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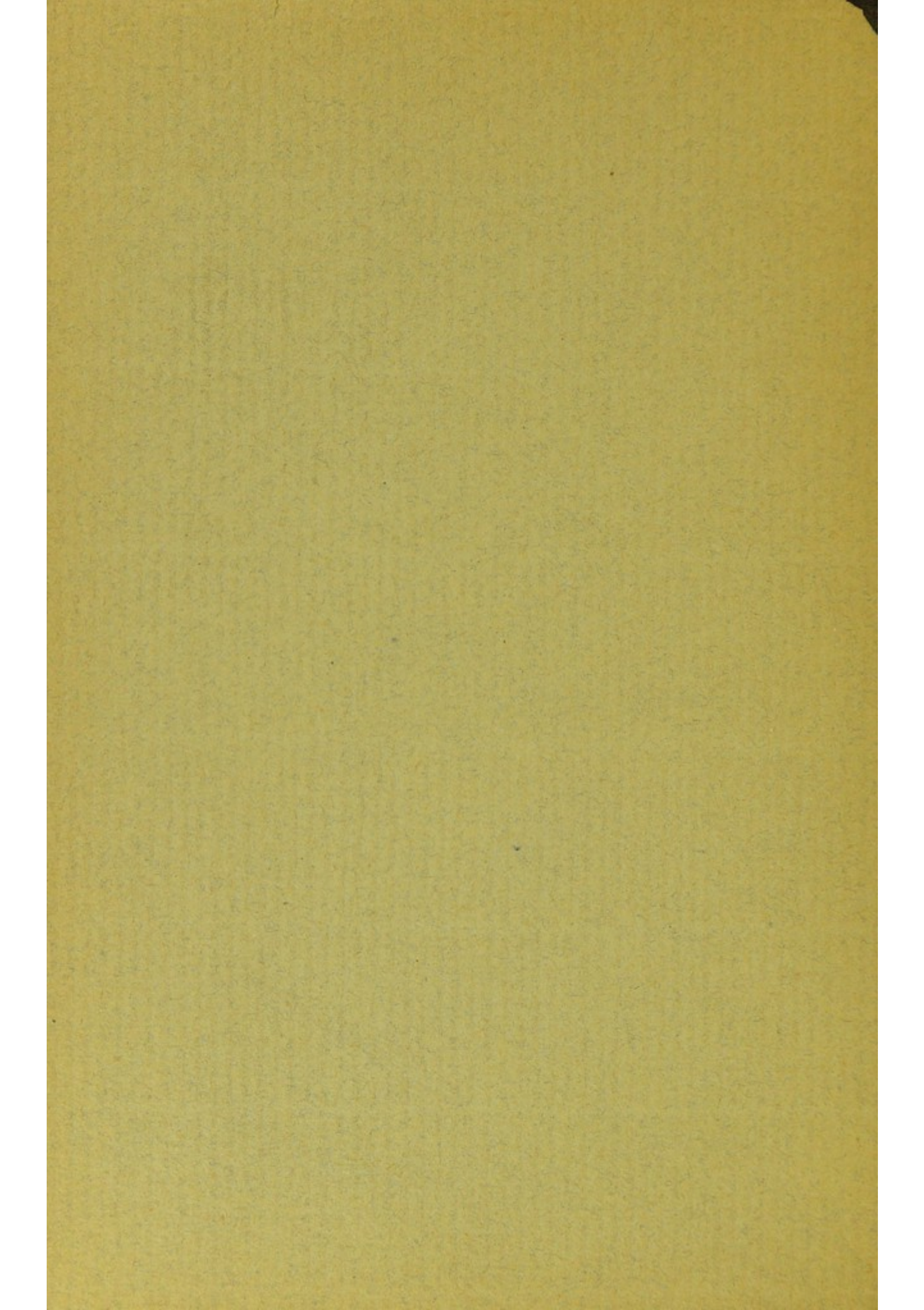
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WALTER REED.

