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WORKSHOPS OF THE BACTERIOLOGICAL REVOLUTION:
A HISTORY OF THE LABORATORIES OF THE NEW YORK
CITY DEPARTMENT OF HEALTH, 1892-1912.

CITY UNIVERSITY OF NEW YORK, PH.D., 1979

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WORKSHOPS OF THE BACTERIOLOGICAL REVOLUTION:
A HISTORY OF THE LABORATORIES OF THE NEW YORK CITY
DEPARTMENT OF HEALTH, 1892-1912
by
DAVID BLANCHER

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to the Graduate Faculty in History
in partial fulfillment of the requirements
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Abstract

WORKSHOPS OF THE BACTERIOLOGICAL REVOLUTION:
A HISTORY OF THE LABORATORIES OF THE NEW YORK CITY
DEPARTMENT OF HEALTH, 1892-1912

by

David Blancher

Adviser: Professor Theodore M. Brown

By the mid-nineteenth century Germany had become the major destination for American doctors interested in advancing their knowledge of scientific medicine as there had developed there a number of well-equipped laboratories with prominent scientists. Two medical school graduates who went abroad during the late 1870s to receive training in laboratory-oriented subjects were William Welch and T. Mitchell Prudden. Both became aware of the exciting work underway--by Koch, Pasteur, and their colleagues--that indicated that minute organisms, called bacteria, were the etiological agents of many of man's most devastating ailments. Upon his return Welch initiated a laboratory course in pathology at Bellevue Medical Center while Prudden did the same at the College of Physicians and Surgeons in New York. Both men taught the rudiments of bacteriology and so helped diffuse knowledge of the Germ Theory in America.

One of Welch's most enthusiastic pupils was Hermann Biggs who, while a Cornell University undergraduate, had become greatly impressed by Koch's announcement in 1882 that he had discovered the bacillus that caused tuberculosis. Biggs, acting out of impulses of Christian humanism,

patriotism, and noblesse oblige rooted in his Yankee-Protestant upbringing, suggested--as he would throughout his career--that bacteriological knowledge should be applied in publicly supported programs to improve the health, and through it the behavior and morality, of the immigrant masses then streaming into America's industrialized cities.

Biggs got his opportunity in 1892 when he was given permission to establish a bacteriological division. Although the laboratory was an ad hoc creation, hastily conceived as a means to prevent epidemic cholera from entering the city, Biggs was able to gain support for the division and guarantee its survival.

The discovery in Germany of the microorganisms responsible for diphtheria led to the creation of a free diphtheria diagnosis service; diphtheria antitoxin was later provided to physicians as the laboratory helped develop techniques--widely imitated throughout the country--for the manufacture of a safe, effective product. Physicians generally cooperated with the anti-diphtheria program but clashed with Biggs--who hoped to establish a powerful public health department inspired by the authoritarian German model he admired--over some of his plans to combat tuberculosis that would have interfered with the doctor-patient relationship.

By the early decades of the twentieth century the successful political efforts of organized medicine to dampen certain public health schemes, the decline in the incidence of some infectious diseases, and the emergence of philanthropically endowed research facilities all led to the assumption by others of activities previously within the exclusive domain of the public health laboratory. Nonetheless, New York City's municipal laboratory served as an important transitional institution and implemented life-saving procedures based on the Germ Theory of disease.

PREFACE

The fundamental discoveries of Pasteur, Koch, their contemporaries and successors--that microscopic organisms were the causative agents of a number of communicable diseases--constitute what is aptly designated the "bacteriological revolution." Subsequent revelations that inoculation of weakened or killed microorganisms could bring about immunity to the very disease they normally produce, that the blood of animals who had recovered from certain infections was effective in treating others suffering from the same condition, and that the toxic wastes of pathogens could be modified into therapeutic or prophylactic agents, added staggering dimensions to what were already tremendous breakthroughs. As the etiology of contagious disease became better understood, the hope emerged that from this knowledge there would soon flow the means to reduce the human suffering and tremendous mortality that so often accompanied such ailments as yellow fever, cholera, typhoid fever, diphtheria, pneumonia, poliomyelitis, typhus, and tuberculosis.

In America, the implications of the new science of bacteriology were realized by what seems, in retrospect, a small number of individuals, most of whom had become converts while studying in Germany. Lacking direct contact with the overpowering laboratory and clinical evident in support of the Germ Theory, the majority of American physicians continued to employ a spectrum of techniques ranging from the mild but useless procedures of the homeopathic school to the depletive "heroic measures"--vomiting, bleeding, purging--whose antiquity is measured in millenia.

The most successful preventive method of the day was simple cleanliness. Sanitary measures suggested by public health reformers did in fact lower the incidence of certain illnesses associated with filth and overcrowded living conditions. While environmental sanitation helped certainly to minimize the eruption and distribution of infectious disease, it had little potential for systematically eliminating contagion, based as it was on the incorrect notions of miasma, poisonous exhalations, and effluvia. A prerequisite for the effective prevention or treatment of disease is knowledge of its origin, an insight that precious few American physicians had in the late nineteenth century.

Despite the lukewarm reception accorded the Germ Theory, ironically it was in the United States that much of the pioneer labor was initiated of translating the revolutionary discoveries of bacteriology into practical procedures for the betterment of public health. It is the claim of this dissertation that the bacteriological laboratory of the New York City Department of Health had a special role in this development, due not only to its being among the first of its kind and a model for others, but also to its substantive work in the research and development of diagnostic, preventive, and therapeutic procedures. These efforts contributed significantly to the course of modern medicine and public health administration.

In 1894 William Welch lamented that "the history of research in general and medical research in particular had still to find its historian." Eighty-five years have since elapsed, during which time a number of studies on medical research have come forth. Nevertheless, Welch's observation is valid to the extent that a considerable amount

of history concerning the development of medical research institutions remains to be written.

Most recent works on bacteriology and immunology which exclusively, or in part, deal with their histories, mention New York's municipal laboratory and invariably laud its accomplishments. These references are, nevertheless, essentially parenthetical.

Somewhat more ambitious accounts have been produced by members of the Department of Health itself. Special occasions such as Department anniversaries, cornerstone ceremonies, and retirements have prompted the production of such narrations as Charles Bolduan's Over a Century of Health Administration in New York City (1915), Leona Baumgartner's effort in 1969, "One Hundred Years of Health: New York City, 1866-1966," and Dr. Morris Schaeffer's untitled speech delivered at the dedication of a Health Department research facility in 1968. Reviews of this type, often unpublished and in mimeographed form for Department consumption, contain encapsulated histories of the laboratory, varying from a few lines to a few pages, but inevitably echo the same general information.

George Rosen's A History of Public Health and even John Duffy's recent two volumes limited to the history of public health in New York City are both of such scope as to preclude more than a passing study of the laboratory. To gain some meaningful insights into the institution's efforts one must consult the biographies of Hermann Biggs, The Life of Hermann M. Biggs, Physician and Statesman of the Public Health, by Charles-Edward Winslow, and of William Park, The Man Who Lived for Tomorrow, by Wade Oliver. The former deals only with the first few years of the laboratory as Biggs, its founder, soon moved on to other activities;

the latter examines the life of the figure who served as its director and guiding spirit for over forty years. Park's biography is the most comprehensive secondary source available, although it is the story of a man and thus includes considerable details unrelated to the laboratory. More importantly, Oliver's work touches predominantly on those events in which Park was directly involved, thereby excluding important phases of the laboratory's history, and is noticeably weak in its account of the late 1920s and 1930s when Park served more as resident advisor and administrator than active investigator.

In the account that follows here, the strategy will be to narrate and analyze the laboratory's role in the progress of medical bacteriology and public health administration within a historical context and with the intention of considering the spectrum of relevant factors, both scientific and nonscientific, which played a part in these developments. Scientific and medical journals, and texts on bacteriology and medicine, will be explored to create a backdrop against which the work of New York City's municipal laboratory may be evaluated.

The success of any public health program depends to a considerable extent on voluntary submission, and thus the reactions of the public and media to the prospect and eventually to the outcome of various innovations will be explored. Newspapers and popular periodicals will be consulted in this regard; these two sources will also be counted on to provide the bulk of material on those political happenings which influenced the laboratory's development.

The reaction of the medical profession to the efforts of the bacteriological laboratory also demands attention. The views of private

practitioners will be extracted primarily from local publications aimed at this audience, for example the New York Medical Journal, Medical Record, and Medical News.

While there exists a bountiful supply of biographies of key figures in the growth of bacteriology and sufficient general histories on the backgrounds of the Germ Theory, there is, as noted, a deficiency of literature on those institutions whose efforts played a major role in bringing about tangible applications of these nineteenth-century developments. Surely there is a more personal appeal in the vision of Robert Koch working incessantly in a cluttered makeshift home laboratory with hand-made instruments than in the picture of a staff of white-coated bacteriologists huddled over a mass of bewildering, sophisticated instruments in a slick modern facility; certainly there is greater drama in recreating the incident when Pasteur, in full view of newsmen and scientific detractors, tested his concept of immunity in a French field among dead and dying non-inoculated animals than there is in the description of experiments performed on guinea pigs or rhesus monkeys in the quiet confines of a modern laboratory. Nonetheless, it has been in well-equipped laboratories with trained personnel that the practical applications of the bacteriological revolution have been realized.

The day of the great scientific discovery by an individual working independently is perhaps over, and may have been so for some time. Recognition of this fact is overdue as are scholarly treatments of research laboratories. This dissertation proposes to partially redress this situation by focusing on the history of one such facility in a holistic approach, sensitive to the realization that institutions, like

people, are products of a diverse and continually changing environment. In the process of drawing attention to the bacteriological laboratory of New York City's Department of Health, it is hoped that a contribution will be made to the historiography of research institutions, public health, and medical microbiology.

Citations in footnotes have been given in accordance with "Method A" of Kate L. Turabian's A Manual for Writers of Term Papers, Theses and Dissertations published by the University of Chicago Press in 1955 (pp. 45-46).

I wish it were possible for words to express the tremendous sense of gratitude I feel for my dissertation adviser, Professor Theodore M. Brown. When I first started to search for a topic he aroused my interest in the bacteriological laboratory of the New York City Health Department and gave me the confidence that I could produce a dissertation on its early history. Throughout the years of researching, writing, and revising, he was always available as a source of inspiration and direction despite his own hectic family and professional responsibilities. I followed Dr. Brown's advice during the early phases because I knew little about the field; during the later stages of my work, as I picked up some expertise, I confidently followed his recommendations out of an awareness of the brilliant guidance I was receiving. I will always be grateful and hope to justify Professor Brown's faith in me.

I also owe a great debt to Professor Joseph Dauben and Dr. Albert Lyons, who read the manuscript and made many excellent suggestions for the final draft. My research was made easier by the assistance of a number of librarians, particularly those from the New York

Academy of Medicine, the William Hallock Park Library of the Public Health Research Institute, the various branches of the New York Public Library, and the New York City Municipal Library. Specifically, I would like to thank librarians Anita Strelisker, Chris Barr, Renee Kaplan, Florence Auerbach, Charlotte Daar, and Linda Shapiro. I would be remiss if I did not express my gratitude to Professor Gertrude Himmelfarb, Professor Edward Rosen, and Miss Florence Bloch of the CUNY Graduate Center for their understanding and support over the years.

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downstairs "working on his Ph.D."

To my wife Judy, who gave up so much to receive so little as I worked on this project, and to whom I owe so much, I dedicate this dissertation.

TABLE OF CONTENTS

Abstract	iv
Preface	vi
CHAPTER	
1 THE BIRTH OF THE LABORATORY	1
2 THE GROWING YEARS	70
3 EXPANDING HORIZONS	143
4 TIMES OF CONFLICT	196
5 GLORY AND DECLINE	234
6 EPILOGUE	284
SELECTED BIBLIOGRAPHY	293

CHAPTER I

THE BIRTH OF THE LABORATORY

On the evening of August 30, 1892, the Hamburg-American steamship Moravia dropped anchor in New York, completing a voyage which had left Hamburg on August 16. The ship was brought into Quarantine the following day, where its captain and doctor were visited by a health officer of the port who routinely questioned the two and learned that twenty-two deaths from gastro-intestinal disorders had occurred at sea. Certain that the scourge of Asiatic cholera had reached America, health officials ordered the ship held under strict quarantine in Gravesend Bay; within days, five other ships were similarly detained.¹

During most of the month of September, New York City was the scene of much tumultuous activity as various municipal, state, and federal agencies took action to minimize the spread of epidemic cholera which it appeared, following the report of some local cases, had already reached these shores.² Interest in events surrounding the disease so dominated the news that the New York Times carried front-page stories on its course and ramifications each day from the announcement of the Moravia fatalities on September 1 until September 20.³ Thereafter, as it had already become evident that no epidemic was imminent, the public's attention moved from health to politics, national elections being only weeks away.

On September 13, during the height of the frenzy, the city's

Board of Health adopted a resolution creating a new division, to be known as the Division of Pathology, Bacteriology, and Disinfection.⁴ This branch of New York City's Health Department, created more out of desperation than enthusiasm, with little fanfare and inadequate facilities, was to emerge as a notable force in the evolution of modern public health. Here, in these bacteriological laboratories, notable contributions would be made in deriving practical public health procedures from the growing knowledge of the nature of microorganisms as the etiological agents of infectious disease.

A sizeable number of biographies have been written on the key figures in the bacteriological revolution of the nineteenth century as well as histories on the general development of the Germ Theory. Less literature exists on those institutions whose efforts transformed basic theories into successful techniques for the diagnosis, prevention, and treatment of disease. It is the purpose of this study to place in historical perspective one such facility which to this time has escaped the scholarly attention it most certainly deserves.

* * * * *

The arrival of Asiatic cholera in New York in late 1892 was not the first contact between this pestilence and the city, nor was it the first time that fear of its epidemic nature aroused public health authorities to action. In its first sweep across the American continent in 1832 the disease struck the metropolitan area, leaving in its wake immense suffering and many dead.⁵ Local health authorities had tried to prepare for the onslaught by dispatching four physicians to Canada to investigate the disorder and report their findings. Their

account, while a vivid portrait of cholera's various debilitating effects, was almost entirely descriptive and thus useless to a city on the verge of a health emergency.⁶ They ventured the view that no quarantine could possibly halt this ailment which they attributed to the indiscrete use of purgatives, fruits, raw vegetables, and the drinking of cold water when the body was heated.⁷ Such views representing the thinking of prominent physicians, it is little wonder that when the disease arrived, the therapeutic response was the millennia-old techniques of bleeding, leeching, and the administration of fanciful, useless, and dangerous medications.⁸

New Yorkers were reassured that the malady only struck the filthy, hungry, ignorant, and immoral.⁹ The prediction was largely fulfilled by the mass exodus of the wealthy (many doctors included), while the poor remained behind and bore the brunt of the epidemic.¹⁰ Those unable or unwilling to leave were largely dependent on the ministrations of ill-prepared public health officials and physicians for their protection.¹¹ Water was drained from hydrants a few times each day, warnings were issued to the population to be calm and temperate in their drinking and dining, and a new system of street cleaning was introduced.¹² At its height cholera was killing hundreds each day.¹³

The disorder devastated the country once more in 1849. New York was again particularly hard hit; over 5,000 death were reported in five months.¹⁴

As has unfortunately often been the case, it took the suffering and loss of lives through by these epidemics to awaken health officers, the public, the media, and municipal and state authorities to the

desperate need for positive measures to safeguard the well-being of the city's burgeoning population. During and following each of these waves of cholera, existing sanitary ordinances were more rigidly enforced and new ones created.¹⁵

For the next decade, and into the first half of the 1860s, the New York area was to be spared from any unusually severe flare-up of fatal cholera.¹⁶ Then, in late 1865, reports arrived that serious outbreaks had occurred in Egypt and Spain and that the disease was following its usual pattern of western movement.¹⁷ The city braced for the clash as memories of the misery of 1849 were awakened; a good number of people could even still recall the horrors of the 1832 epidemic.

The Sanitary Police conducted inspections throughout the city and saw to it that unsightly water-closets, yards, sewers, cellars, alleys, and sidewalks were cleaned.¹⁸ Inspectors later extended this work to include visits to businesses which dealt with food, animals, or organic matter; offal docks, stables, slaughterhouses, and public markets were carefully examined. When filthy or illegal conditions were detected stern warnings were issued and in a number of cases companies were ordered closed.¹⁹ House-to-house examinations were carried out and subsequent action was taken against certain tenements; residents were ordered to vacate the premises until repairs were made and the structures brought up to sanitary standards.²⁰

The program of inspection and enforcement had become accelerated after New York City was granted an autonomous Board of Health by the State legislature. The Metropolitan Health Bill, the successful results of the crusading efforts of New Yorkers dissatisfied with the

ineffectiveness of the existing public health system of City Inspectors under state authority, had been defeated only months earlier.²¹ The bill was subsequently approved and enacted into law on February 26, 1866-- the impending threat of cholera playing no small role in this reversal on the part of the legislators.²² Once again, the fear of a calamitous confrontation with Asiatic cholera inspired action on behalf of the public's welfare.

