the Farne Islands, Isle of May at the entrance to the Firth of Forth, and again, after missing a long extent of the Scotch coast, at the Pentland Skerries. The Bell Rock also came in for a share, although apparently a much smaller one than the Isle of May. The easterly winds prevailed all along our east coasts, generally strong to gales; and the succession of south-easterly and easterly gales in October, between the 8th and 23d, occurring as they did at the usual time of the principal migration, brought vast numbers of land-birds to our shores. From the Faroes in the north, to the extreme south of England, this is found to have been the case.

Although migration — that is, direct migration — on our east coast is shown to have extended over a long period, commencing in July, and continuing, with but slight intermissions, throughout the autumn and into the next year to the end of January, yet the main body of migrants appears to have reached the east coast in October, and of these a large proportion during the first fortnight in the month. From the 6th to the 8th inclusive, and again from the 12th to the 15th, there was, night and day, an enormous rush, under circumstances of wind and weather, which, observations have shown, are most unfavorable to a good passage. During these periods, birds arrived in an exhausted condition; and we have reasons for concluding, from the many reported as alighting on fishing-smacks and vessels in the North Sea, that the loss of life must have been very considerable. Large flights, also, are recorded as having appeared round the lanterns of lighthouses and lightvessels during the night migration. From the 6th to the 9th inclusive, strong east winds blew over the North Sea, with fog and drizzling rain; and from the night of the 12th to 17th very similar weather prevailed. Mr. W. Littlewood, of the Galloper lightship, forty miles south-east

[1] Loc. cit., pp. 267–269.

[2] Report of the committee of the British association for the advancement of science, appointed for the purpose of obtaining observations on the migration of birds at lighthouses and lightships, and of reporting on the same. (From *Nature*.)