A MEMOIR.

WASHINGTON, D. C.

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WALTER REED.

A MEMOIR.

It is given to but few scientific men to lay bare a secret of nature materially affecting the prosperity of nations, and the lives, fortunes and happiness of thousands. Fewer still succeed in so quickly convincing brother scientists and men in authority of the truth of their discoveries that their own eyes behold the glorious result of their labor.

Of the fifty-one years of Walter Reed's industrious, blameless life, twelve only were spent in the study of the special branch of science in which he became famous, but his name now stands with those of Jenner, Lister and Morton, as among the benefactors of humanity.

Walter Reed was born in Gloucester County, Virginia, September 13, 1851, the son of the Rev. Lemuel Sutton Reed and Pharaba White, his wife.

The circumstances of his family were modest, and some of the years of his boyhood were spent in a much troubled section of the south during the great civil war. He acquired, however, a good preliminary education, and at an age when most boys are still in the schoolroom, he began the study of medicine at the University of Virginia, graduating as M. D. in 1868, when only seventeen years old.

A second medical degree was received later from Bellevue Medical College, New York, and then came terms of service in the Brooklyn City Hospital, and the City Hospital, Blackwell's Island.

Before the age of twenty-one, Reed was a district physician in New York city, and at twenty-two one of the five inspectors of the Board of Health of Brooklyn.

He entered the Army of the United States as Assistant Surgeon with the rank of First Lieutenant, in 1875, and for the next eigh-

teen years, with the usual varying fortunes of a young medical officer of the army, he served in Arizona, Nebraska, Dakota, and in the Southern and Eastern States.

According to the exigencies of the service he was moved frequently from station to station, everywhere recognized by men of his own age as a charming and sympathetic companion, and by older officers as an earnest and intelligent physician, whose industry, fidelity to duty, and singularly clear judgment, gave brilliant promise for the future. In the poor cabins and dugouts of the pioneers in the sparsely settled districts where he served his flag, Reed was ever a messenger of healing and comfort. At that time army posts on the frontier were usually remote and with small garrisons. The young medical officer, generally the only one at the station, was called upon by the settlers for miles around. Without help, and with only such instruments and medicines as could be hastily stuffed in his saddle-bag, he was summoned to attend a fractured thigh, a child choking with diphtheria, or, most trying of all, a complicated child-birth.

Such experience schools well in self-reliance, and in the formation of quick and accurate observation.

For a man like Reed, already an earnest student, no better preparation could perhaps have been had. His earlier army service must have singularly tended to develop in him the very qualities most necessary to his final success. To the end of his life it was noticeable that even when he had long given up the practice of medicine for the work of the laboratory, he was nevertheless unexcelled at the bedside for rapid unerring diagnosis and sound judgment in treatment. So also were the series of experiments which robbed yellow fever of its terrors especially remarkable for simplicity, accuracy, and completeness, or they never would have so quickly convinced the world of their truth. Too much reverence for accepted teachings, and too little experience in grappling with difficulties unassisted, and they might never have been conceived or carried out.

In 1890, he was assigned to duty in Baltimore and remained there over a year. Here he had the great advantage of working in the laboratories of Johns Hopkins University and the happiness of winning the close friendship of his distinguished teacher, Prof. William H. Welch.

In 1893, Reed was promoted surgeon with the rank of Major, and in the same year was detailed in Washington as Curator of the Army Medical Museum and Professor of Bacteriology at the newly organized Army Medical School. Here he worked industriously at his specialty and wrote many valuable monographs, all characterized by accuracy and originality. His excellent judgment made him especially valuable in investigating the causes of epidemic diseases at military posts, and in making sanitary inspections. He was, therefore, frequently selected for such work, which with his duties as teacher and member of examining boards, occupied much of the time that he would otherwise have spent in his laboratory. Here again it seems that duties which must often have been irksome were specially fitting him for his culminating work.