Again, then, in 1865-1866, as in 1832 and 1849, the city's resources were largely directed to what was, in effect, a massive clean-up campaign. If streets, tenements, businesses, docks, yards, and the myriad alleys of the sprawling metropolis could be kept reasonably free from filth then, the contemporary wisdom held, epidemic diseases might be prevented from taking root or, at least, their fatal effects reduced. Although afflicted individuals were isolated after the first few cases appeared in 1866, and incoming ships with cholera aboard were quarantined, sanitary measures were generally acknowledged to be the best weapons for the successful defense of the city.²³

The knee-jerk sanitary response by health officials during each of the cholera episodes reflected the prevailing view on disease causation. Disease came about as the result of contact, particularly via the respiratory system, with the poisonous exhalations (miasmas) emitted by organic matter as it underwent decomposition or putrefaction.²⁴ Prevention was therefore basically a matter of detecting and then eliminating the sources of these illness-inducing emanations. The reports of the City Inspectors illustrate the commitment to this hypothesis. These annual publications contained a variety of lists and charts on the

illnesses and deaths records in the previous year, along with lucid descriptions of the unsanitary conditions of the city, declarations on how the filth contributed to disease, what hygienic measures were employed, and how difficult it was to remedy the entire situation.²⁵

The emphasis did not change when the Metropolitan Board of Health was created. From its inception, and throughout the 1870s, the bulk of its activities centered around the general goal of keeping the city in a state of comparative decency.²⁶ Attempts to minimize the sheer magnitude of the filth were frustrated by an apathetic public; the ignorant poor were basically unimpressed with the necessity for cleanliness and were not, in any case, in a position to effect much change, while the rich generally demonstrated a "laissez-faire" attitude on such matters;²⁷ landlords and businessmen were on the whole unwilling to discontinue unsanitary practices or improve their properties and could not be effectively coerced by an understaffed health department with inadequate and indefinite powers.²⁸ In addition, supervision of health affairs had fallen largely into the hands of politicians who used their positions to distribute patronage and who had no preparation as sanitarians.²⁹

Abuses and deficiencies within the Department of Health were trivial when compared to those in the street-cleaning service. This municipal function, for many years contracted out to private firms, became the center of one embroglio after another involving charges and countercharges of breach of contract, chicanery, and incompetency while the streets, through it all, became filthier and filthier.³⁰

As early as the 1860s the city of New York had become, even by the standards of that day, an appallingly squalid area. The new Board

of Health in fact issued a statement to the public in 1866 labeling certain parts of the city as "unfit to be inhabited" and warned that the unsanitary conditions threatened all, but that "especially the poor are in peril."³¹ Mortality figures bear out this assessment--the annual rate, of the first two decades of the century, of about 21 deaths per 1,000 members of the population had already increased about 80 percent by the late 1850s.³² The death rate of children under five years of age, generally considered an accurate barometer of general health, was 123 per 1,000 in the period 1866 to 1873.³³ In New York City during the 1870s, 235 of every 1,000 babies born alive would perish before reaching their first birthday.³⁴

Corrupt and uncaring politicians, an inadequate force of basically powerless health inspectors, an ineffectual street-cleaning system, avaricious and cold-hearted landlords and businessmen, the explosive influx of impoverished immigrants into what were among the world's seediest tenements, and a general apathy towards hygienic concerns all undoubtedly contributed to the city's poor health record.³⁵ Had New York not been faced with this complex of intertwined problems, it surely would not have had as high a rate of morbidity and mortality. However, the hopes of sanitary reformers that the high incidence of disease could be substantially and rapidly reduced if only a successful clean-up campaign were implemented could not have been realized. Illness-provoking miasmas, poisonous exhalations and emanations are not in reality cast off from decomposing animal and plant refuse. Filth, its aesthetic and sociological influences notwithstanding, is not the fundamental pathology-generating medium and thus preventive and therapeutic measures based

solely on this premise are generally destined to limited success.³⁶

The miasmatic theory of disease etiology did not command universal acceptance. The contagion doctrine maintained that sickness is caused by a specific physical or chemical entity which can be transferred to other victims by direct contact, or fomites (inanimate objects), or if not too distant, through the air. This view, which would find expression in the Germ Theory and serve as a foundation of modern medicine, was considered in 1800 an old, weak hypothesis.³⁷ Although the sixteenth-century Italian physician Girolamo Fracastoro is generally acknowledged to have made the first definitive statement that some sort of self-productive particles ("seminaria") were capable of inducing illness, an argument can also be made that the ancient practice of isolating and segregating the seriously sick (particularly sufferers of leprosy) was a tacit recognition of the contagion concept.³⁸ The centuries-old practice of quarantine was also predicated on the basis of the communicability of many maladies.³⁹

The miasma-contagion controversy continued and American medical practices reflected the absence of any universally accepted, scientifically confirmed concept of the disease process. Nevertheless, the careful post-mortem observations of Karl von Rokitansky (1804-1878) and colleagues (the "new" Vienna school) and the work done in Paris hospitals in the first half of the century of correlating clinical symptoms with pathological lesions had led to a more precise differentiation of the varied types of diseases.⁴⁰ As long, however, as the source of illness had not been concretely established, the possible methods of treatment were influenced by desperation, faith in traditional cures, and a fair

amount of superstition and connivery. Blood-letting, a remnant of the ancient humoral imbalance concept, was still advocated and apparently employed--venesection was preferred but leeches were still in vogue.⁴¹ On the assumption that the severity of the ailment must be more than matched by the severity of the cure, there evolved a host of "heroic measures." Patients were treated for scarlet fever by being blistered with hot water, covered with mutton tallow, and doused with cold water;⁴² alkalis and acids were poured down the throat in attempts to dissolve croupous membranes;⁴³ tumors were subjected to electrical shock;⁴⁴ ice was applied to the spine of tetanus sufferers.⁴⁵

More humane, but as useless, were the curative measures of the hydro-therapists⁴⁶ and those physicians who relied on the medical values of mineral water.⁴⁷ Drifting from the extremes of harsh procedures and polypharmacy to the opposing philosophy that doing little or nothing was in the best interests of the patient, the healing arts were in a quandary.⁴⁸ A local monthly publication for doctors bemoaned the popularity of "quacks" and that "materia medica had been allowed to dribble into a disgraceful nothingness."⁴⁹

* * * * *

From 1863 on considerable worldwide attention was given to minute rod-like living bodies, called "bacteria" by Casimir Davaine, a French researcher, who had found them in the blood of animals suffering and dead from anthrax. By 1868 Louis Pasteur had demonstrated conclusively that two silkworm diseases were caused by microorganisms and Davaine had shown that one-millionth of a drop of anthrax blood contained enough bacteria to cause the malady. Others had attempted to prove that

minute living entities were the cause of certain forms of illness; never before though were the attempts as rigorous or convincing.⁵⁰

Pasteur's techniques were often elaborate and difficult to duplicate. Particularly perplexing was the crucial process of isolating specific microorganisms and then growing them outside the living body. It was Robert Koch who developed the method of obtaining pure strains of bacteria by culturing them in glass plates on a solid transparent medium of meat infusion solidified by agar-agar.⁵¹ He and others introduced standard procedures for the growing, staining, examining, preserving, and photographing of bacteria so that by the late 1870s reasonable reliable methods were available to assist scientists in their efforts to unravel the mysteries surrounding some of man's most devastating enemies.⁵²

By the early 1880s the basic bacteriological procedures had been improved upon (largely through the efforts of German scientists) and implemented to the extent that methodical laboratory studies were underway in the investigation of typhoid fever, leprosy, malaria, tuberculosis, cholera, diphtheria, tetanus, pneumonia, and staphylococcal and streptococcal infections--in some cases leading to the positive identification of the pathogenic organism.⁵³ Pasteur and his colleagues meanwhile were devoting their energies to the search for medications based on the discovery that animals can develop immunity to certain sicknesses following inoculation of those very microbes, in a modified state, which normally produce these ailments.⁵⁴

The study of microorganisms in the 1880s created a solidly impressive foundation for future investigations of disease and, in the process, brought forth such an overwhelming array of evidence on

the causative role of microbes as to place opposing views in a defensive position by the end of the decade. George Rosen considers the period as the one which ushered in "the age of bacteriology."⁵⁵

The reaction of the American medical community to the revolutionary discoveries of European scientists was unenthusiastic despite the high rate of illness and death during the then recently concluded Civil War. Malaria, typhoid, typhus, "common continual fever," dysentery, smallpox, and pneumonia ran uncontrolled through one Southern camp after another;⁵⁶ Northern troops were particularly hard hit with attacks of typhoid, dysentery, measles, mumps, scarlet fever, and a variety of intestinal maladies classified as "diarrhea disorders."⁵⁷ Proponents of the filth theory could argue with some justification that the high incidence of disease was directly related to the unsanitary conditions of army camps--nonetheless, when miasma-destroying methods were employed they failed.⁵⁸ Of the 600,000 fighting men mobilized by the Confederate states it is estimated that each, on the average, fell victim to diseases and wounds six times.⁵⁹ The Union army reported almost six million cases of illness during the war years.⁶⁰

Those measures that were employed to treat sicknesses were as unsuccessful as those used to prevent them. From January 1, 1862, to July 1, 1863, over 68,000 Confederates died of typhoid fever, typhus, and "common continual fever," while about 20,000 succumbed to pneumonia during this same period.⁶¹ In 1865 typhoid killed 65 percent of its large number of victims among the soldiers of the North.⁶²

The infections that followed wounds, or resulted from surgical procedures, also exacted a high toll.⁶³ Pyemia (blood poisoning or

"bacteremia") in one instance was responsible for the death of 2,747 men of the 2,818 who were stricken with it following surgery--a 97 percent mortality.⁶⁴ Lockjaw killed 90 out of every 100 patients inflicted while two of every three injured with compound fractures did not survive.⁶⁵ Tetanus, gangrene, erysipelas, pyemia, and septicemia--the common "surgical fevers"--were so rampant that amputation of wasted limbs became a routine procedure.⁶⁶ The piles of arms and legs frequently seen outside army hospitals gave testimony to the need for a new departure for the practitioners of the healing arts.⁶⁷ The loss of life by disease of over 350,000 of the approximately 500,000 Civil War dead was a clear indictment of the basic concepts and practices of medicine then in vogue.⁶⁸

Despite the eclectic and often gullible nature of American medicine, when Pasteur's views on the germ origin of disease had begun to circulate, only years after the horrors of the Civil War, they were met with general disinterest.⁶⁹ Those American physicians who studied the germ hypothesis were, on the whole, unconvinced. Austin Flint, for example, professor of medicine at Bellevue Hospital Medical College, an influential local figure and one of the few in New York with a rudimentary interest in bacteria, gave mention of the studies of the European researchers in his popular medical text, but characterized them as inconclusive.⁷⁰ Recognizing that the prevailing theory, like that on germs, was based largely on inference, he understandably preferred to remain in support of the accepted view that disease was the product of "poisonous miasma [that] emanate from the soil."⁷¹

The reluctance of the American medical community to embrace the

bacteriological theory reflected the profession's usual resistance to innovation and its particularly conservative attitude during this period, a consequence of the threat of competing medical sects. To have accepted the hypothesis of minute living organisms as the causes of disease implied the possibility of far-reaching revisions of the traditional order with unforeseen, and thus potentially undesirable, consequences. Many of those in positions of power who controlled the medical press and medical education were reluctant to throw their support behind any significant departure from the status quo. The mainstay of American medicine, the general practitioner, conscious of the transitory popularity of medical fads and fancies, was unwilling to spare the time and effort to master the complexities of the Germ Theory and was thus not disposed to effect any change.⁷² Furthermore, the physician served a curative function in society and his reputation and success depended on his ability to treat illness once it appeared. Knowledge of the cause of disease might be important in hygiene but the prevention of illness was to the layman more a matter of common sense and folk tradition. Their supremacy rivaled by the rapid spread of alternative sects--homeopathy, hydrotherapy, Thomsonianism, and others--and with public confidence at a low ebb, the "regulars" were in no frame of mind to abandon what they knew best for a new framework for dealing with the disease process.⁷³

By the early 1880s it was still uncertain what direction American medicine would take. Dr. Alfred L. Loomis, a giant influence at New York's University Medical College and an early supporter of the contagion doctrine,⁷⁴ by 1882 considered the concept of bacterial causation as having been disproved and rapidly becoming abandoned.⁷⁵ Others equivocated,

however; seduced by the compelling discoveries of the Germ Theory proponents on the one hand, and their training and empirical experiences which supported the validity of the miasmatic filth theory on the other,⁷⁶ they assumed two intermediary positions: one was that microorganisms were capable of causing and/or transmitting disease only after having been altered or spontaneously generated by adverse environmental conditions;⁷⁷ the other held that only those few ailments not of miasmatic origin were possibly bacterial.⁷⁸ Some doctors had meanwhile become totally committed to the Germ Theory and were confident that all infectious conditions would eventually be proven to be parasitic.⁷⁹

By the mid-1880s bacteriology had begun to establish itself as a legitimate science in a small number of American medical schools, and yet there were really no acknowledged "bacteriologists" in the country. The study of microorganisms was made one small aspect of the general area of pathology, a specialty which itself was looked upon in these schools as an accessory to medicine and surgery. However, while satiating their obsession to catalogue and describe the minute details of lesions, "pathologists" began to realize more fully than ever that disease was a "process" and not merely a collection of abnormal tissues. Eventually they came to appreciate that the fundamental characteristics of diseases were not to be found in the anatomical effects but rather in the very factors which caused their occurrence. As the work of Pasteur, Koch, their colleagues and successors continued to confirm the causative role of bacteria and suggest their mode of attack and procedures for their identification and eventual control, it was the pathologists who enthusiastically embraced the neophyte science and absorbed it into their

discipline.⁸⁰ T. Mitchell Prudden, one of the first of these American pathologist-bacteriologists, remembered the initial fervor: "No young pathologist was so ill provided with utensils and none so busy that he did not hasten to lay some new microbe at the newly risen shrine."⁸¹

The growing interest in microorganisms had its critics. Dr. Abraham Jacobi was disturbed by the trend enough to make it the subject of his inaugural address as president of the New York Academy of Medicine. Cautiously adhering to the view that microbes were most likely incidental to the poisons that cause illness, Jacobi lashed out against the "bacteriomania of modern times" which he hoped would not become "the universal gospel of modern pathology." His statement, that almost all in America who had not been able to do research on their own had accepted the discoveries of bacteriology, was an exaggeration easily denied by a scan through contemporary medical journals.⁸² More likely, the average practitioner was little interested, rather skeptical, and so continued on treating his patients as in the past.⁸³

One of the primary factors preventing the more rapid acceleration of bacteriological influence on American medicine was the absence of any well-established learning or research centers.⁸⁴ Most American colleges in the latter part of the nineteenth century were concerned primarily with instruction in philosophy, theology, and the classics, and could not immediately provide the requisite facilities for the fledgling science. The faculties of those institutions with programs in the natural sciences had little or no training in research and scarcely any provisions for experimentation. Medical schools were financially and academically poor and could thus contribute little. Their faculty members, and those

of technical schools, were commonly private practitioners who taught in order to supplement their income and who had consequently little leisure for investigative laboratory studies.⁸⁵

The lack of any well-supported facility where young zealots could pursue their interest in germs into the laboratory was just one aspect of the destitution of American research. The core of this condition might be traced to the "wilderness" tradition of a young country which looked to science solely to provide immediate practical means for a more comfortable survival.⁸⁶ Whatever its origins, however, the growing industrial class was unwilling to provide philanthropically for "idle curiosity" and government, on all levels, offered no meaningful assistance to research. Americans wishing to gain expertise in the theory and methods of laboratory study had to travel abroad.⁸⁷

Germany was the chief destination for those with such interests. Here there flourished a number of well-equipped university, non-university, and often government-supported, facilities where students and investigators could learn the latest concepts in chemistry, physiology, pharmacology, hygiene, pathology, and, by 1885, bacteriology, under renowned authorities.⁸⁸

Three young Americans who made the pilgrimage--William Welch, T. Mitchell Prudden, and Herman Biggs--were to be instrumental in establishing microscopic pathology, and through it bacteriology, on a sound footing in New York. Their efforts, directly and indirectly, figured prominently in the creation of the bacteriological laboratories of the New York City Health Department.⁸⁹

Welch, who would become a titan of American medicine for half

a century, graduated in 1875 from the College of Physicians and Surgeons in New York where, as was typical of the medical education of that day, he had received no laboratory instruction at all.⁹⁰ During the following year, however, while interning at Bellevue, he acquainted himself with the rudimentary studies of diseased tissue being done by progressive local physicians and became increasingly committed to the developing field of microscopic anatomy. With no American medical school offering any graduate course in histology (microscopic anatomy), Welch left for Germany in April, 1876, to study under the masters.⁹¹

Somewhere during his odysseys from one laboratory to another, Welch learned, with some anxiety, that another young American, T. Mitchell Prudden, was studying pathology in Heidelberg with Julius Arnold, a leading figure in that field.⁹² Prudden has also come to Europe to further his knowledge of microscopy and the study of diseased tissue. As a recent graduate of the two-year lecture system at Yale's medical school, he too was well aware of the inadequacy of his training. After learning the basics of tissue preparation under Dr. Francis Delafield of New York's Roosevelt Hospital, he had departed in 1876, like Welch, for a two-year intensive course of study in the laboratories of Germany.⁹³

From Colonial days on, American medical students and graduates often left home for European schools. Even following independence American doctors continued to travel to Europe to upgrade their knowledge through postgraduate study. At the beginning of the nineteenth century Paris had replaced Edinburgh as the chief center for the study of medicine abroad and was replaced in turn by midcentury, as the fame of the achievements of German scientific medicine spread. Despite the objections of

those who spoke out against servility to the Old World and others who emphasized native "practicality" and scorned European "theorizing," American doctors flocked to Germany in tremendous numbers in the last quarter of the nineteenth century.⁹⁴ What most Americans found was a revelation; few failed to be impressed by the German university system with its emphasis on research, seminars, excellent facilities, genuine school spirit, and concern for productivity. It is not surprising that many looked to the German model after their return home and became actively involved in promoting research and in spreading the gospel of scientific medicine.⁹⁵

Welch returned to New York in 1878 anxious to introduce laboratory work into the medical curriculum.⁹⁶ At the time, the few "pathological laboratories" in existence in this country were little more than small corners in the dead house. An ambitious student wishing to augment his flimsy knowledge of the basics of disease gained from lectures, books, and charts might view an occasional autopsy. Beyond this there was little else.⁹⁷ Nevertheless, when Welch offered his services to his alma mater he was turned away. He then approached the far less prestigious Bellevue Medical Center. Here, after convincing the professors that his course in microscopy and pathology would not upset the delicate politics of the school, he was granted three small rooms to organize as a laboratory.⁹⁸

Despite the miserable facilities and the unavailability of equipment, the lure of the laboratory and the friendly enthusiasm of Welch made the course immediately popular with those attending Bellevue (it was not a mandatory subject) and attracted students from the other two

local medical schools, i.e., the College of Physicians and Surgeons and the University Medical College.⁹⁹

The Bellevue class became so popular that within months the Alumni Association of the College of Physicians and Surgeons was prompted to contribute the money for the creation of a pathological laboratory and invited Welch to take charge. Although tempted, Welch recommended Prudden for the position who, soon after he was contacted, leaped at the opportunity and was appointed Assistant in Pathology and Director of the Laboratory of the Alumni Association.¹⁰⁰

Despite the grudging support they received initially from their employers, Welch and Prudden renounced private practice and devoted themselves entirely to research and teaching in pathology.¹⁰¹ Their well-attended courses established histological investigation on a firm basis in this country and gave support to the notion that considerable knowledge of the disease process could be gained in the laboratory.¹⁰² Important in their own right, their efforts to bring respectability to microscopic pathology helped pave the way for the introduction of medical bacteriology in the United States.