During the Spanish-American war the camps of the volunteer troops in the United States were devastated by typhoid fever, and Major Reed was selected as the head of a board to study the causation and spread of the disease. This immense task occupied more than a year's time. With the utmost patience and accuracy the details of hundreds of individual cases were grouped and studied. The report of the commission, now in course of publication by the Government, is a monumental work which must always serve as a basis for future study of the epidemiology of typhoid fever.

The most original and valuable work of the board is the proof that the infection of typhoid fever is spread in camps by the common fly, and by contact with patients and infected articles, clothing, tentage and utensils, as well as by contaminated drinking water.

In June, 1900, Major Reed was sent to Cuba as president of a board to study the infectious diseases of the country, but more especially yellow fever. Associated with him were Acting Assistant Surgeons James Carroll, Jesse W. Lazear, and A. Agramonte.

At this time the American authorities in Cuba had for a year and a half endeavored to diminish the disease and mortality of the Cuban towns, by general sanitary work, but while the health of the population showed distinct improvement and the mortality had greatly diminished, yellow fever apparently had been entirely unaffected by these measures. In fact, owing to the large number of non-immune foreigners, the disease was more fre-

quent than usual in Havana and in Quemados near the camp of American troops, and many valuable lives of American officers and soldiers had been lost.

Reed was convinced from the first that general sanitary measures alone would not check the disease, but that its transmission was probably due to an insect.

The fact that malarial fever, caused by an animal parasite in the blood, is transmitted from man to man through the agency of certain mosquitoes had been recently accepted by the scientific world; also several years before, Dr. Carlos Finlay, of Havana, had advanced the theory that a mosquito conveyed the unknown cause of yellow fever, but did not succeed in demonstrating the truth of his theory.

Dr. H. R. Carter, of the Marine Hospital Service, had written a paper showing that although the period of incubation of yellow fever was only five days, yet a house to which a patient was carried did not become infected for from fifteen to twenty days.

To Reed's mind this indicated that the unknown infective agent has to undergo a period of incubation of from ten to fifteen days, and probably in the body of a biting insect.

Up to this time the most generally accepted theory as to the causation of yellow fever was that of Sanarelli, who claimed that the *Bacillus icteroides* discovered by him was the specific agent of the disease. Major Reed, in association with Dr. Carroll, had, however, already demonstrated that this bacillus was one widely disseminated in the United States, and bore no special relation to yellow fever.

In June, July and August, 1900, the commission gave their entire attention to the bacteriological study of the blood of yellow fever patients, and the post-mortem examination of the organs of those dying with the disease. In twenty-four cases where the blood was repeatedly examined, as well as in eleven carefully studied autopsies, *Bacillus icteroides* was not discovered, nor was there any indication of the presence in the blood of a specific cause of the disease.

Application was made to General Leonard Wood, the Military Governor of Cuba, for permission to conduct experiments on non-immune persons, and a liberal sum of money requested for

the purpose of rewarding volunteers who would submit themselves to experiment.

It was indeed fortunate that the military governor of Cuba was a man who by his breadth of mind and special scientific training could readily appreciate the arguments of Major Reed as to the value of the proposed work.

Money and full authority to proceed were promptly granted, and to the everlasting glory of the American soldier, volunteers from the army offered themselves for experiment in plenty, and with the utmost fearlessness.

Before the arrangements were entirely completed, Dr. Carroll, a member of the commission, allowed himself to be bitten by a mosquito that twelve days previously had filled itself with the blood of a yellow fever patient. He suffered from a very severe attack, and his was the first experimental case. Dr. Lazear also experimented on himself at the same time, but was not infected. Some days later, while in the yellow fever ward, he was bitten by a mosquito and noted the fact carefully. He acquired the disease in its most terrible form and died a martyr to science, and a true hero.

No other fatality occurred among the brave men who, in the course of the experiments, willingly exposed themselves to the infection of the dreaded disease.