In their travels through Germany, both Prudden and Welch had come in contact with scientists and other young physicians who were beginning to show an interest in microorganisms.¹⁰³ Both men were so involved in learning, and then giving instruction in, laboratory techniques, that neither became an avid proponent of bacteriology during his first few years after returning to America. It seems, however, that both were following European scientific developments, for only weeks after Koch's announcement of March 1882 that he had identified the specific bacillus

that caused tuberculosis, Prudden partitioned off a section of his laboratory for bacteriology and he and Welch began to teach the basic techniques of bacterial investigation.¹⁰⁴

Although both men were to contribute to the process of convincing the American medical community of the validity of the Germ Theory of disease, it was Prudden who actively took up the cause and became a specialist in bacteriology (the term "bacteriologist" was seldom used then, "pathologist" was the usual label). He published two articles on Koch's demonstration of the tubercle bacillus¹⁰⁵ and, perhaps through the efforts of Julius Arnold, received a personal invitation from Koch to study bacteriology with him at his hygienic laboratory that was due to open soon. Prudden took advantage of the opportunity and, in 1885, left for Germany where he took a month course with Dr. Koch in Berlin and spent some time in visiting other laboratories.¹⁰⁶

Prudden's impressions of Germany's bacteriological laboratories were of interest to the Connecticut State Board of Health (he had by this time become a lecturer in normal histology at the Yale Medical School); in May of 1885 this agency had requested that he look into the methods of studying germs employed by Koch and any other scientists he might contact.¹⁰⁷ In his response, written later that year, Prudden points out that throughout Europe laboratories were springing up, as universities and governments were being awakened to the necessity of bacterial research. What was supposed to be a report on current laboratory techniques develops into a polemic as Prudden was obviously impressed by the disparity, quantitative and qualitative, between American and European research facilities and public health care practices.¹⁰⁸ He

comments that the "physical well-being of the race" depends on the application of preventive and prophylactic methods that can be derived only from richly supported programs for bacterial research.¹⁰⁹ Physicians, Prudden is certain, will gain the knowledge of applying these methods in medical schools, but local and national health boards must assume a large role in bacteriological research, testing, and disease diagnosis and treatment--a view based on his personal observations of Koch's model, the Imperial Department of Health in Berlin.

The public health system Prudden saw in Germany was the most highly organized on the Continent and--with the possible exception of that of England--the most efficient in the world. The sanitary administration of the different states did not differ much from that of Prussia, where he spent most of his time. The general direction of public health was under the control of the Chancellor of the Empire, who was assisted by a consulting council, the Imperial Office of Health. The council occasionally allowed its policies to be influenced by the recommendations of laymen, doctors, engineers, architects, and apothecaries and drew assistance from various scientific and medical commissions which acted under the title of consulting authorities. Matters relating to the reporting of infectious diseases, enforcement of legislation regarding the proper handling of foods, meat, and milk by tradesmen, disinfection of public places, and compliance with health laws--such as the one requiring all children to be vaccinated within one year of birth--were all under the supervision of the Minister of Public Instruction (or Minister of the Interior) in each of the states of the empire. The direct administration and enforcement of health policies on the local level was the

responsibility of the police force.¹¹⁰ The system was one, in short, which attempted to treat the general well-being of the community as a matter of public policy through the galvanization of traditional practices and newer scientific developments within an authoritative bureaucracy. This official concern with the public's health was stepped up in the years following German unification as a major element in Bismarck's social reform program.¹¹¹

In his report to the Connecticut State Board of Health, Prudden makes what was certainly one of the first published statements by an American suggesting that laboratories devoted to the study of microorganisms and the application of related techniques ought to be established in connection with health departments. Prudden suggests that the publicly supported facilities ought to employ individuals trained in the methods of identifying bacteria and enforcing measures for their destruction; that they ought to routinely carry out bacterial analyses of water (in conjunction with chemical analyses, then already a common procedure), investigate poisoning cases resulting from impure foods, milk, and spoiled meat, to determine if microorganisms were responsible (in 1885, still a novel concept); that they should be provided with the personnel and material for "original research on the relation of bacteria to disease."¹¹²

There are no indications that the Connecticut State Board of Health adopted these suggestions at the time. The similarity, however, between Prudden's recommendations and the eventual program of New York City's bacteriological laboratories strongly suggests his influence,¹¹³ especially considering the general direction of his activities following

his return from Europe.

By 1887 the College of Physicians and Surgeons--operating out of its new laboratories on Fifty-Ninth Street, the gift of W. H. Vanderbilt--was offering, under Prudden's guidance, courses in bacteriology to graduates in medicine, and other qualified students, that were almost identical to those given by Koch. A "Course in Pathology and Bacteriology" was made a requirement in the first-year medical curriculum.¹¹⁴

In addition to his teaching responsibilities, Prudden became a literary crusader in the cause of creating a greater awareness of microorganisms. In a series of what were, in effect, primers, he sketched the basic characteristics of bacteria for the laymen and uninformed, or perhaps unconvinced, and illustrated the dangers of not taking these minute organisms seriously.¹¹⁵

Prudden's experience as advisor to the Connecticut State Board of Health had evidently initiated, or perhaps heightened, a desire on his part to get public officials to update health services to include measures based on the growing knowledge of infectious disorders.¹¹⁶ In pursuit of this goal his appointment as Consulting Pathologist to the New York City Health Department in 1887 proved to be a mixed blessing. On the one hand, he was now in a favorable position to have his views reach the policy makers; in 1889, for example, he co-authored a report, requested by the Board of Health, on the nature of tuberculosis which emphasized that the ailment was not inherited but was transmitted by a tubercle bacillus and was therefore amenable to prevention by the implementation of certain public precautions by health authorities.¹¹⁷ On the other hand, the years 1884-1890 were tumultuous ones for the Health

Department, which was charged with mismanagement, negligence, ineffectiveness, and its president, General Shaler (1884-1887), brought to trial for corruption.¹¹⁸ Under these circumstances it would hardly have been appropriate for Prudden, in his unpaid but official capacity, to criticize the department's services. He instead, according to colleagues, resorted to an anonymous newspaper campaign, carried out over a number of years, in which he warned of the need for reform.¹¹⁹

One of the collaborators on the report on tuberculosis was Hermann M. Biggs, a young pathologist who, while an undergraduate at Cornell University, had demonstrated his enthusiasm for the work of Pasteur and Koch and offered the view that public hygiene procedures based on their discoveries would produce a significant improvement in the general health. In his baccalaureate thesis submitted in 1882, entitled "Sanitary Regulations and the Duty of the State in Regard to Public Hygiene," Biggs expressed his views that

The enjoyment of health, immunity from suffering and long life are the greatest temporal blessings that man can desire, and the questions of the attainment and maintenance of these are questions of no ordinary interest to the human race. Sanitary science is the science that pertains to health, and this affords a key to the correct answers to all these questions. . . .

It has been wisely said that 'men are slow to learn the extent to which their destinies are in their hands.' They are astonished and incredulous when it is pointed out to them, that the most terrible maladies which have afflicted the human race are the direct and obvious consequences of the neglect or violation of the laws of health. . . .

Upon the recognition and careful observance of hygienic laws depend the health, physical condition and so the prosperity not only of individuals and communities, but also of whole states and nations. More and more is this true as the destiny of population increases and great cities spring up, where vast numbers from the lowest grades of society are crowded together in small areas, which become the breeding places and hotbeds of disease. . . .

Individuals, families, and communities are inevitably so related to each other that mutual and harmonious action is

indispensable for the best good of the whole. The relations of the states to each other are essentially the same, so that individual and state action on the questions of public hygiene, invaluable as they are in themselves, do not go far enough to answer the purpose; there must be something broader and more far-reaching than either or both of these, viz., action by the general government. . . .

Not only is the physical condition of a people dependent on their sanitary surroundings, but their moral and intellectual condition is also largely determined by these same surroundings, for it has been truly said that 'ignorance and vice are rather the effects than the causes of physical misery, and the surest mode of attacking them is to improve the physical condition of the lower classes, to abolish foul air, fouled water, foul lodgings and overcrowded dwellings, where mortality is difficult and common decency impossible.' When this is done not only will there be less suffering and disease, but there will be also a higher standard of morality and intelligence throughout the country¹²⁰

His words are quoted extensively here as they typify the kind of thinking that characterized the reformist movement then growing in America and illustrate the sentiments that motivated the man who would, more than any other, determine the direction of New York City's bacteriological laboratory.

Biggs had been brought up in a secure and rigid Yankee-Protestant environment and so readily accepted the obligations of his Christian commitment to serve mankind. Imbued with this sense of spiritual dedication he, like most Americans, was not greatly influenced by the logic of Social Darwinism, and so maintained that the state as well as the individual had an obligation to provide for those who were unable to help themselves.¹²¹ The objects of this Christian charity, the downtrodden of mankind--essentially the poor, ignorant, and foreign--were viewed not as equals but as inferiors and burdens to the educated and gifted members of society. The better classes had little choice, Biggs suggests, other than to accept their responsibility for the stewardship of the poor to prevent them from sinking into utter physical and

moral depravity. This monumental undertaking could best, and perhaps only, be accomplished through the massive application of the latest advances in medical science and then only through implementation of the coercive powers of the state. Governmental intervention into the lives of the lower classes was the sine qua non for improving the level of the nation's health; scientifically justifiable state action could thus at once serve the causes of Christian altruism and social utilitarianism.¹²²

Influential elements of Biggs' rearing were the examples and teachings of his father on the merits of discipline and hard work.¹²³ His early thinking reflects his acceptance of the work ethic which, along with his youthful idealism and optimism, created an almost missionary-like zeal to spread its gospel. Social and economic inequities could not be instantly wiped away, but the privileged could bring about somewhat of a spiritual and physical uplifting of the lower classes through forceful health improvement procedures which would lead, in time, to their greater productivity. Social control of the weak would not only provide moral benefits to society and allow the wise and well-born to justify their own chosen state, but would also serve the marketplace.¹²⁴

As a student at Bellevue Hospital Medical College Biggs enrolled in Welch's laboratory course and so impressed his teacher that he was given the key to the laboratory to pursue independent studies. After graduation he began his internship at Bellevue Hospital, working under a number of powerful and well-respected Senior Visiting Physicians, including A. L. Loomis, Austin Flint, Sr., E. G. Janeway, Abraham Jacobi, and Francis Delafield. Within months Biggs was informed by Dr. Frederick S. Dennis of the Bellevue staff that he would be recommended for the

position of first assistant at the soon-to-be-built Carnegie Laboratory.¹²⁵

He welcomed the chance to be associated with the first substantial institution in this country devoted entirely to medical research. Following a stint of a few months in German laboratories, he returned in March of 1885 as an instructor, under directors Dennis and Janeway.¹²⁶ Biggs' duties included teaching bacteriology, a subject in which he had not been able to receive instruction while overseas. While he was given free rein to pursue whatever investigations he wished--it appears that although classified as an instructor he was in practical charge of the laboratory--he developed a strong interest, and a rapid expertise, in microbiology.¹²⁷ Based on studies made at the Carnegie Laboratory, he supported Koch's identification of the comma bacillus as diagnostic, and most likely the source, of Asiatic cholera.¹²⁸ Twice he presented his views before the New York State Medical Association, once in 1886 when he discussed the relation of the tubercle bacillus to tuberculosis and once again in 1887 when he supported the findings of Koch, Ebert, and Gaffky which pinpointed the bacillus responsible for typhoid fever.¹²⁹ So that his students could learn the latest experimental techniques, and since he felt that no satisfactory guide existed in English, he translated Hueppe's text from the German.¹³⁰

Biggs' efforts were not to be confined to teaching and research, for he was soon drawn into a position of applying bacteriological methods beyond the walls of the laboratory. After only a few months at the Carnegie Laboratory he was dispatched to Plymouth, Pennsylvania, a community in the midst of a typhoid outbreak that struck over 1,000 of its 8,000

residents.¹³¹ The water supplies were subjected to chemical and bacteriological tests, including Koch's plate culturing method on solid beef-gelatin media, through which it was learned that many of the town's wells contained large numbers of bacteria. Biggs was not successful in finding the typhoid bacillus but was able to trace the origin of the epidemic to a particular home whose sewerage emptied into one of the public reservoirs. Notwithstanding his erroneous and rather vague assertion that the typhoid bacteria could have arisen spontaneously, he had now had first-hand exposure to the possibilities of employing laboratory procedures in the service of community health.¹³²

Months later, in November 1885, Biggs was personally sent to Paris by Andrew Carnegie in the company of four children who had been bitten by a mad dog. Biggs' role was to study Pasteur's method of treatment.¹³³

In 1880 the French scientist had noted the curious phenomenon that chickens inoculated with old cholera cultures not only showed no signs of the malady but, in addition, acquired immunity to it, as evidenced by later unsuccessful attempts to cause the condition in the same animals by inoculation of fresh virulent cultures. Recognizing that the finding might be illustrative of a general principle with enormous practical value, Pasteur developed an anthrax vaccine for cattle; in July 1885 he administered successfully a preparation of attenuated rabies germs to a young boy who had been savagely attacked by a rabid dog.¹³⁴ It was with such a rabies vaccine, produced from the spinal cord of an infected rabbit, that the American youngsters were immunized. Biggs became extremely enthused by what he saw in Pasteur's laboratory and suggested

upon his return, in a paper delivered before the New York County Medical Association, that similar preventive methods might be employed against other diseases.¹³⁵

The successful applications of diagnostic and prophylactic bacteriological procedures, in Plymouth and Paris respectively, had stirred Biggs. In none of his contemporary presentations on these experiences, however, does he give specific recommendations that public health agencies ought to adopt such measures, or that they ought to have their own laboratories. It is, however, very likely that Biggs was entertaining such thoughts since he was on close terms with T. Mitchell Prudden, to whom he often turned for advice.¹³⁶ Prudden had only recently returned from Europe. In light of his strong views on the matter of the alliance and public health,¹³⁷ and the future course of events, it seems quite probably that he influenced the younger man.

Biggs' association with local public health affairs had, in fact, already begun. In the summer of 1885, Dr. William M. Smith, Health Officer of the Port of New York, requested that he undertake experiments at the Carnegie Laboratory to determine the advisability of using sulphur dioxide to disinfect suspected germ-laden items brought in by immigrants. Rags soaked in solutions of various pathogenic microbes were placed in chambers from which air was evacuated, exposed to sulphur dioxide, and then used to inoculate culture tubes. In addition to Smith, other members of the city's Health Board showed an interest in the work and were present when the germicidal capabilities of sulphur dioxide against the spirilla of cholera and the streptococcus of erysipelas were demonstrated.¹³⁸

Two years later Biggs was again approached by Smith, this time with a more pressing health dilemma. On October 18 a young boy, who two days before had been removed ill from the quarantined ship *Britannia*, died of a condition that appeared to be Asiatic cholera.¹³⁹ Since the *Britannia* had come from the same Italian port as another ship which three weeks earlier had reported eight cholera deaths during its voyage, the Officer of the Port was alarmed that the seeds of an epidemic lay in waiting in New York's harbor.¹⁴⁰ It was essential, he felt, to learn whether the boy had true Asiatic cholera or the usually non-fatal, and non-epidemic, sporadic cholera. Symptomatically the two were difficult to distinguish and thus Biggs was summoned to settle the matter scientifically. He inoculated gelatin culture tubes with intestinal material from the dead boy and discovered, days later, microscopic organisms with the morphological and physiological characteristics of the comma bacillus, found by Koch to be diagnostic of the Asiatic form.¹⁴¹ Samples were sent to Prudden and J. J. Kinyoun of the United States Marine Hospital, both of whom ran similar tests and came up with the identical conclusions.¹⁴²

The four hundred immigrants were removed from the *Britannia* and thus, according to Biggs, "biological examination . . . [was] alone the cause of the exclusion of epidemic cholera from New York in 1887."¹⁴³ This claim is difficult to substantiate--more important is the practice that was being established, one which would be repeated in 1892 with more lasting effect. A city health official had, in time of potential crisis, turned for assistance to scientists familiar with diagnostic laboratory techniques and had based his subsequent actions on their

findings. Biggs, ever alert to the opportunity to advertise to his colleagues the effectiveness of the avenues for scientific medicine opened by bacteriology and the value of strong official action, presented a paper on the incident in November which was published in a local medical journal soon after.¹⁴⁴

The Health Commissioner during this time was Dr. Joseph D. Bryant, a knowledgeable and progressive administrator who had only months before been chosen for the position by Mayor Abraham Hewitt. Biggs, who had studied under him at Bellevue, was appointed by the new commissioner as one of three semi-official, unsalaried, Consulting Pathologists.¹⁴⁵ Over the following years, at Biggs' suggestion, Bryant advocated extending the Health Department's work to include a division of bacteriology and disinfection. He appealed, on a number of occasions, to the Board of Estimate and Appropriations for the funds to establish a municipal laboratory and for the creation of a corps of disinfectors, but to no avail.¹⁴⁶

The inability to secure the backing for a city laboratory for bacteriological investigations is, considering the times, not surprising. The number of physicians, within or outside the Health Department, convinced of the practical applications of the Germ Theory and concerned with community health problems, had not risen to a number sufficient enough to create a ground swell of demand that the growing body of knowledge on the microbial origins of disease ought to be channeled into workable services in the public sector. The public and press were also lethargic on this matter since the normal stimulus for reform, a health crisis or fear of an impending one, did not present itself.

What was needed was an active champion of the cause of public

health bacteriology. The logical choice was Biggs. He, however, served as pathologist to Bellevue and City Hospitals, taught pathological anatomy, clinical medicine and therapeutics, was a visiting physician to Bellevue and the Workhouse and Almhouse Hospitals, and continued at the Carnegie Laboratory;¹⁴⁷ with such a schedule his ability to crusade for the establishment of a Health Department laboratory had to be quite restricted.

Bryant's initial commitment to a laboratory was probably not as strong as Biggs', but in addition he had a host of other problems which limited his time and affected his ability to introduce change. One of his goals was to soothe relations between the physicians and the Board of Health. New York's doctors had long been disturbed by Tammany's influence on the department and the patronage system, practiced widely and openly. From the early years of the Metropolitan Board of Health they complained that too many of the department's appointments were being made to individuals with no medical training; they were especially upset by the regulation that the president of the health board had to be a layman.¹⁴⁸ In view of such circumstances it is to Bryant's credit that he was successful in introducing contagious disease rules requiring doctors to report more information to the Health Department than in the past and yet be able to elicit the beginnings of a spirit of cooperation with the medical profession--members of the New York Academy of Medicine, after a conciliatory address by Bryant, chose a committee to work to bridge the gap between the two.¹⁴⁹

Physicians, at this time, were also engaged in elevating their professional stature and, as part of this process, seeing to it that

their bailiwick was not reduced by the activities of non-professionals. The involvement of health workers in areas they considered the domain of the private practitioner was thus strongly resented.¹⁵⁰ And yet, if there was any opposition to a city laboratory by doctors fearful that such a facility would provide medical services infringing on their sphere, and affecting their incomes, it did not surface in the literature. On the contrary, an occasional voice could be heard expressing disappointment with the sluggishness of New York's health officials in utilizing microbiological laboratory techniques.¹⁵¹

The city's physicians presented little hindrance to Health Department activities. Bryant, however, met resistance in his efforts to combat interference from the Tammany organization and in his attempts to curtail its practice of placing favorites in Health Board positions. In 1889 a try was made by club-house politicians to remove Bryant from office on charges that he had violated section 606 of the Consolidation Act requiring the Board of Health to keep records of all births, marriages, and deaths.¹⁵² The charges did not hold up, but three years later the Tammany machine was able to exert its influence to force the resignations of Sanitary Superintendent Dr. W. A. Ewing and Health Board counsel W. P. Prentice, and replace them with partisan choices. The power play was so offensive that in a public display of displeasure three board consultants, Drs. Abraham Jacobi, T. Mitchell Prudden, and Stephen Smith, resigned their positions.¹⁵³ Jacobi lashed out that the Health Board "no longer an independent body for the public good . . . has become subservient to an outside influence who knows nothing about or cares nothing for the public health."¹⁵⁴

Tammany's muscle and its willingness to use it in Health Department affairs for its own political ends might have been a factor delaying the formation of a city bacteriological laboratory. Bryant's lack of success in establishing such a facility, despite his advocacy of it since 1887,¹⁵⁵ was quite possibly due to his fear that, if he were to take it upon himself to introduce innovation, such action would be used by his enemies to his embarrassment or as a pretext for his dismissal.

The efforts of Bryant, Biggs, and Prudden were not sufficient to convince authorities of the advantages of updating public health care through the incorporation of bacteriological methods and the encouragement of related research. Where logic failed, however, disaster succeeded; the cholera epidemic of 1892 was to be the catalyst responsible for the establishment of the New York City Health Department's division of bacteriology.

* * * * *

The arrival of cholera in the fall of 1892 could hardly have occurred at a worse time. Not in twenty years had there been a July and August as continually hot; hundreds slept on tenement rooftops and windows and the Croton water was actually too warm to drink after traveling through miles of pipe.¹⁵⁶ The hospitals were already crowded and the mortality figures high when diplomatic officers cabled, and press dispatches verified, that Asiatic cholera was moving in a devastating path from India to Persia, to Russia, and had reached Western Europe.¹⁵⁷

The Treasury Department, attempting to minimize opportunities for the plague to enter the United States, issued an order that no vessel

having on board rags, furs, wools, or hides from cholera-infected districts was to be allowed in American ports unless it had certification that the ship and its contents had been thoroughly disinfected.¹⁵⁸ On August 18 the order was extended to include the personal belongings of passengers. It was to go into effect exactly one month later to allow time for compliance since articles were to be disinfected at the point of embarkation.¹⁵⁹ The decree had a minimal effect in New York, port of entry to three of every four immigrants, as the systematic disinfection of the possessions of new arrivals from the Continent, Russia, and Poland had already begun months earlier following the outbreak of typhus fever on an incoming vessel.¹⁶⁰

A matter of great local concern was that fatal cholera would penetrate Germany and reach the city of Hamburg, a busy point of departure for thousands immigrating to America.¹⁶¹ The worst fears were realized. The first case was reported on August 16 and, by September 1, over 3,000 deaths had occurred, officially attributable to Asiatic cholera.¹⁶²

The reaction of the New York City Health Department to European developments was swift and predictable. An accelerated program of street cleaning was instituted, tenements were carefully inspected and disinfected (when unsanitary conditions were found), and the food and water supplied to the city came increasingly under the scrutiny of inspectors.¹⁶³ In the midst of this activity the steamship *Moravia* arrived, on August 30, from Hamburg with cholera aboard and with the news that twenty-two passengers were buried at sea after having succumbed to severe intestinal attacks.¹⁶⁴

Health officials visited the vessel the following day and demanded that passengers be transferred to Quarantine on Hoffman Island where all were to be scrubbed and disinfected. Every piece of luggage was to be put in a steamroom and orders were given to fumigate the Moravia with sulphur from top to bottom and to scrub its interior with a strong solution of bichloride of mercury. Until the immigrants were unloaded and the ship disinfected, word was left by the Health Officer of the Port, Dr. W. T. Jenkins, to "shoot on sight any man who attempted to board the vessel."¹⁶⁵

The precautionary measures taken in response to the plague lying in New York's harbor reflect the transitional nature of the times. There was no serious mention of the filth concept of the disease in the medical or popular literature, such phrases as "poisonous emanations" and "miasmas" were rapidly becoming anachronistic (even the newspapers nonchalantly referred to "cholera-germs"),¹⁶⁶ and yet great efforts were made to see to it that the streets were kept especially clean.¹⁶⁷ Another vestige of the older thinking was the orders issued to the police to arrest peddlers selling ripe or rotten fruit, decaying fish, and other such, presumably, cholera-inducing matter.¹⁶⁸ A circular released by the Health Department informed the public that "Healthy persons 'catch' cholera by taking into their systems . . . the germs of the disease," and yet, reminiscent of the moralistic admonitions of earlier episodes, encouraged modest and clean living and warned against excesses in eating or drinking.¹⁶⁹ Dr. Cyrus Edson, Sanitary Superintendent, publicly advocated methods of treatment that were more "heroic" than effective.¹⁷⁰

Clearly, though, the emphasis had shifted and the bulk of the

city's preparations were consistent with the best medical knowledge of the day. Plans were drawn up for the thorough disinfection of cellars, gutters, sinks, and tenement yards.¹⁷¹ Even the quarantine, then in effect, was seldom challenged--the major issue surrounding this measure, based on the assumption of the communicable nature of disease, was what level of government could most effectively assume the responsibility for its successful imposition.¹⁷² Circulars were sent to factories, ferries, and railroad companies informing them of the best means to detail and isolate individuals taken ill with cholera, and mail from overseas was fumigated.¹⁷³

On August 31 Biggs was called in to conduct bacteriological examinations to determine positively the cause of the deaths aboard the Moravia. On the same day Health Department president Charles G. Wilson disclosed that the chemical laboratory at 42 Bleeker Street had been improved so that research in bacteriology could be conducted there. The new facility was to be used for differential diagnosis in difficult cases, for "scientific investigation in regard to the bacilli of cholera, yellow fever, anthrax, etc.," for bacterial counts of Croton water, for testing foods for pathogens, and for determining the value of different disinfectants and germicides.¹⁷⁴

The timing of Wilson's announcement of this reorganized laboratory with its emphasis on bacteriological work seems rather suspect. Could it have been sheer coincidence that it was revealed on the very day that the city found itself in a situation where just such a facility would be beneficial?--possible, but not probably. More likely, it seems that Wilson was attempting to convince the public and the media that the

Health Department had at its disposal the most modern procedures available and was adequately prepared for emergencies. His reassurances, however, seem far from honest, for a number of reasons. The "new" laboratory did not have the equipment necessary to conduct the ambitious program he outlined, nor is there any indication that it had personnel trained in microbiological techniques--the existing head of the "reorganized" laboratory and his assistant were both chemists.¹⁷⁵ A search of the department's Annual Report for 1892, local papers, and medical journals reveals no mention of this laboratory prior to August 31. Furthermore, when a division of bacteriology was established days later, its diagnostic work was not conducted at Bleeker Street, as would have been most natural if this location were as ideally equipped as Wilson indicated.¹⁷⁶

In a similar vein, when questioned in regard to the possible contamination of the Croton watershed (a frightening possibility since cholera germs disseminate in drinking water), Wilson responded that it was in good condition as determined by "exhaustive" weekly examinations.¹⁷⁷ A glance at Health Department reports belies this statement. Chemical analyses were carried out on a regular schedule, but there is no indication that any specific tests were conducted to determine the presence of bacteria despite the fact that the water was often described as turbid and yellowish-brown in color.¹⁷⁸

Why Wilson had to stoop to hyperbole and deception to create the impression that the department had the ready expertise, experience, and necessary tools to apply the latest bacteriological measures to the imminent health emergency is a matter of conjecture. As president it is

to be expected that he would attempt to prevent alarm and provide a sense of security to the city's millions. Other factors, however, seem instrumental in explaining his behavior. His presidency was marked from the beginning with controversy, he was accused of being unfit, a liar, a manipulator, and a tool of Tammany; only two months earlier he was implicated in the stormy protest that resulted in the resignations of a number of Health Department consultants.¹⁷⁹ His posturing was thus perhaps intended as a defense for himself and the city department he represented against anticipated criticisms of unpreparedness and general malfeasance. Of particular interest here, and indicative of an awareness of the beginnings of an appreciation of the Germ Theory by some of the better-informed members of the public, is that Wilson placed such emphasis on the readiness to employ the laboratory methods of the bacteriologist.¹⁸⁰

Despite the bad press he had received in the past, Wilson never did come under attack during the cholera scare, intensified by the arrival on September 3 of the steamships *Normannia* and *Rugia* from Hamburg. During the voyages five passengers on the *Normannia* and four on the *Rugia* had died of what was diagnosed as "cholera." Both ships were immediately quarantined in the lower bay; before the first day was over three more had died.¹⁸¹ To determine if the disease were truly Asiatic cholera, the procedure of fecal bacterial examination--employed by Koch and his aides on thousands of Germans after the disease struck Hamburg in August--was adopted. Discharges from patients (there were a number of ill aboard both ships) were sent to temporary laboratories set up by Drs. J. M. Byron and Abbott on Swinburne Island and to William Welch at Johns Hopkins University.¹⁸² Further testimony of the growing

faith in scientific medical methods was the confident attitude of the Times that the bacteriologists could provide definitive diagnosis since they were now provided with infected body fluids from stricken passengers.¹⁸³

News of the two plague-ridden ships spread rapidly. As more fatalities occurred aboard the Normannia, Rugia, and Moravia, over the following days, panic set in among the over 1,900 people remaining in Quarantine.¹⁸⁴ On the mainland, health officials reacted swiftly and instituted a variety of precautions with the cooperation of other branches of government. The streets of New York were cleaned and washed as never before, Croton water was carefully inspected, the police cracked down harshly on food purveyors who violated sanitary regulations, extra physicians were sworn in to conduct house-to-house inspections, hospitals were readied, communications were arranged to guarantee the quick disinfection of infected tenements, and police boats patrolled the harbor to prevent any unofficial contact with the detained passengers.¹⁸⁵ A number of municipal, state, and federal officials visited contaminated vessels to see that maximum care was being observed, and the United States Navy readied three ships for patrol duty to enforce the President's twenty-day quarantine.¹⁸⁶

The wide range of fervent activities going on did not succeed in quelling, and perhaps contributed to, the growing public fear that the scourge could not be confined to the harbor.¹⁸⁷ Commissioner Bryant, seizing the opportunity, approached the Board of Estimate and Apportionment which had denied similar requests in the past, and recommended that the funds be allocated for the outfitting of a Health Department

laboratory to provide the bacteriological services for the diagnosis of epidemic cholera and other infectious diseases, for the establishment of a modern disinfecting plant and the formation of a corp of disinfectors.¹⁸⁸ The timing was perfect for, as Bryant was certainly aware, anxious Board members had informed the mayor and Health Department authorities on September 2 that there would be no trouble in furnishing revenues, in any amount, for any purpose, without delay, to meet the emergency.¹⁸⁹

On September 9 agreement was reached to create the Division of Pathology, Bacteriology, and Disinfection.¹⁹⁰ The plans for this new department received no public attention for a few days; the efforts of the media were directed at exposing the horrendous conditions in Quarantine and at reporting the struggle to move the detained passengers to new locations.¹⁹¹ On September 14 a small notice appeared that on the previous day the Board of Health had formally adopted the following resolution:

Whereas, The Advancement of the knowledge of the prevention and detection of disease is both rapid and effective; and, Whereas, It should be the policy of this department to keep step with every advancement intended to prevent the inception and spread of disease; therefore, be it Resolved, That a division known as the Division of Pathology, Bacteriology, and Disinfection of this department be and is hereby created. Resolved That Prof. H. M. Biggs be and is hereby appointed Chief Inspector of such division (subject to civil service examination) at a salary of three thousand dollars (\$3,000) per annum.¹⁹²

The Board's action brought no immediate changes; it merely gave official sanction to create a division to provide services which were in fact already being furnished at a de facto city laboratory, the Carnegie Laboratory, by the man chosen to head the new unit. When the first local case of Asiatic cholera (as diagnosed by the attending doctors) had been

reported to the Health Department on September 6, that of a laborer who had collapsed and died after suffering through the typical course of the disease--severe diarrhea and vomiting, followed by persistent cramps in the abdomen and limbs--it was Biggs who was called in to investigate.¹⁹³ The body was taken to the Carnegie Laboratory where an autopsy was performed and boullion medium inoculated with the intestinal contents of the victim. By September 10 characteristics cultures were evident; when examined microscopically they revealed an abundance of cholera bacilli.¹⁹⁴ To be certain that no error had occurred, the results were not reported to the Health Department for days, until Biggs received confirmation of his diagnosis from T. Mitchell Prudden.¹⁹⁵ Over the next three weeks, twenty-three other suspicious cases were similarly examined--eleven revealed the presence of the comma bacillus of epidemic cholera, nine of which were fatal.¹⁹⁶ Concerned with the accuracy of his results, and with the reputation of the new division at stake, Biggs not only sent cultures to Prudden (who stayed on in the Health Department as a Consulting Pathologist and Bacteriologist) and Dr. Henry P. Loomis (same title) for confirmation, but also to other prominent bacteriologists.¹⁹⁷ Among those contacted who conducted examinations, and who agreed in every case with the original diagnosis, were Dr. Harold Ernst (Professor of Bacteriology at Harvard Medical School), Dr. George M. Sternberg (Deputy Surgeon General of the United States Army, now acting as Consulting Bacteriologist to the New York Quarantine Station), Dr. J. M. Byron, Dr. J. J. Kinyoun (of the United States Marine Hospital Service, then guiding the disinfection of some of the quarantined ships), Dr. Petri (Chief of the Bacteriological Department of the Imperial

Board of Health of Germany), and Dr. William Welch.¹⁹⁸

The knowledge that the means were available to conduct biological diagnosis of Asiatic cholera and that scientific methods for its eradication were readied, was used to boost the hope that the chances of the malady's taking a foothold were extremely slim.¹⁹⁹ Bacteriological testing procedures were patiently explained to the public and official pronouncements on the course of the disease, as determined by the results of individual laboratory tests on suspected cases, were issued by the Health Department, with the clear notification that the information was received from the Carnegie Laboratory.²⁰⁰

When a positive diagnosis was made, or whenever a health inspector believed it likely that a particular home harbored the cholera microbes, a Health Department crew was dispatched to disinfect the quarters. This activity, carried out for a number of years on an ad hoc basis under the general guidance of the Bureau of Contagious Disease, was now placed under the direction of Biggs, who was assigned nine medical inspectors and sixteen disinfectors for this purpose. Suspected lodgings were scrubbed with bichloride solution, water pipes and sinks were flushed with disinfectant, all rooms were fumigated, while clothing and bedding were removed in department vehicles to a plant on Sixteenth Street where they were treated or cremated. Circulars were distributed (in English, Spanish, German, French, Hebrew, and Italian) to tenement dwellers entitled "Prevention of Cholera Easier Than Cure," which stressed the necessity of personal cleanliness and care in handling food.²⁰¹

Much to the relief of New Yorkers, no outbreak of Asiatic

cholera took place--the eleven victims (which included one resident of New Brunswick, New Jersey) were most likely the only true cases of the illness in the metropolitan area.²⁰² Considering the sequence of events, i.e., the inception of the municipal laboratory at the height of the anxiety, succeeded by the absence of any epidemic, it becomes rather tempting to assume a causal relationship between the two.²⁰³ There is, however, little support for this contention. In the first place, the positive identification of cholera bacteria was made, in eight out of eleven instances, from the intestinal contents of individuals who had already died.²⁰⁴ Any possibility that germ-laden dejects from these people could have entered the digestive system of others through handling of clothing or bedding, or through the water supply (common sources of transmissions) would have most likely already occurred; the fumigation and disinfection which followed were carried out after the period of greatest contamination had passed. In addition, the confirmed cases were widely disseminated and gave no indication of being related; the efforts of Biggs and his associates to question the families of the cholera victims to find the source of infection--an endeavor which if successful and followed up on might have given credence to the claim that the bacterial diagnoses were instrumental in turning back an epidemic--were met with resistance and false responses.²⁰⁵ Finally, scientific procedures of determining the existence of pathogenic microorganisms among members of a population can be of only limited value to the community as long as effective devices for prevention and treatment are unknown.²⁰⁶

The specific laboratory tests performed by Biggs and Dunham at

the Carnegie Laboratory broke no new ground, nor was there any great controversy surrounding their assumption that the presence of the cholera comma bacillus was sufficient grounds for a positive diagnosis. Reports in American journals on Koch's thorough studies in India and Egypt had by 1885 already convinced even the most conservative members of the New York County Medical Association that a distinct comma-shaped microorganism was characteristic and pathognomonic of Asiatic cholera.²⁰⁷ By 1892 it had become a matter of general medical consensus that Koch's germ presented certain identifiable growth patterns and chemical reactions that made its laboratory identification a simple and very dependable procedure.²⁰⁸

The matter of priority arises, and here too there is really no basis for considering the city laboratory, in its initial form, as a distinctly unique institution for America.²⁰⁹ As a public facility emphasizing bacterial studies it was predated by the laboratory opened in 1888 at the nearby Marine Hospital on Staten Island where, in its first year, diagnostic cholera tests were conducted on immigrants.²¹⁰ Public health laboratories were also already established in Providence, Rhode Island, by the progressive Charles V. Chapin, in the state health department of Michigan by Victor C. Vaughan, and in Massachusetts where experimentation was guided by William T. Sedgwick--their efforts, however, were directed mainly towards food and water analysis.²¹¹

Forerunners can even be found in New York's own past; the Metropolitan Board of Health in its first year, 1866, invited Professor Charles F. Chandler, a Columbia University chemist, to prepare quarters for the testing of food and water and for the detection of adulterated

liquor and poisonous cosmetics.²¹² Health officers depended heavily on chemicals to detoxify miasma sources and so set aside space on Mulberry Street for investigating disinfectants.²¹³ In 1874 the legislature approved a bill providing for a special corps of vaccinators and a laboratory for the preparation of vaccine.²¹⁴ In the same year some simple experiments were undertaken on the pathology of diphtheria which included some microbiological procedures.²¹⁵

None of these activities, however, created any significant philosophical change in the city's health program or notably affected the deliverance of health services. The vaccine laboratory was primarily a production plant for smallpox vaccine while the "research" on disinfectants was uninspired and out of touch with the giant strides being made in bacteriology.²¹⁶ By 1891 the Health Department's only legitimate laboratory consisted of two cramped, dingy rooms where an undersized staff of chemists tried to keep up with the immense task of determining whether the sources of the fish, meat, milk, and fruit samples brought to them by Sanitary Inspectors and Sanitary Police ought to be seized and condemned.²¹⁷

The new Division of Pathology, Bacteriology, and Disinfection was thus not a totally novel creation, either in terms of its emphasis on bacteriology or in its reliance on the laboratory as a functioning unit of a municipal health department. What was unique was the unifying of the two on a permanent basis, with long-range objectives. Other emergency laboratories had been set up by local governments to conduct cholera diagnoses but were disbanded following the passage of the menace.²¹⁸ In New York, the bacteriological laboratory would continue, not merely

as a stop-gap to be evoked when calamity threatened, but as an active, integral component of its Health Department, and would reshape the city's approach to health care, mitigate enormous suffering and untimely deaths, and influence other public health bodies and the history of medicine in the process.