A camp was especially constructed for the experiments about four miles from Havana, christened Camp Lazear in honor of the dead comrade. The inmates of the camp were put into most rigid quarantine and ample time was allowed to eliminate any possibility of the disease being brought in from Havana.

The personnel consisted of three nurses and nine non-immunes, all in the military service, and included two physicians.

From time to time Spanish immigrants, newly arrived, were brought in directly from the immigrant station; a person not known to be immune was not allowed to leave camp, or if he did was forbidden to return.

The most complete record was kept of the health of every man to be experimented upon, thus eliminating the possibility of any other disease than yellow fever complicating the case.

The mosquitoes used were specially bred from the eggs and kept in a building screened by wire netting. When an insect was wanted for an experiment it was taken into a yellow fever hospi-

tal and allowed to fill itself with the blood of a patient ; afterward at varying intervals from the time of this meal of blood it was purposely applied to non-immunes in camp.

In December five cases of the disease were developed as the result of such applications ; in January, three, and in February, two, making in all ten, exclusive of the cases of Drs. Carroll and Lazear. Immediately upon the appearance of the first recognized symptoms of the disease, in any one of these experimental cases, the patient was taken from Camp Lazear to a yellow fever hospital, one mile distant. Every person in camp was rigidly protected from accidental mosquito bites, and not in a single instance did yellow fever develop in the camp, except at the will of the experimenters.

The experiments were conducted at a season when there was the least chance of naturally acquiring the disease, and the mosquitoes used were kept active by maintaining them at a summer temperature.

A completely mosquito-proof building was divided into two compartments by a wire screen partition ; infected insects were liberated on one side only. A brave non-immune entered and remained long enough to allow himself to be bitten several times. He was attacked by yellow fever, while two susceptible men in the other compartment did not acquire the disease, although sleeping there thirteen nights. This demonstrates in the simplest and most certain manner that the infectiousness of the building was due only to the presence of the insects.

Every attempt was made to infect individuals by means of bedding, clothes, and other articles that had been used and soiled by patients suffering with virulent yellow fever.

Volunteers slept in the room with and handled the most filthy articles for twenty nights, but not a symptom of yellow fever was noted among them, nor was their health in the slightest degree affected. Nevertheless they were not immune to the disease, for some of them were afterward purposely infected by mosquito bites. This experiment indicates at once the uselessness of destroying valuable property for fear of infection. Had the people of the United States known this one fact a hundred years ago, an enormous amount of money would have been saved to householders.

Besides the experimental cases caused by mosquito bite, four non-immunes were infected by injecting blood drawn directly from the veins of yellow fever patients in the first two days of the disease, thus demonstrating the presence of an infectious agent in the blood at this early period of the attack.

Even the blood serum of a patient, passed through a bacteria proof filter, was found to be capable of causing yellow fever in another person.

The details of the experiments are most interesting, but it must here suffice to briefly sum up the principal conclusions of this admirable board of investigators of which Reed was the master mind :

1. The specific agent in the causation of yellow fever exists in the blood of a patient for the first three days of his attack, after which time he ceases to be a menace to the health of others.

2. A mosquito of a single species, *Stegomyia fasciata*, ingesting the blood of a patient during this infective period is powerless to convey the disease to another person by its bite until about twelve days have elapsed, but can do so thereafter for an indefinite period, probably during the remainder of its life.

3. The disease can not in nature be spread in any other way than by the bite of the previously infected *Stegomyia*. Articles used and soiled by patients do not carry infection.

These conclusions pointed so clearly to the practical method of exterminating the disease that they were at once accepted by the sanitary authorities in Cuba, and put to the test in Havana, where for nearly a century and a half, by actual record, the disease had never failed to appear annually.