NOTES

¹New York Times, September 1, 1892, pp. 1, 2 (hereinafter cited as Times); September 4, 1892, p. 1; September 10, 1892, p. 1; Reynold W. Wilcox, M.D., "The Cholera of 1892 in New York: Its Prophylaxis and Treatment," American Journal of the Medical Sciences, n.s., CV (January, 1893), 59 (hereinafter cited as Am. Jnl. of Med. Sci.); Hermann M. Biggs, M.D., "History of the Recent Outbreak of Epidemic Cholera in New York," Am. Jnl. of Med. Sci., n.s., CV (January, 1893), 63-64.

²Ibid., pp. 64-68; Times, September 2, 1892, pp. 1, 2; September 3, 1892, pp. 1, 2, 5; September 4, 1892, pp. 1, 2; September 5, 1892, pp. 1, 5; September 6, 1892, pp. 1, 5; September 7, 1892, p. 2.

³Ibid., September 1-September 20, 1892, p. 1.

⁴Ibid., September 14, 1892, p. 2.

⁵Charles E. Rosenberg, The Cholera Years: The United States in 1832, 1849, and 1866 (Chicago: The University of Chicago Press, 1962), pp. 17-32, 114; A. Brigham, Treatise on Epidemic Cholera, Including a Historical Account of its Origin and Progress to the Present Period (Hartford, Connecticut: H. & F. J. Huntington, 1832), pp. 138-139. For additional historical information on the disease see H. Harold Scott, History of Tropical Medicine (London: Edward Arnold & Company, 1939), II, 649-659.

⁶Report of the Commissioners Employed to Investigate the Origin and Nature of the Epidemic Cholera of Canada (New York: Board of Health, 1832), pp. 11-68.

⁷Ibid., p. 9.

⁸Brigham, pp. 139, 233, 235-236, 243; Rosenberg, pp. 166-168.

⁹Ibid., pp. 7, 30, 40-54.

¹⁰Ibid., pp. 57-58.

¹¹Brigham, p. 242.

¹²Chamber, pp. 17, 23, 85-88.

¹³Ibid., p. 32.

¹⁴Rosenburg, p. 114; Report of the Proceedings of the Sanatory Committee on the Board of Health in Relation to the Cholera as it Pre-vailed in New York in 1849 (New York: New York City Board of Health, 1849). This report contains some enlightening information on the supposed association between cholera and immoral behavior. See pages 16, 31-32.

¹⁵Rosenburg, pp. 85, 88, 111-112; John Duffy, "Science and Medicine," Science and Society in the United States, ed. David D. Van Tassel and Michael G. Hall (Homewood, Illinois: The Dorsey Press, 1966), p. 128.

¹⁶During this period the ailment accounted for about 2 percent of the city's total mortality. From Biggs, "The Health of the City of New York," Transactions of the New York Academy of Medicine, 2nd ser., XII (1895), 446. (Hereinafter cited as Trans. of N.Y.A.M.) The effectiveness of sanitary regulations during this time is difficult to assess. New York experienced no devastating attack of Asiatic cholera, most likely because there was no pandemic during these years; the disease began a decline in the United States following the 1849 epidemic. See John Duffy, A History of Public Health in New York City, 1866-1966 (New York: Russell Sage Foundation, 1974), p. 13.

¹⁷Times, August 5, 1865, p. 1; August 24, 1865, p. 2; Scott, II, 652.

¹⁸Times, November 14, 1865, p. 4.

¹⁹Times, March 16, 1865, p. 8; March 17, 1865, p. 17; March 22, 1865, p. 2; March 29, 1865, p. 4; March 30, 1865, p. 2; "We're 100 Years Old . . . Centennial Highlights," Inside Health, XIII, no. 7 (April 29, 1966), 2.

²⁰Times, March 25, 1866, p. 5; May 6, 1866, p. 4.

²¹Times, April 15, 1865, p. 4.

²²Ibid., February 7, 1866, p. 4; February 9, 1866, p. 4; February 13, 1866, p. 4; February 14, 1866, p. 4; February 21, 1866, p. 4; Duffy, A History of Public Health in New York City, 1866-1966, p. 1.

²³Inside Health, p. 2; Charles Bolduan, M.D., Over a Century of Health Administration in New York City, No. 13 of Monograph Series (23 vols.; New York: New York City Health Department, 1916), p. 16; Times, April 19, 1866, p. 5; April 22, 1866, p. 4.

²⁴Charles Leale, "A Study of Asiatic Cholera During the Epidemic of 1866," New York Medical Journal, XXXI (January 24, 1885), 95 (hereinafter cited as N.Y. Med. Jnl.), April 28, 1866, p. 4; May 6, 1866, p. 4; June 8, 1866, p. 4; June 17, 1866, p. 4; July 28, 1866, p. 4. For an elaboration of this view see the paper of Dr. John W. Sterling, former Physician-in-Chief of Marine Hospital, Staten Island, in the

Minutes of the Proceedings of the National Quarantine Convention (Philadelphia: Crissy and Markley, 1857), pp. 54-56.

²⁵Annual Report of the City Inspector, 1851 (New York, 1852), pp. 350-443; 473-476; 1852, pp. 104-271, 281-283, 285-294; 1855, pp. 5-148, 180-207; 1856, pp. 4-138, 194-207; 1857, 4-140, 190-213; 1859, 3-123; 1860, 19-38, 63-166; 1861, 11-25, 79-226; 1862, 6-24, 31-308; 1864, 10-12, 13-336; 1865, 7-123, 133-301.

²⁶The Health Department was faced with the herculean task of regulating offensive trades and nuisances; slaughtering, tallow and lard rendering, stabling, manure removal, and the yarding of swine and cattle were some of the activities subject to inspection. See Ann. Rep., Bd. of Health, 1870-1871, p. 10. In addition, the city's streets were in a slovenly state, a problem which grew worse as the influx of immigrants caused the population to become more and more dense. The streets reeked from the heavy odors of excrement, bones, the decayed remains of slaughtered animals and dead pets, sweepings from the thousands of tenement dwellings, and the varied rubbish from factories. For a lurid picture of conditions see the following: Ibid., p. 11; John H. Griscom, The Sanitary Condition of the Laboring Population of New York, With Suggestions for its Improvement (New York: Harper and Bros., 1845), passim.; and a report on New York in the mid-1860s by a key moved in securing passage of the Metropolitan Health Bill, Stephen Smith, The City That Was (reprint, published originally in 1911; New York: Library of the New York Academy of Medicine, 1973), pp. 49-151.

²⁷James J. Walsh, History of Medicine in New York: Three Centuries of Medical Progress (New York: National Americana Society, Inc., 1919), I, 240; Richard Shryock, Medicine in America, Historical Essays (Baltimore: The Johns Hopkins Press, 1966), p. 128.

²⁸Ann. Rep., Bd. of Health, 1870-1871, pp. 10-12; George Rosen, A History of Public Health (New York: MD Publications, Inc., 1958), p. 234; Leona Baumgartner, "One Hundred Years of Health," Bulletin of the New York Academy of Medicine, XLVI, no. 6 (June, 1969), 557-558 (hereinafter cited as Bull. of N.Y.A.M., Bolduan, Over A Century of Health Administration in New York City, p. 11.

²⁹Walsh, p. 241; Rosen, A History of Public Health, p. 235; "The New Health Law," Medical Record, V, no. 4 (April 15, 1870), 85.

³⁰Times, September 1, 1865, p. 2; October 31, 1865, p. 2; March 26, 1867, p. 8; March 17, 1868, p. 2; April 11, 1877, p. 4; May 9, 1877, p. 2; March 12, 1876, p. 4; March 11, 1879, p. 8; October 23, 1881, p. 16; November 24, 1881, p. 3; December 10, 1881, p. 2; June 1, 1883, p. 4; December 29, 1889, p. 5; August 18, 1889, p. 9.

³¹Metropolitan Board of Health, Address to the Public, circular distributed to the public, March 1866, p. 1.

³²Bolduan, Over a Century of Health Administration in New York City, p. 3.

³³Biggs, Trans. of N.Y.A.M., 2nd ser., XII (1895), 430.

³⁴Harry Wain, A History of Preventive Medicine (Springfield, Illinois: Charles C. Thomas, 1970), p. 253.

³⁵Baumgartner, Bull. of N.Y.A.M., XLVI, no. 6 (June 1969), 558; Biggs, Trans of N.Y.A.M., 2nd ser., XII (1895), 435; Bolduan, Over a Century of Health Administration, p. 11.

³⁶Sir Edwin Chadwick's Report on the Sanitary Condition of the Labouring Population of Great Britain (London: W. Clowes and Sons, 1843), pp. 122-273, the bible of the sanitary reformers, stressed that a clean environment was possible and would contribute to a significant improvement in community health.

³⁷Erwin H. Ackerknecht, "Anticontagionism between 1812 and 1867," Bulletin of the History of Medicine, XXII, no. 5 (1948), 563-566.

³⁸Robert Reid, Microbes and Men (Saturday Review Press, 1975), p. 15; Wain, pp. 7-10, 53.

³⁹Ibid., p. 62.

⁴⁰Esmond R. Long, A History of Pathology (New York: Dover Publications Inc., 1965), pp. 105-107; Duffy, Science and Society in the United States, p. 125.

⁴¹Isaac I. Taylor, M.D., "Antiphlogistics in Diseases of Children," Medical Record, V, no. 11 (September 1, 1870), 305-307; "A Plea for Bloodletting," Medical News, XLI (October 7, 1882), 417-418; S. Baruch, M.D., "Advances in the Treatment of Fever," The Independent, XLIX (October 7, 1897), 5.

⁴²"Treatment of Scarlet Fever," Medical Record, VII, no. 16 (October 15, 1872).

⁴³C. C. Terry, M.D., "The Use of Sulpho-Carbolate of Potash and of Lactic Acid as Solvents of Croupous Membrane," Medical Record, V (March 15, 1870), 52-53.

⁴⁴"The Treatment of Malignant Tumors by Electrolysis," Medical Record, V (October 1, 1870), 355-356; A. D. Rockwell, "Electricity in Gynecology," N.Y. Med. Jnl., SLVI (November 12, 1887), 542-546.

⁴⁵"The Treatment of Tetanus," Am. Jnl. of Med. Sci., n.s., CV (February 1893), 188.

⁴⁶Frederick Peterson, M.D., "Hydrotherapy in the Treatment of Nervous and Mental Diseases," Am. Jnl. of Med. Sci., n.s., CV (February 1893), 132-140.

⁴⁷John Bell, M.D. "Observation on the Adirondack Mineral Springs," Medical Record, V (March 1, 1870), 33-34; James E. Newcomb, "Doses and Kinds of Medicine," The Independent, XLIX, (October 7, 1897), 4; Henry B. Millard, "Marienbad and Its Waters and Baths," N.Y. Med. Jnl., XLI (January 17, 1885), 67-68.

⁴⁸Ibid., p. 3; Austin Flint, M.D., A Treatise on the Principles and Practice of Medicine (4th ed.; Philadelphia: Henry C. Lea, 1873), pp. 126-127; "Our Therapeutics," Medical Record, V (June 15, 1870), 181.

⁴⁹"Quackery and the Press," Medical Record, V (April 1, 1870), 61-62.

⁵⁰Gerald Geison, "Louis Pasteur," Dictionary of Scientific Biography, ed. Charles C. Gillispie, X (New York: Charles Scribner's Sons, 1974), pp. 372-376; Jean Theorides, "Casimir Davaine," ibid., III, p. 587; William Bulloch, The History of Bacteriology (London: Oxford University Press, 1938), pp. 180-181.

⁵¹Charles-Edward Armory Winslow, "The Life of Hermann M. Biggs" (Philadelphia: Lea and Febiger, 1929), pp. 53-54 (hereinafter cited as Life of Biggs); Wain, p. 246.

⁵²Ibid.; Winslow, Life of Biggs, p. 54; Simon Flexner, M.D., and James Thomas Flexner, William Henry Welch and the Heroic Age of American Medicine (New York: The Viking Press, 1941), p. 146 (hereinafter cited as Welch and The Heroic Age).

⁵³Rosen, A History of Public Health, p. 314.

⁵⁴Ibid., pp. 314-315; Vallery-Radot, pp. 299-301.

⁵⁵Rosen, A History of Public Health, p. 314.

⁵⁶H. H. Cunningham, Doctors in Gray: The Confederate Medical Service (Baton Rouge: Louisiana State University Press, 1958), pp. 184-185, 190-202.

⁵⁷George W. Adams, Doctors in Blue: The Medical History of the Union Army in the Civil War (New York: Henry Schuman Inc., 1952), pp. 15, 20.

⁵⁸Ibid., p. 18; Cunningham, pp. 108-109. Tar was burnt in the vicinity of hospitals to ward off malaria miasma and yet, in one area where reliable records were kept, 41,539 cases of the disease were reported among 25,723 troops in a 19-month period (ibid., p. 190).

⁵⁹Ibid., p. 3.

⁶⁰Adams, p. 56.

⁶¹Cunningham, pp. 194, 202.

⁶²Adams, p. 56.

⁶³One physician who served during the war reminisced on how operations were carried out by surgeons wearing old blood-stained, pus-stained coats, with instruments from undisinfected cases which had been used in prior pus cases and cleaned only by being held for a few seconds under tap water. Silks, "moistened with bacteria-laden saliva" and rolled "between bacteria-infected fingers," were used to tie up wounds. In Major W. W. Keen, M.D., "Military Surgery in 1861 and 1918," The Annals of the American Academy of Political and Social Science, LXXX (November 1918), 11-12.

⁶⁴Adams, p. 139.

⁶⁵Keen, p. 15.

⁶⁶Ibid.; Adams, pp. 138-139; Cunningham, p. 222.

⁶⁷Ibid., p. 117.

⁶⁸Ibid., p. 3; Adams, p. 3.

⁶⁹Keen, pp. 11-12. The recent revelations of cellular pathologists led some to consider the infectious process as solely a physiological alteration of body tissues to intrinsic factors. For such a view see Abraham Jacobi, M.D., "Antiphlogistic Treatment in Children," Medical Record, V (April 15, 1870), 9. Others remained unpersuaded, noting that the same microorganisms are often found in totally different pathological conditions, or shrugged off bacteria as accidental rather than causative entities. See "The Parasitic Theory of Diphtheria," Medical Record, X (January 16, 1875), 41. One physician hypothesized that "animiculae" arose spontaneously and actually aided the ill by removing the putrative material from the body. See Ezra M. Hunt, M.D., "Some Remarks on Diphtheria," ibid., p. 58.

⁷⁰Flint, A Treatise on the Principles and Practice of Medicine (4th ed., 1873), pp. 105-110.

⁷¹Ibid., p. 107.

⁷²Bernhard J. Stern, Social Factors in Medical Progress (New York: Columbia University Press, 1927), pp. 11-15, 24, 30. Even those American doctors who showed a genuine desire to learn about microbes were limited by the sparsity of literature. No book in English was available until the publication, in 1884, of Edward E. Klein's Micro-Organisms and Disease; the first book by an American was Introduction to Practical Bacteriology, by Thomas E. Satterthwaite, published in 1887. Howard D. Kramer, "The Germ Theory and the Early Public Health Program in the United States," Bulletin of the History of Medicine, XXII (May-June 1948), 240.

⁷³Because vaccination assumed a contagion in the etiology of smallpox, the controversy concerning the procedure became intertwined with that surrounding the role of microbes in disease. Its association with "quacks," and the occasional secondary infections caused by vaccination, tended to reflect poorly on the Germ Theory, largely through the efforts of a small but vocal number of anti-vaccinationists. Martin Kaufman, "The American Anti-Vaccinationists and Their Arguments," ibid., XLI (September-October 1967), 474-475.

⁷⁴Alfred L. Loomis, M.D., "A Clinical Lecture on Relapsing Fever," Medical Record, V, no. 1 (March 1, 1870), 5-8.

⁷⁵Flexner and Flexner, p. 119.

⁷⁶Ackerknecht suggests that the conservative American attitude was in part due to the association of contagion with quarantine. Quarantine meant business losses, unnecessary delays, limitations on expansion, and represented to liberals the epitome of bureaucratic interference. Ackernecht, p. 567. In addition, quarantine had failed to prevent yellow fever and cholera in the past. By comparison, the connection of cleanliness with godliness put the sanitarians on the side of the angels; to ignore their credo would be tantamount to heresy. For an excellent example of such sanctimony see Henry O. Marcy, The Recent Advances of Sanitary Science, The Relation of Micro-Organisms to Disease, Annual Address delivered before the American Academy of Medicine, New York, October 10, 1883 (Philadelphia, 1883), pp. 8-9.

⁷⁷Mario Semmola, "Scientific Medicine and Bacteriology in Their Relations to the Experimental Method," N.Y. Med. Jnl., XLVI (September 17, 1887), 312-313; Austin Flint, M.D., A Treatise on the Principles and Practice of Medicine (5th ed.; Philadelphia: Henry C. Lea's Sons and Co., 1844), pp. 89-97; "New York Letter," The Journal of the American Medical Association, IV (January 17, 1885), 82 (hereinafter cited as JAMA). An attempt to combine the divergent views of sanitarians and contagionists was made in 1857 at a national health convention at which both schools were represented. This compromise, described in Minutes of the Proceedings of the National Quarantine Convention, pp. 40-43, was, as in the other cases, awkward and inconsistent.

⁷⁸Flint, A Treatise on the Principles and Practice of Medicine (5th ed.), p. 97; George M. Sternberg, Photo-Micrographs and How to Make Them (Boston: James R. Osgood and Comp., 1883), p. 136.

⁷⁹George M. Sternberg, M.D. "Is Tuberculosis a Parasitic Disease," The Medical News, XLI (July 1, 1882), 6-7; J. Lewis Smith, "Clinical Remarks on Scarlet Fever," ibid., (July 15, 1882), 57-59; "The American Public Health Association, Thirteenth Annual Meeting, held at Washington, D.C., December 8, 9, 10, and 11, 1885," Medical News, XLVIII (January 2, 1886).

⁸⁰T. Mitchell Prudden, M.D., "Progress and Drift in Pathology," Medical Record, LVII, no. 10 (March 10, 1900), 397-398.

⁸¹Ibid., p. 398.

⁸²Abraham Jacobi, M.D., "Inaugural Address," Trans. of N.Y.A.M., VI (1885), 163-164. Jacobi perhaps was referring to the fascination the Germ Theory apparently held for the lay reader. Popular magazines such as the North American Review, Science, and Popular Science Monthly carried numerous articles in the early 1880s on bacterial organisms and thereby catered to, and helped foster, the hope that great curative remedies and powerful antidotes were on the horizon. Kramer, pp. 241-242. The lag between public enthusiasm for medical developments and changes in medical practice during the nineteenth century has been briefly examined by John Duffy in "Anglo-American Reaction to Obstetrical Anesthesia," Bulletin of the History of Medicine, XXXVIII (January-February 1944), 32-44.

⁸³Prudden, Medical Record, LVII (March 10, 1900), 398.

⁸⁴The formal study of bacteria was probably introduced in the 1870s at the University of Illinois in the botany course of Professor J. Burrill who was interested in the role of microorganisms in plant maladies. H. L. Russell, "Bacteria and Their Relation to Vegetable Tissue" (Doctoral dissertation, Board of University Studies, Johns Hopkins University, 1892), p. 1; Frederick P. Gorham, "The History of Bacteriology and Its Contribution to Public Health Work," Contributions from the Biological Laboratory (Brown University), X (May 1927), 7. By the early 1880s some routine observations of cultures and a few simple experiments were being conducted in the biology laboratories at Johns Hopkins University and Harvard University, with nothing of any substance coming out of either. For representative examples of early American bacterial studies, see George M. Sternberg, M.D., A Fatal Form of Septicemia in Rabbits Produced by the Subcutaneous Injection of Human Saliva (Baltimore: John Murphy and Co., 1880), p. 16; William Trelease, M.D., "Observations on Several Zoogloae," Studies from the Biological Laboratory of the Johns Hopkins University, III, no 4 (1885?), 193.

⁸⁵Richard Shryock, Medicine and Society in America, 1660-1860 (New York: New York University Press, 1960), p. 137; George W. Corner, A History of the Rockefeller Institute, 1901-1953 (New York: The Rockefeller Institute Press, 1964), p. x; Flexner and Flexner, Welch and the Heroic Age, p. 85.

⁸⁶Shryock, Medicine and Society in America, 1660-1860, p. 136; Alexis de Tocqueville, Democracy in America (New York: Langley, 1843; reprint ed., Garden City: Doubleday, 1969), passim; Shryock, Medicine in America, Historical Essays, pp. 74-75. By midcentury the commercial spirit had taken hold and created an attitude that was essentially hostile to the basic sciences. Physicians were concerned with earning a living and it was a well recognized fact that there was neither income nor prestige for those interested in scientific investigations of the sort that would not yield immediate practical results. See ibid., p. 78, and Edward H. Clarke et al., A Century of American Medicine (Philadelphia: Henry C. Lea, 1876), p. 13. For the feelings of one contemporary

appalled by this state of affairs, there is Samuel Jackson, Address to the Medical Graduates of the University of Pennsylvania (Philadelphia: T. K. and P. G. Collins, 1840), pp. 12-15. In fact, those few whose curiosity drove them to sacrifice money for science were looked upon with suspicion. Shryock, Medicine and Society in America, 1660-1860, p. 135; Flexner and Flexner, Welch and the Heroic Age, pp. 62-63.

⁸⁷Shryock, Medicine in America, Historical Essays, pp. 79-85; Gorham, p. 7. The tradition of "basic research" as pursued by the gentleman scientist of the eighteenth century had diminished under the impact of Jacksonian democracy, with its disdain of the aristocratic and its emphasis on utility. Shryock, Medicine in America, Historical Essays, pp. 82-83. By the 1870s the deliberate and often exaggerated efforts of individuals and societies, such as the National Academy of Sciences, had convinced the general public to support the scientific community because its work was useful. George H. Daniels, Science in American Society (New York: Alfred A. Knopf, 1971), pp. 270-271. The growing status of science prompted a number of affluent Americans to support generously various universities. Enlarged and enriched by such contributions, and determined that knowledge must not only be preserved but also advanced, universities began to introduce science into the required curriculum, even on the undergraduate level. The process was a tedious one and often met resistance so that the practice of traveling to Europe for a superior scientific education continued. Daniel C. Gilman, "The Launching of a University," Scribners Magazine XXX (March 1902), 327-329; Richard Hofstadter and William Smith (eds.), American Higher Education: A Documentary History, I (Chicago: University of Chicago Press, 1961), pp. 593-594. The federal government attempted to assist science education through the Morrill Act (1882) which offered large land grants to any state that would maintain a college which taught agriculture and the mechanical arts. Hofstadter, The American Republic, II, p. 303.

⁸⁸William H. Welch, M.D., "The Evolution of Modern Scientific Laboratories," Annual Report of the Board of Regents of the Smithsonian Institution (July 1895), pp. 498-500; Edgar M. Crookshank, An Introduction to Practical Bacteriology (New York: J. H. Vail and Co., 1886), p. 2; Corner, pp. 27-28.

⁸⁹There are two biographies of Welch, the one by Flexner and Flexner already alluded to, n. 52, and Donald Fleming, William H. Welch and the Rise of Modern Medicine (Boston: Little, Brown and Co., 1954), and a disjointed collection of pieces on Prudden between the covers of a work edited by his wife, Lillian E. Prudden (ed.), Biographical Sketches and Letters of T. Mitchell Prudden (New Haven: Yale University Press, 1927) (hereinafter cited as Sketches and Letters).

⁹⁰Flexner and Flexner, Welch and the Heroic Age, pp. 62, 68.

⁹¹Ibid., pp. 68-76. He studied normal histology with Wilhelm Waldeyer, physiological chemistry with Felix Hoppe-Seyler, microscopic

anatomy with Ernst Wagner, physiology with Carl F. W. Ludwig, and pathology with Julius Cohnheim and Friedrich D. von Recklinghausen (Virchow's most brilliant student), See ibid., pp. 77-110.

⁹²Welch's chagrin stemmed from his desire to receive an appointment in pathology at the Johns Hopkins Medical School, which was still in its planning stages. He feared, and rightfully so, that with opportunities so limited, every other American physician with training in this specialty was a potential competitor for the Hopkins position. See ibid., p. 102, and Prudden, Sketches and Letters, pp. 25, 48.

⁹³Ibid., pp. 2, 24-25, 39. While in Breslau during this, his first trip to Germany (he returned again in 1885), Welch learned of some of the basic work going on in the study of microbes. Evidently impressed by what he saw, he went to visit Klebs in Vienna to learn more about the subject before returning home. George Rose, "Carl Ludwig and His American Students," Bulletin of the Institute of the History of Medicine, IV (October 1936), 663-634; Barnett Cohen, "Comments on the Relation of Dr. Welch to the Rise of Microbiology in America," Bulletin of the History of Medicine, XXIV (July-August 1950), 321

⁹⁴In the most comprehensive account of the phenomenon, the author describes the temporary migration of American physicians to Germany as a "stream" in the 1860s and a "torrent" in the 1870s and 1880s. Such visits varied from private courses in clinical specialties which lasted six weeks to intensive university research lasting often from two to three years. It is estimated that around 15,000 Americans undertook some serious study in Germany between 1870 and 1915. Thomas N. Bonner, American Doctors and German Universities (Lincoln: University of Nebraska Press, 1963), pp. 1-23. For a highly detailed account of what Americans came for, see Theodor Billroth, The Medical Sciences in the German Universities, trans. William H. Welch (New York: The Macmillan Company, 1924), passim.

⁹⁵Daniels, p. 276; Bonner, pp. 13-14. Bonner estimates that between one-third and one-half of the more influential and best-known members of the American medical community received some of their training in Germany. Ibid., p. 23.

⁹⁶Flexner and Flexner, Welch and the Heroic Age, p. 111; Winslow, Life of Biggs, p. 50.

⁹⁷Prudden, Medical Record, LVII, no. 10 (March 10, 1900).

⁹⁸Flexner and Flexner, Welch and the Heroic Age, pp. 112-113. With the exception of Harvard Medical School, those few schools in America with instruction in pathology had it merged in the chair of the practice of medicine where it was taught as an adjunct. Objections evidently arose when the subject was considered worthy of independent status, as pointed out in ibid., p. 118, Prudden, Sketches and Letters, p. 56, and Winslow, Life of Biggs, p. 50.

⁹⁹Ibid., p. 52; Prudden, Sketches and Letters, pp. 50-51; Flexner and Flexner, Welch and the Heroic Age, pp. 114-120; Gilbert Dalldorf, "Something from the Past," Fiftieth Anniversary, fiftieth anniversary celebration of the Division of Laboratories and Research of the New York State Department of Health (Albany, 1964), p. 11.

¹⁰⁰Flexner and Flexner, Welch and the Heroic Age, p. 116; Prudden, Sketches and Letters, pp. 34-36, 50-54. The Board of Trustees approved this action more out of a sense of embarrassment caused by the spectacle of their students attending a Bellevue course than because of any sudden revelations that physicians could benefit from gaining some familiarity with laboratory study. Prudden was assigned a dingy, poorly lit area over an ice-cream cellar where for the next three years he was charged rent of \$750.00 annually while he taught the rudiments of microscopic pathology. W. P. Northrup, one of the many of his students who were to specialize in pathology, recalled how Prudden received such little assistance from the college that he, the director, had to stay long hours after his classes left to cut tissue sections for the following day's work. See ibid., pp. 40-41.

¹⁰¹Ibid., p. 54.

¹⁰²Walter C. Burket, Papers and Addresses by William Henry Welch (Baltimore: The Johns Hopkins Press, 1920), III, 352-353 (hereinafter cited as Welch Papers). Even the trustees of the College of Physicians and Surgeons came to realize the popularity, and perhaps even the significance, of Prudden's work. By 1882 his yearly rent was dropped; the proprietors of the school, true to their businesslike approach, now simply deducted the lab's deficits from Prudden's yearly salary. See Prudden, Sketches and Letters, p. 44. The frugal Bellevue Hospital Medical College enlarged Welch's laboratory in 1882 as increasing numbers of students continued to come to receive his instruction. See Flexner and Flexner, Welch and the Heroic Age, p. 119.

¹⁰³Burket, Welch Papers, III, 352-353; Prudden, Sketches and Letters, pp. 55-56. Welch recalled being a student in Breslau when Koch brought his anthrax work to demonstrate to Cohnheim. Although the event actually occurred before his arrival, it is hard to imagine Koch's research not being an active topic of discussion among Welch and his associates. See Burket, Welch Papers, III, 352, and Flexner and Flexner, Welch and the Heroic Age, pp. 100-101. Furthermore, while in Germany, Welch worked alongside of Weigert and Ehrlich, who were then using aniline dyes for staining tissues and bacteria, as noted in ibid.

¹⁰⁴Ibid., p. 119; Prudden, Sketches and Letters, pp. 60, 71.

¹⁰⁵T. Mitchell Prudden, "Occurrence of the Bacillus Tuberculosis in Tuberculosis Lesions," Medical Record, XXIII (April 14, 1883), 397-400; T. Mitchell Prudden, "On the Occurrence of Tubercles in which the Bacillus Tuberculosis is not Demonstrable by the Ordinary Method of Staining," Medical Record, XXIII, no. 24 (June 16, 1883), 645-648.

¹⁰⁶Prudden, Sketches and Letters, pp. 52-53, 60.

¹⁰⁷T. Mitchell Prudden, M.D., On Koch's Methods of Staining the Bacteria, A Report to the Connecticut State Board of Health, November 30, 1885, p. 213.

¹⁰⁸Ibid., pp. 215-216.

¹⁰⁹Ibid., pp. 226-228.

¹¹⁰Albert Palmberg, A Treatise on Public Health and Its Applications in Different European Countries, trans. Arthur Newsholme (London: Swan, Sonnenschein and Co., 1895), pp. 355-395. For the history of the relation of police power to public health, see George Rosen, "Cameratism and the Concept of Medical Police," Bulletin of the History of Medicine, XXVII (July-August 1952), 21-42; Rosen, "The Fate of the Concept of Medical Police, 1780-1890," Centaurus, V (1957), 97-113.

¹¹¹The Chancellor's heritage had given him a certain sense of noblesse oblige that found expression in his concept of the patriarchal state; furthermore, he hoped to take "some of the wind from the sails" of the Social Democrats, who were attracting a large following among the growing numbers of the industrial proletariat. Geoffrey Barraclough, The Origins of Modern Germany (New York: Capricorn Books, 1963), pp. 426-427; Marshall Dill, Germany: A Modern History (Ann Arbor: University of Michigan Press, 1964), pp. 162-164.

¹¹²Ibid., p. 226.

¹¹³See Chapter II.

¹¹⁴Prudden, Sketches and Letters, p. 72.

¹¹⁵Prudden, The Story of Bacteria (New York: G. P. Putnam's Sons, 1889), passim; Prudden, Dust and Its Dangers (New York: G. P. Putnam's Sons, 1890), passim; Prudden, "On Bacteria in Ice, and Their Relation to Disease with Special Reference to the Ice-Supply of New York," Medical Record, XXXI (October 1887), 341-369; Prudden, "Our Ice Supply and Its Dangers," Popular Science Monthly (March 1888), 668-682.

¹¹⁶Prudden, Sketches and Letters, p. 53.

¹¹⁷Alfred L. Loomis, T. Mitchell Prudden, and Herman M. Biggs, Report on the Prevention of Pulmonary Tuberculosis, in Winslow, Life of Biggs, appendix II, pp. 393-396.

¹¹⁸Duffy, A History of Public Health in New York City, 1866-1966, pp. 78-86.

¹¹⁹Prudden, Sketches and Letters, pp. 53, 88.

¹²⁰Winslow, Life of Biggs, pp. 39-42.

¹²¹Ibid., pp. 17-27; Charles E. and Carroll S. Rosenberg, "Pietism and the Origins of the American Public Health Movement: A Note on John H. Griscom and Robert M. Hartley," Journal of the History of Medicine and Allied Sciences, XXIII (January 1968), 16-17. The Rosenbergs' article deals with the earlier years of the nineteenth century, but it is cited here because of its emphasis on the role of evangelical religion in bringing about a concern for health conditions in American cities. In Biggs' case, his religiosity provided an early motivating source for his energetic dedication, although his goals were considerably more secular than those of his pietistic predecessors.

¹²²Arthur Mann, Yankee Reformers in the Urban Age (Cambridge: The Belknap Press, 1954), pp. 17, 121-122; Louis J. Budd, "Altruism Arrives in America," American Quarterly, VIII (Spring 1956), 40-42; Morris J. Vogel, "Patrons, Practitioners, and Patients: The Voluntary Hospital in Mid-Victorian Boston," Victorian America, ed. Daniel Walker Howe (University of Pennsylvania Press, 1976), pp. 131-134; George Rosen, From Medical Police to Social Medicine (New York: Science History Publications, 1974), p. 82.

¹²³Winslow, Life of Biggs, pp. 17-31

¹²⁴Ibid., pp. 40-42; Vogel, p. 131. For an example of the complex professional interactions that served to dampen efforts to bring about a degree of social control and behavioral modification of the lower classes within a health care context--in this case, hospitals--see Charles E. Rosenberg, "And Heal the Sick: The Hospital and the Patient in 19th Century America," Journal of Social History, X (1977), 428-447.

¹²⁵Ibid., pp. 52, 59, 61. The Carnegie Laboratory was proposed initially as a means to keep Welch in New York. His wish to become part of the research-oriented medical school then being planned at Johns Hopkins University became reality when he was offered a professorship in pathology. His acceptance stirred Dennis to appeal to Andrew Carnegie who promised to provide Bellevue with \$50,000.00 for a medical research facility. Welch was informed of this proposal but preferred the Hopkins opportunity. The trustees at Bellevue meanwhile subscribed \$45,000.00 to buy land on East Twenty-Sixth Street and, soon after, the plans for the laboratory were carried to completion. See ibid., pp. 60-61, Flexner and Flexner, Welch and the Heroic Age, pp. 128-134, and "The Carnegie Laboratory Building," N.Y. Med. Jnl., XCI (May 9, 1885), 529.

¹²⁶Biggs spent most of his time in Berlin and Greifswald and so had sufficient time to observe and assess the German public health system. Winslow, Life of Biggs, pp. 61-63.

¹²⁷Winslow, Life of Biggs, p. 65.

¹²⁸Hermann M. Biggs, M.D., "The Koch Comma-Bacillus and Its Relation to Asiatic Cholera," Medical News, XLVII (August 29, 1885).

¹²⁹Hermann M. Biggs, M.D., "Question III: Through What Avenues Do the Bacilli of Tubercle Find Lodgment in the Lungs? Question IV: What Does Observation Prove Regarding the Likelihood of Bacillary Infection When there is No Constitutional Enfeeblement, Either Inherited or Acquired," Transactions of the New York State Medical Association for the Year 1886, III; Hermann M. Biggs, M.D., "What Part is Played by Micro-organic Ferments in the Causation of Enteric Fever?" Transactions of the New York State Medical Association for the Year 1887.

¹³⁰Ferdinand Hueppe, The Methods of Bacteriological Investigation, trans. Hermann M. Biggs (New York: D. Appleton and Company, 1890). The methods of the master, Koch, were now at the disposal of American medical students since it was he who requested Hueppe to write this work, as pointed out, ibid., p. 5.

¹³¹Hermann M. Biggs, M.D., "The Epidemic of Typhoid Fever in Plymouth, Pa.," N.Y. Med. Jnl., XLI (May 23, 1885), 577, XLI (June 6, 1885), 639.

¹³²Ibid., pp. 576, 637-639.

¹³³Winslow, The Life of Hermann M. Biggs, p. 69; Hermann M. Biggs, M.D., "The Etiology of Rabies, and the Method of M. Pasteur for Its Prevention," Medical News, XLVIII (April 3, 1886), 384-387.

¹³⁴Geison, pp. 400-405.

¹³⁵Biggs, Medical News, XLVIII (April 3, 1886), 383-388.

¹³⁶Winslow, Life of Biggs, p. 78.

¹³⁷See above, pp. 20-22.

¹³⁸Hermann M. Biggs, M.D., "The Germicidal Power of Sulphur Dioxide," Medical News, LI, no. 25 (December 17, 1887), 702-705.

¹³⁹Hermann M. Biggs, M.D., "The Diagnostic Value of the Cholera Spirillum as Illustrated by the Investigation of a Case at the New York Quarantine Station. Read Before the Society of Bellevue Hospital Alumni, November 2, 1887," N.Y. Med. Jnl., XLVI (November 12, 1887), 548.