In February, 1901, the Chief Sanitary Officer in Havana, Major W. C. Gorgas, Medical Department, U. S. Army, instituted measures to eradicate the disease, based entirely on the conclusions of the commission. Cases of yellow fever were required to be reported as promptly as possible, the patient was at first rigidly isolated, and immediately upon the report a force of men

from the sanitary department visited the house. All the rooms of the building and of the neighboring houses were sealed and fumigated to destroy the mosquitoes present. Window and door screens were put up, and after the death or recovery of the patient, his room was fumigated and every mosquito destroyed. A war of extermination was also waged against mosquitoes in general, and an energetic effort was made to diminish the number bred by draining standing water, screening tanks and vessels, using petroleum on water that could not be drained, and in the most systematic manner destroying the breeding places of the insects.

When the warm season returned a few cases occurred, but by September, 1901, the last case of yellow fever originated in Havana, since which time the city has been entirely exempt from the terrible disease, that had there kept stronghold for a hundred and fifty years. Cases are now admitted into Havana from Mexican ports, but are treated under screens with perfect impunity, in the ordinary city hospitals. The crusade against the insects also caused a very large decrease in malarial fevers.

The destruction of the most fatal epidemic disease of the western hemisphere, in its favorite home city is but the beginning of the benefit to mankind that may be expected to follow the work of Reed and his associates. There can be no manner of doubt should Mexico, Brazil, and the Central American Republics, where the disease still exists, follow strictly the example set by Havana, that yellow fever will become extinct and the United States forever freed from the scourge, that has in the past slain thousands of our citizens and caused the loss of untold treasure.

More recent investigations into the cause and spread of yellow fever have only succeeded in verifying the work of Reed and his commission in every particular and in adding very little to our knowledge of the disease.

Later researches by Guiteras in Havana, by the Public Health, and Marine Hospital Service in Vera Cruz, and lastly by a delegation from the Pasteur Institute of Paris in Rio de Janeiro, all confirm in the most convincing manner, both the accuracy and comprehensiveness of the conclusions of the American commission. It has been well said that Reed's experiments "will always remain as models in the annals of scientific research, both

for the exactness with which they were adapted to the points to be proved, and the precautions taken that no experiment should be vitiated by failure to exclude all possible sources of error."

Appreciation of Reed's work was instant in the scientific world. Honorary degrees from Harvard University and the University of Michigan were conferred upon him, learned societies and distinguished men delighted to honor him, and after his death Congress voted a special pension to his widow.

To the United States the value of his services cannot be estimated. Ninety times has yellow fever invaded the country, carrying death and destruction, leaving poverty and grief.

New Orleans, Memphis, Charleston, Galveston, Portsmouth, Baltimore, Philadelphia, New York, and many smaller towns have been swept by the disease.

The epidemic of 1853 cost New Orleans eight thousand lives, that of 1793 wiped out ten per cent. of Philadelphia's population.

The financial loss to the United States in the one epidemic of 1878 was estimated as amounting to fifteen million three hundred and thirty-five thousand dollars, but suffering, panic, fear, and the tears of widows and orphans, can never be estimated. Now, however, if yellow fever should again cross our southern border, there need be no disturbance of commerce or loss of property in the slightest degree comparable with that which epidemics in the past have caused.

The death of Major Reed took place November 23, 1902, in Washington, from appendicitis. It is gratifying to think that, although his country and the scientific world were deprived of one from whose future services more benefit to humanity might reasonably be expected, nevertheless he was privileged before his life's close to know that his discovery had been tested, and that a great city was freed from her ancient foe, to know that his conscientious work had contributed immeasurably toward the future prospects of an infant republic, and even more to the welfare of his own beloved country, whose flag he had served so faithfully.

In the National Capital and in the great cities of the United States, there are stately monuments to the country's great ones. Statues of warriors, statesmen and patriots stand as silent witnesses of a people's gratitude. Is there not room for the effigy of Walter Reed, who so clearly pointed out to his fellow man the way to conquer America's worst plague?

WALTER D. McCAW.

The first part of the paper is devoted to a general
discussion of the problem. It is shown that the
problem is of great importance in the theory of
the differential equations of the second order.
The second part of the paper is devoted to a
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