¹⁴⁰S. T. Armstrong and J. J. Kinyoun, "Observations on the Cholera Bacillus as a Means of Positive Diagnosis," ibid., 546.

¹⁴¹Biggs, N.Y. Med. Jnl., XLVI (November 12, 1887), 549.

¹⁴²Ibid., Armstrong and Kinyoun, ibid., XLVI (November 12, 1887), 547.

¹⁴³Biggs, Am. Jnl. of Med. Sci., n.s., CV (January, 1893), 71; Annual Report of the Board of Health of the Health Department of the City of New York, 1892 (New York, 1894), p. 172 (hereinafter cited as Ann. Rep., Bd. of Health).

¹⁴⁴Biggs, N.Y. Med. Jnl., XLVI (November 12, 1887), 548-549.

¹⁴⁵Prudden, Sketches and Letters, p. 288.

¹⁴⁶Ibid.; Hermann M. Biggs, M.D., "The Development of the Research Laboratories," Monthly Bulletin of the Department of Health of the City of New York, I, no. 3 (March 1911), 54 (hereinafter cited as Monthly Bulletin).

¹⁴⁷Biographical sketch of Hermann Biggs, with annotations in the hand of Biggs, New York Academy of Medicine, MSS 288, ca. 1920, p. 1.

¹⁴⁸"The New Health Law," Medical Record, V (April 15, 1870), 85; "The Proposed Department of Safety in the Charter of Committee of Seventy and the Health Department," Medical Record, VII (March 15, 1872), 61. Duffy, A History of Public Health in New York City, 1866-1966, p. 94.

¹⁴⁹Times, July 12, 1887, p. 8; "How New York's Physicians Can Aid the Board of Health," N.Y. Med. Jnl., XLVI (November 12, 1887), 550; see also untitled announcement to physicians, ibid., p. 547.

¹⁵⁰"The Duty of Reporting Infectious Diseases to the Board of Health," N.Y. Med. Jnl., XCI (May 16, 1885), 554; "The Board of Health and Its Infectious Diseases Order," ibid., p. 557. The American medical profession was in a dismal state at the time, in large part due to the proliferation of sectarianism and the inability of the regulars to do much about it. The doctors' most potent organization, the American Medical Association, was troubled by the divisive effects of specialization within its own ranks and the decline in its power due to the formation of specialist societies. Kramer, pp. 369-370; James G. Burrow, AMA: Voice of American Medicine (Baltimore: The Johns Hopkins Press, 1963), p. 7; Charles E. Rosenberg, "The Practice of Medicine in New York a Century Ago," Bulletin of the History of Medicine, XLI (March-April 1967), 248-249; Kaufman, pp. 468-469. Most doctors considered their finances inadequate, and their social standing humiliating, in comparison to that of other professionals. Their indifference to matters of public medicine generally turned to hostility when they sensed that governmental involvement in matters of health might be competitive and reduce their income. Gerald E. Markowitz and David Karl Rosner, "Doctors in Crisis: A Study of the Use of Medical Education Reform to Establish Modern Professional Elitism in Medicine," American Quarterly, XXV (March 1973), 86-88; Manfred Wasserman, "The Quest for a National Health Department," Bulletin of the History of Medicine, XLIX (Fall 1975), 165.

¹⁵¹Times, October 19, 1887, p. 1.

¹⁵²Ibid., February 26, 1889, p. 8; July 1, 1889, p. 5.

¹⁵³Ibid., June 25, 1892, p. 8; June 26, 1892, pp. 4, 9; June 29, 1892, p. 8.

¹⁵⁴Ibid., June 25, 1892, p. 8.

¹⁵⁵Biggs, Monthly Bulletin, I, no. 3 (March 1911), 54; Bolduan, Over a Century of Health Administration in New York City, p. ; Hermann M. Biggs, M.D., "The Organization, Equipment, and Methods of Work of the Division of Pathology, Bacteriology, and Disinfection of the New York City Health Department," Trans. of N.Y.A.M., 2nd ser., X (1893), 320. Bryant was later to call the Division of Bacteriology, Pathology, and Disinfection a dream come true. His sentiments were probably sincere, for he did succeed in obtaining a grant of \$3,600.00 for the Health Department from Mayor Hewitt for the purpose of setting up some experimental disinfection apparatus in a project to which Biggs and Prudden lent their efforts. See ibid.

¹⁵⁶Charles A. Leale, M.D., "Asiatic Cholera," Am. Jnl. of Med. Sci., n.s., CV (June 1893), 667.

¹⁵⁷Ibid., Times, July 9, 1892, p. 4; August 19, 1892, p. 8.

¹⁵⁸Ibid., August 7, 1892, p. 17.

¹⁵⁹Ibid., August 19, 1892, p. 8.

¹⁶⁰Ibid., Wilcox, Am. Jnl. of Med. Sci., n.s. CV (January, 1893), 58.

¹⁶¹Times, August 8, 1892, p. 4. With strong hints of the xenophobia that was quite typical of the period, the Times' editors declared, on August 8, 1892, p. 4, "We do not need the immigrants from those countries Russia and Poland, and they may bring upon us an epidemic that will cost thousands of lives and enormous pecuniary loss." Emphasizing the latter point, it was estimated that cholera caused losses of 500 million dollars in Europe in the previous eight years.

¹⁶²F. Reiche, M.D., trans. A. A. Eshner, "The Cholera in Hamburg," Am. Jnl. of Med. Sci., n.s., CV (February 1893), 112-113.

¹⁶³Ann. Rep., Bd. of Health, 1892, pp. 34-36.

¹⁶⁴Times, September 1, 1892, pp. 1-2; Biggs, Am. Jnl. of Med. Sci., n.s., CV (January 1893), 63-64. In May Biggs had traveled to Europe to look into the measures being taken at various ports to prevent the export of cholera to America. An official of the Hamburg-American Line assured Biggs that, before leaving, all emigrants were subjected to a number of thorough medical examinations, were forced to bathe, and that their clothing was routinely fumigated and disinfected. See Winslow,

The Life of Hermann M. Biggs, pp. 92-94. Care was indeed taken by Hamburg authorities, but it was suspected that it was aimed more at deterring contact between Russian and Polish emigrants and Germans than at minimizing the possibility of an infected passenger going undetected and untreated. It was reported, in fact, that steerage passengers on the Moravia had been whisked across Germany by train and placed immediately aboard ship with no medical examination nor quarantine. Such allegations can be found in Wilcox, Am. Jnl. of Med. Sci., n.s. CV (January 1893), 58, and in Times, August 8, 1892, p. 4, and ibid., September 2, 1892, p. 1. The same irresponsible behavior continued on this side of the Atlantic. The ship's doctor, who apparently did nothing to stamp out cholera after its appearance at sea, referred to the condition euphemistically as "cholérine," supposedly a mild form of the malady. See ibid., September 1, 1892, pp. 1, 2.

¹⁶⁵Ibid., p. 1.

¹⁶⁶Ibid., September 2, 1892, p. 2; September 1, 1892, p. 2; September 3, 1892, p. 5.

¹⁶⁷Ibid., September 3, 1892, p. 5; September 4, 1892, p. 4.

¹⁶⁸Ibid., September 1, 1892, p. 2.

¹⁶⁹Ibid., September 3, 1892, p. 2.

¹⁷⁰Ibid., p. 5.

¹⁷¹Ibid., September 1, 1892, p. 2; September 2, 1892, pp. 1, 2; September 3, 1892, pp. 1, 2, 5; Wilcox, pp. 59-61. Disinfection was an old method employed to purify decomposing organic matter during the days when the miasmatic theory prevailed; it continued as a means to destroy microorganisms when the Germ Theory gained acceptance. It seems that the rationale for its anticipated use during the cholera scare was for the latter reason. See Joseph H. Raymond, M.D., "Sulphur Fumigation in Cholera," N.Y. Med. Jnl., LVI (September 24, 1892), 351-354, and Times, September 1, 1892, p. 2. A circular issued by the Department of Health cautioned against using disinfectants to "correct conditions due to dirt, decomposition, defective ventilation, or neglect," in ibid., September 4, 1892, p. 2.

¹⁷²Ibid., September 1, 1892, p. 2; September 2, 1892, pp. 1, 2; September 3, 1892, pp. 1, 2, 5; Wilcox, Am. Jnl. of Med. Sci., n.s. CV (January 1893), 59-61.

¹⁷³Times, September 1, 1892; p. 2, September 2, 1892, p. 2.

¹⁷⁴Ibid., September 1, 1892, p. 2.

¹⁷⁵Ibid.; Ann. Rep., Bd. of Health, 1892, pp. 4-8.

¹⁷⁶Ibid., pp. 48-49; Times, September 15, 1892, p. 1. The Health Department, in Biggs' words, was "without facilities for making bacteriological exams," and had the "most inadequate facilities for carrying on any measures of disinfection." See Biggs, Monthly Bulletin, I, no. 3 (March 11, 1911), 54.

¹⁷⁷Times, September 1, 1892, p. 2.

¹⁷⁸Weekly Report of the Health Department of the City of New York, II, nos. 1-34 (1892), p. 5 (hereinafter cited as Weekly Report).

¹⁷⁹Times, May 13, 1887, p. 1; May 16, 1887, p. 4; June 27, 1889, p. 4; above, p. 33.

¹⁸⁰Times, September 1, 1892, p. 2.

¹⁸¹Ibid., September 4, 1892, p. 1.

¹⁸²Ibid., September 5, 1892, p. 1; Biggs, Am. Jnl. of Med. Sci., n.s. CV (January 1893), 64. Dr. J. M. Byron, a bacteriologist at the Quarantine Station, was put in charge of Swinburne Island and the ships at Lower Quarantine by the Health Officer of the Port of New York. The actions taken there are described by Byron in "Asiatic Cholera at Lower Quarantine in 1892," Trans. of N.Y.A.M., 2nd ser., IX (1892), 289-299.

¹⁸³"There will be no difficulty this time in proving whether the deadly bacilli of the Asiatic disease is responsible for the deaths and sickness aboard the *Normannia* and *Rugia*, for the bacteriologists have the material to work on." Times, September 4, 1892, p. 1.

¹⁸⁴Ibid., September 5, 1892, pp. 1, 5; September 6, 1892, pp. 1, 5; Wilcox, p. 59.

¹⁸⁵Ibid., September 4, 1892, p. 2; September 5, 1892, pp. 1, 5; September 6, 1891, p. 6; September 7, 1892, p. 2.

¹⁸⁶Ibid., September 5, 1892, p. 5; September 6, 1892, p. 5.

¹⁸⁷The Health Board, reported the Times, September 6, 1892, p. 5, decided to issue statements twice a day on the cholera situation in order to "render rumor mongering unprofitable."

¹⁸⁸Biggs, Monthly Bulletin, I, no. 3 (March 1911), 54.

¹⁸⁹Times, September 3, 1892, p. 5.

¹⁹⁰Ann. Rep., Bd. of Health, 1892, p. 48. The arrival of the steamship *Scandia* from Hamburg at 1:30 a.m., with its report of 32 cholera deaths at sea, must have added a further sense of urgency to whatever deliberations preceded the decision to release funds for this laboratory facility. See Times, September 10, 1892, p. 1.

¹⁹¹Ibid., September 9, 1892, pp. 1, 9; September 10, 1892, p. 2; September 11, 1892, p. 2; September 12, 1892, p. 1; September 13, 1892, pp. 1, 2; September 14, 1892, p. 1; Wilcox, Am. Jnl. of Med. Sci., n.s. CV (January 1893), 58.

¹⁹²Times, September 14, 1892, p. 2.

¹⁹³Ibid., September 9, 1892, p. 2; Ann. Rep., Bd. of Health, 1892, pp. 172-173; Biggs, Am. Jnl. of Med. Sci., n.s., CV (January 1893), 64-65.

¹⁹⁴Ibid., p. 65; Edward K. Dunham, M.D., "The Bacteriological Examination of the Recent Cases of Epidemic Cholera in the City of New York," Am. Jnl. of Med. Sci., n.s., CV (January 1893), 72-77. Dunham, the director of the Carnegie Laboratory, had studied at the Hygienic Institute in Berlin under Koch and had served as bacteriologist to the Massachusetts Board of Health. See Times, September 15, 1892, p. 2. He worked closely with Biggs during the cholera incident; his descriptions, with accompanying photographs, of the bacteriological tests conducted at the time represent the most modern methods of the day and show the variety of rigorous techniques then available for disease diagnosis and the identification of pathogenic microbes. Ibid., pp. 72-80.

¹⁹⁵Prudden, who had to be satisfied with the advent of the new laboratory, was engaged as an advisor to the Quarantine Station. See Ann. Rep., Bd. of Health, 1892, pp. 172-173; Times, September 13, 1892, p. 2; Prudden, Sketches and Letters, pp. 82-83.

¹⁹⁶Ann. Rep., Bd. of Health, 1892, pp. 48, 173; Biggs, Am. Jnl of the Med. Sci., n.s., CV (January 1893), 65-68.

¹⁹⁷Ann. Rep., Bd. of Health, 1892, pp. 4, 173; Times, September 15, 1892, p. 2.

¹⁹⁸Ann. Rep., Bd. of Health, 1892, pp. 173, 177-179. Welch, now professor of pathology at Johns Hopkins University, continued to have a strong interest in bacteriology and had the dubious honor of having a pathogenic, gas-producing bacillus named after him, discussed in considerable detail by Eugene Franklin McCampbell, "The Toxic and Antigenic Properties of B. Welchii," (reprint of Ph.D. dissertation from The Journal of Infectious Disease, Vol. 6, no. 4, September, 1909; Chicago, 1909), p. 537.

¹⁹⁹Times, September 15, 1892, p. 2; September 16, 1892, p. 2; September 17, 1892, p. 2.

²⁰⁰Ibid., September 15, 1892, p. 1; September 17, 1892, p. 2; September 18, 1892, p. 2; September 19, 1892, p. 2; September 22, 1892, p. 2; September 25, 1892, p. 2.

²⁰¹Ann. Rep., Bd. of Health, 1892, pp. 32, 48, 49, 68.

²⁰²Biggs, Am. Jnl. of Med. Sci., n.s., CV (January 1893), 65-68.

²⁰³Ibid., p. 71; Prudden, Sketches and Letters, p. 288; New York Tuberculosis and Health Association, The Contribution of Hermann M. Biggs to Public Health (New York, 1928), p. 7.

²⁰⁴Biggs, Am. Jnl. of Med. Sci., n.s., CV (January 1893), 65-67.

²⁰⁵Ibid., p. 69.

²⁰⁶For a picture of the frustration scientists faced in the search for potent, and yet safe, germicides see D. D. Stewart, M.D., "The Prevention and Treatment of Cholera by the Naphthols," and George M. Sternberg, M.D., "Bacteriological Report," Am. Jnl. of Med. Sci., n.s., CV (April 1893), 388-393; William Osler, M.D., "Notes on the Diagnosis and Treatment of Cholera," Medical News, LXI, no. 12 (September 10, 1892) 290-291; and Stewart "Suggestions as to the Prophylaxis and Treatment of Cholera," Medical News, LXI (September 17, 1892), 326-328.

²⁰⁷Biggs, "Dr. Biggs' Report on the New York Cholera Cases of September, 1892," N.Y. Med. Jnl., LVI (December 24, 1892), 752; "New York Letter," JAMA, IV (January 17, 1885), 81-83. Koch had been sent by the German government in 1884 as head of a commission to study Asiatic cholera in Egypt and India. His substantial findings on the etiological role of the common bacillus can be found in translation from the Deutsche Medicinische Wochenschrift as "An Address on Cholera and Its Bacillus," The British Medical Journal, II (August 30, 1884), 403-407, and (September 6, 1884), 453-459.

²⁰⁸"Cholera, Measures for Its Prevention and Management in Brooklyn," Sanitarian (October 1892), 397; A. C. Abbott, "Prophylactic Measures against Asiatic Cholera," Medical News, LXI (September 10, 1892), 288; Osler, pp. 290-291; Stewart, Medical News, LXI (September 17, 1892), 326-328. The American doctor now had at his disposal a sizeable number of publications with impressive discussions and instructions on laboratory methods--i.e., preparation of nutrient media, culturing, staining, microscopy, photomicroscopy, animal experimentation, chemical tests, tissue sectioning, etc.--with particularly thorough procedural data on cholera diagnosis. For an illuminating view on how far bacteriology had come and how sophisticated were its instruments and techniques, sample any of the following: James Eisenberg, M.D., Bacteriological Diagnosis: Tabular Aids for Use in Practice Work, trans. Norval H. Pierce, M.D. (Philadelphia: F. A. Davis Co., 1892), pp. v-vii, 57, 161-179; Sternberg, Photo-Micrographs and How to Make Them, pp. 2-47; Charles Sumner Dolley, Technology of Bacteria Investigation (Boston, 1885), pp. 117-127; Crookshank, pp. 5-99; Herman Rohrback, M.D., Supplement to Catalogue of Bacteriological and Hygienic Apparatus, p. 1; Sternberg,

Practical Results of Bacteriological Researches, read at meeting of Association of American Physicians, Washington, May 24, 1892, pp. 1-17.

²⁰⁹Biggs, Monthly Bulletin, I, no. 3 (March 1911), 54.

²¹⁰J. J. Kinyoun's hospital laboratory was moved to Washington, D.C., in 1892 and became known as the Hygienic Laboratory, the predecessor of what is today the National Institute of Health. See Rosen, A History of Public Health, p. 333; Geoffrey Marks and William K. Beatty, Story of Medicine in America (New York: Charles Scribner's Sons, 1973), pp. 267-268; Duffy, Science and Society in the United States, p. 131; Armstrong and Kinyoun, pp. 546-547.

²¹¹James H. Cassedy, Charles V. Chapin and the Public Health Movement (Cambridge: Harvard University Press, 1962), pp. 70-71; Barbara Gurman Rosenkrantz, Public Health and the State, Changing Views in Massachusetts, 1842-1936 (Cambridge: Harvard University Press, 1972), pp. 99-101; Rosen, A History of Public Health, p. 333.

²¹²President Chandler and the New York City Health Department, 1866-1883 (New York, 1883), p. 1; Baumgartner, p. 559.

²¹³Ann. Rep., Met. B. of Health, 1866, p. 17; Ann. Rep., Bd. of Health, 1870-1871, pp. 117-120.

²¹⁴Inside Health, XIII, no. 7 (April 29, 1966), 2; Estelle Brodman, "New York City Department of Health, Periodicals and Serials Published 1866-1939," Special Libraries, XXXI, no. 1 (January 1940), 24; Bolduan, Over a Century of Health Administration in New York City, p. 19.

²¹⁵Ibid., pp. 19-20.

²¹⁶Ann. Rep., Bd. of Health, 1870-1871, pp. 117-120; 1872-1873, pp. 86-89; 1874-1875, pp. 243-256. It is difficult to determine precisely to what extent research was carried on and whether there developed a bacterial awareness during the 1800s, since the best source of information on the Health Department's activities, its Annual Reports, were not published from 1881 to 1888. Indications are, however, that little changed during these years. Biggs, it is true, at the department's request, conducted a research study on anti-bacterial disinfection and carried out some diagnoses using microbiological procedures--see above, pp. 29-31--but these appear to be exceptions. There is no sign in other normal outlets, i.e., local medical journals, that any significant initiative in bacteriology was launched. Also, with resumption of publication of the Annual Reports in 1889, there is no evidence of recent innovation of any consequence; the report, similar to those of fifteen years earlier, consisted of a variety of morbidity and morality charts and disclosures of sanitary inspections. Compare Ann. Rep., Bd. of Health, 1874-1875, pp. 152-243, to Ann. Rep., Bd. of Health, 1889, pp. 7-16.

²¹⁷Times, October 5, 1891, p. 3.

218 Bolduan, "Laboratory Research, Its Influence on Health Administration," memoir prepared in connection with the dedication of the Health Department's Research Laboratory, 1936, p. 3; Israel Weinstein, "Eighty Years of Public Health in New York City," Bull. of N.Y.A.M., 2nd ser., XXIII (April 1947), 231.

CHAPTER 2

THE GROWING YEARS

By the end of September 1892, the great fear which had attended the start of the month, that a devastating cholera epidemic would sweep across New York City, had disappeared. Biggs, not surprisingly, credited the bacteriological examinations that he and his associates had carried out with having saved the city--a view not without its supporters but one, as previously noted, with little scientific foundation.¹ By contrast, the Department's official explanation for the happy turn of events was that its recognition that the cholera germ must enter through the mouth on food or drink gave it well-defined channels to guard, while news of the spread of the disease through Europe had provided it with the time to implement successfully the proper defensive measures.² In a similar assessment, the Times, which had welcomed the introduction of bacteriological services and had given considerable coverage to the laboratory's efforts during the scare, gave complete credit for the city's good health to its cleaner streets and more habitable tenements.³

Although its diagnostic examinations were, in retrospect, accorded only scant attention, the labors of the Division of Pathology, Bacteriology, and Disinfection in carrying out a program of disinfection were officially viewed by the Health Department as vital in the triumphant battle against cholera.⁴ Even prior to the formal creation of his laboratory division, Biggs had been called upon, in his capacity as

Consulting Pathologist, to prepare a circular on the preparation of disinfectants and another on their methods of application. On September 5 the circulars were printed and distributed to the Health Department's contagious disease hospitals with orders that their directions be followed. The influence of the author was clear in the opening line: "contagious diseases are caused by minute living germs" and it is "the object of disinfection . . . to destroy these." After briefly suggesting the proper means of using heat, carbolic acid, corrosive sublimate (bichloride of mercury), and milk of lime, Biggs put to rest any lingering remnants of miasmatic thinking with the warning that a substance is not a disinfectant simply because it can destroy bad odors.⁵ Days later, when the Board of Health adopted the resolution creating the laboratory division, it did so with the understanding that all matters related to disinfections would be placed under the direction of its new Chief Inspector.⁶ Biggs, who in 1885 had conducted tests for the health officer of the New York City ports on the bactericidal strength of sulfur dioxide, considered himself prepared for this area of work and was advised by the Mayor that whatever funds he needed would be made available.⁷

The Division of Pathology, Bacteriology, and Disinfection joined three other branches--the Division of Contagious Diseases, the Division of General and Special Sanitary Inspection, and the Division of Offensive Trades and Food Inspections--to form the Sanitary Bureau, the chief agency for the activities of the Department.⁸ The Division of Contagious Diseases under the direction of Dr. Alvah H. Doty, which was made up in large part of a medical force of vaccinators, field diagnosticians working in the tenements, and inspectors, was to share with

Biggs' laboratory section the rather vague and monumental assignment of maintaining an "oversight" on all contagious diseases treated outside the hospitals.

Consistently the Health Department had relied upon the disinfection of the articles of the afflicted and the general fumigation of the premises in order to eradicate infectious ailments. Doty's division, which previously had charge of this activity and which maintained a corps of disinfectors during the cholera incident, effected a complete transfer of all such work to the Division of Pathology, Bacteriology, and Disinfection by the end of 1892.⁹

Biggs took immediate charge of the disinfecting plant on East Sixteenth Street, a facility which he and Prudden had helped design several years earlier.¹⁰ Small personal items such as clothing and bedding, brought from homes where contagious diseases had been reported by medical inspectors, were "rendered innocuous" here by being boiled or steamed in giant chambers, and returned to their owners in department vehicles. A crematory was also connected with the plant so that, if necessary, infected articles could be destroyed.¹¹ To carry out the work at the Sixteenth Street facility and the fumigations and disinfections to be performed in the homes of contagious disease victims, Biggs was initially assigned six Assistant Medical Inspectors and sixteen foremen and laborers.¹² A further willingness to support the work of disinfection was evident in the Board of Health's immediate approval of plans submitted by Biggs, and the granting of the necessary funds, to modernize the two-story structure at the foot of East Sixteenth Street and to purchase additional equipment for it.¹³

Certain that he now supervised the most efficient plant in the country, Biggs was still not convinced that he had been given a facility with the capacity to meet the demands that the city's health could place upon it.¹⁴ Two small rooms in a dismal tenement on Bleeker Street were to serve as a laboratory, its "work force" being a chemist with no training in bacteriology.¹⁵ No funding was provided to hire additional employees to staff the laboratory, and despite Biggs' insistence that bacteriological procedures had prevented an epidemic and therefore deserved greater support, it was not until April 1893 that the Health Department allocated any money for the laboratory.¹⁶ Three years would pass before the division would be given quarters properly outfitted to handle its rapidly expanding research and diagnostic activities, and be provided with an adequate and permanent staff of specialists.¹⁷

The willingness of health officials to make funds rather generously available for expenses related to disinfection while maintaining a tight-fisted policy with regard to the extension of bacteriological services is hardly surprising. Biggs himself, despite his protestations that employment of modern biological procedures were of the "greatest importance" in helping to exclude an epidemic, realized that considerable sentiment still existed among physicians and health authorities that an accurate clinical history was sufficient evidence that a particular case was Asiatic cholera, and that bacteriological examinations were unreliable or, at best, simply confirmatory.¹⁸ Not having played a part in any dramatic incident capable of arousing significant popular or professional support--laboratory work by definition being done out of the public view and diagnostic identification of microbes being particularly

unspectacular--Biggs' efforts were not widely acclaimed nor was there any support for taxpayers' dollars to be channeled into a facility devoted exclusively to bacteriology. The relative ease by which funds for disinfection were obtained during the same period was an outgrowth of practical developments rooted in the origins and ongoing policies of the Health Department, policies which influenced the seminal activities of the municipal laboratory. A fuller understanding of the laboratory's early years, therefore, necessitates a review of the Department's early history.

The creation of the Metropolitan Board of Health was largely due to the persistence of a number of outraged individuals who, in the early 1860s, organized the Citizens' Association.¹⁹ Its Council on Hygiene and Public Health conducted an extensive sanitary inspection of the city's streets and tenements; its findings, published in 1865, vividly described the utter filth, the obscene squalor, and the physically degrading, morally brutal environment inhabited by the city's tenement population.²⁰ This information was presented by Dr. Stephen Smith that year to a committee of the New York State Legislature; his argument that the conditions of the poor were a potential threat to all of society was strengthened by the memory of the "draft-riot" in July 1863, in which a number of lives were lost and over one million dollars' worth of property destroyed.²¹ Within months the Metropolitan Board of Health was created to safeguard the well-being of the inhabitants of the Sanitary District composed of the counties of New York, Kings, Westchester, and Richmond, and the towns of Newton, Flushing, and Jamaica in the county of Queens.²²

Despite the unselfish campaigning of concerned citizens and a

few socially-minded physicians, the events leading up to the formation of the Metropolitan Board of Health essentially confirm the recent view of historian Richard Shryock that the more affluent and influential members of society are generally willing to "let [the] poor shift for themselves" as long as their misery is not too obvious or doesn't threaten to spread.²³ But in New York the misery had become a matter of public record by the 1860s and, to prevent its further dissemination among the downtrodden and to halt the threat of its ramifications extending into the "better" segments of the population, a sensible program of public hygiene needed to be implemented. The tone was struck in the early reports of the Board of Health. Filth and its concomitant, bad air, when concentrated in poorly ventilated dwellings, were blamed for most fevers and dysenteries, while measles, smallpox, and scarlatine, although they had other origins, were said to be aggravated by these factors.²⁴ The ignorance of all classes stood as a hurdle in the way of better health, but the unsophisticated poor presented a particularly difficult obstacle making it imperative--so thought George B. Lincoln, President of the Board of Health--that hygienic work be done for them until they might show themselves to be capable of promoting their own safety and well-being.²⁵

The immense task facing the new health agency was more than a patronizing undertaking to minimize and contain the misery within the tenements. It was an expedition, a holy campaign against depravity and the spiralling erosion of moral values. The leadership of the Metropolitan Board of Health viewed itself as having a dual mission that extended beyond the immediate improvement of the city's health; its role

was to save human lives and preserve the integrity of the work force. It was clear, an ipso facto statement of urban reality, that "drunkenness, dissoluteness, and wretchedness, are found growing like luxuriant weeds in all places where bad air and poor food are found, and the offspring of these sufferers is [sic] brought up in neglect, without the physical ability to do the work of the world, decrepit, diseased, and dependent.²⁶

Little could be done about the poor food; the "bad air", however--the cause or aggravating factor of the infectious diseases which ran rampant through the tenement dwellings--was an entity conducive to health department machinations. One course of action was to institute stricter regulations against those practices which resulted in the exposure of the atmosphere to decaying organic matter or, if this failed, to bring about, directly or indirectly, the removal of the offensive material. When, however, there occurred an outbreak of illness, a second line of defense had to be implemented to prevent the further spread of the miasmatic contagion and to ward off an epidemic. Any utensils, clothing, bedding, books, furniture, etc., that had been exposed to the afflicted, including the very air where the ill resided, had to be subjected to the action of strong chemicals so as to eliminate the noxious elements. Caustic substances could even be used prophylactically to annihilate decaying matter and its infective odors in cases where removal of the contaminants was difficult or incomplete.²⁷

In its first year of operation, the Metropolitan Board of Health began an ambitious program of disinfection against cholera.²⁸ A disinfectant depot and laboratory on Mulberry Street were put under the

supervision of a druggist. From this location a disinfecting crew was dispatched throughout the city and new substances were tested.²⁹ Despite occasional fears expressed by farsighted officials that the Health Department was putting too great a dependence upon the efficacy of chemical preventive medicine and was therefore headed for disappointment, the liberal use of disinfectants continued and grew into a major weapon of the municipality's health arm.³⁰

The commitment to disinfection received the general support of physicians and the press.³¹ The Department's unification of an ongoing research program and its responsibility for the practical application of preventive disinfecting procedures was unique. The search for new substances and more effective means for their use had been taken up in Europe--many, including such prominent figures as Esmarch, Henle, Fraenkel, Geppert, Behring, and Koch, undertook studies in this area--but were usually conducted under the auspices of universities, national health organizations, private foundations, or through individual initiative.³² Public health disinfecting establishments were in operation in some European cities, but they did not appear to be centers for research; their community involvement seemed limited to providing large furnaces and laundry facilities where the soiled personal articles of the afflicted could be brought for hygienic treatment.³³ By contrast, in the United States, a few health boards began early in the 1870s to conduct their own research on disinfectants and to keep abreast of the work going on in Europe. Having little or no facilities of their own, or simply not considering it their function, they advocated the private disinfection of the quarters and soiled materials of the victims of

disease and, on occasion, they passed acts (which were generally ignored) requiring such precautions.³⁴

In 1881 Koch released the results of extensive tests he had conducted at the Imperial Department of Health (Kaiserliches Reichsgesundheitsamt) in Berlin. Using pure cultures of bacteria, he painstakingly refuted the susceptibility of pathogens to the overwhelming majority of substances popularly used as disinfectants.³⁵ The strength of Koch's reputation, together with the thoroughness and soundness of his techniques, were devastating. Health officials who had put great faith in the use of disinfectants were suddenly faced with overwhelming evidence that a major preventive weapon in their admittedly meager arsenal was largely innocuous.³⁶ Prompted by the confusion and uncertainty that prevailed, the American Public Health Association, at its annual meeting in 1884, appointed a committee to examine the subject of disinfection as it related to preventive medicine and sanitation, and assigned it the task of classifying and rating various agents according to their effectiveness, ease, and economy of application.³⁷ The investigations demonstrated that many of the agents which had been heavily relied upon by health officials were without value. The metallic sulphates, which had long been recommended in printed circulars issued by European and American health authorities, were discovered to be useful in neutralizing the unpleasant odors of putrefaction but without any practical disinfecting capacity.³⁸ The vast majority of proprietary disinfectants on the market were classified as no more than deodorizers and entirely untrustworthy against any microorganisms.³⁹ The revelations of Sternberg and his associates, like those of Koch, discredited certain substances

but did not lead to a wholesale abandonment of the concept of disease prevention through treatment of the environment. The research at Johns Hopkins confirmed and expanded upon what had been found at Berlin, namely that heat--in the form of boiling water, steam under pressure, or dry heat--was an exceptional disinfecting medium.⁴⁰ Furthermore, the reports of both universities established that a number of compounds then in use could inhibit certain pathogenic microorganisms when used under specific conditions and when applied in a concentrated fashion.⁴¹ Once stricter experimental guidelines had been established, the search for new disinfectants, and for more effective means for the utilization of some older ones, continued.⁴²

In New York City chemical disinfection continued to be used. More than an atavism, the practical problem of purifying the disease-ridden premises in thousands of tenements and of sanitizing the streets precluded the use of heat, and besides, under these conditions there was no viable alternative for a method which had a long record of empirical success.⁴³ Consequently, Biggs, who had used the cholera scare of September 1892 to pry from desperate city officials their approval to create a division which he envisioned as serving to bring the science of bacteriology and public health into closer connection, instead found himself primarily involved with the technical upgrading of the East Sixteenth Street plant.⁴⁴

Lacking decent laboratory facilities and without a staff, Biggs was dependent on a coterie of acquaintances in the New York City area to perform the experimentation for his division or, to be more exact, for him, as he alone initiated all research. At his request, and under his

direction, tests were performed at the Carnegie Laboratory, at the laboratory of the College of Physicians and Surgeons (by Dr. William Park under the supervision of Prudden), and by Dr. George Biggs (a pathologist cousin) at the New York Hospital. The tests were conducted to determine the germicidal value of "electrolized sea-water" (chlorinated water), then receiving some attention in the literature, on a number of different pathogenic microorganisms.⁴⁵

The results of such experiments were inconclusive, but the project is of historical significance since it was the first scientific effort of the municipal bacteriological laboratory, and because it set the tone for the type of work that was to characterize the city laboratory. No lofty principles were sought, no attempt was made to increase man's knowledge of the basic biology of microscopic organisms. This was sheer, mission-oriented research. The laboratory division was created, ad hoc, to deal with a specific, imminent health problem, and it was resolved to remain true to its pragmatic origins in the choice and direction of its experimental efforts under Biggs' guidance.

The initial investigations of disinfection further substantiated Biggs' view that the procedure was a costly one--as well as an administrative headache--relative to its preventive values. Experimentally, even under ideal and rigorous conditions, disinfectants worked inconsistently.⁴⁶ Furniture was too cumbersome to be brought to the disinfecting plant, treating it in the home with harsh chemicals often ruined the finish and brought legal claims against the department.⁴⁷ Sanitizing by steam had its disadvantages, for it too could not be done on the premises. Clearly, the logistical problems involved in picking up,

transporting, sterilizing, and returning small articles were immense. Furthermore, the families of the ill could not be counted on to carry out religiously the unpleasant and unfamiliar task of disinfecting their own quarters and isolating their sick, as outlined in the printed instructions left by department inspectors.⁴⁸ The practice of following up such visits to determine the extent of compliance, and the dispatching of chief inspectors to homes where measures had been insufficient, were a drain on the limited manpower of the department.⁴⁹

The conditions under which Biggs' division was created, the prevailing philosophy of health officials, and the nature of the funding it received, mandated a disproportionate emphasis on disinfection. Biggs, like other progressive health officials, had come to appreciate that the emphasis on sanitary engineering, the removal of nuisances, and environmental cleansing were general preventive measures of limited potential.⁵⁰ These tactics had served well enough in the past but they were largely hit-and-miss and did not take sufficient account of the actual etiological aspects of infectious disease. Biggs' European experiences, his associations with Prudden and Welch, his personal experiences with typhoid fever in Plymouth and with cholera in New York, his work at the Carnegie Laboratory, and the flood of reports of discoveries made at the Pasteur Institute and the Institute for Infectious Diseases in Berlin, all convinced him that public health problems were in large part open to bacteriological solutions and that such an approach was particularly essential in New York City.⁵¹

The problem of maintaining a robust citizenry was an especially difficult one for the city's health department, Biggs asserted, because

of the great diversification and complex character of the local population with its large number of foreign inhabitants of many nationalities, jammed together in restricted tenement localities while retaining their native customs and varied ways of life. Unlike rural areas where natural conditions--elevation, soil, climate, etc.--determined the health, in cities general well-being was subordinate to artificial conditions resulting from the unnatural environment.⁵²

Biggs, it should be noted, was born and raised in an affluent home. He attended the proper private schools, graduated from Cornell University, and had the customary upstate disdain of the gentry for the urban poor and lowly foreigner. Although he was not an insensitive man, he seldom showed emotions, was conservative in dress and manner, and reeked of determination and self-assurance. His activities as a health official combined a legitimate concern for the human condition a desire for self-aggrandizement, and, where the downtrodden and tenement-dwelling immigrants were concerned, a strong sense of noblesse oblige.⁵³ As the dominant figure in the laboratory's formative years, and as the major influence on departmental policy when he advanced to the position of General Medical Officer (in 1904), his social values helped to shape the structure of the bacteriological division and the nature of its services.

Biggs' values and expectations reflected the influences of his early environment and, when considered in respect to his later activities, place him within the general profile of the Progressive personality. While it is conceded that the Progressive movement was extremely pervasive and that many different people with contrary ideas on similar

issues have been labeled "Progressive," there is, in fact, a general consensus by some of the prominent historians of the times as to the distinctive elements that contributed to the Progressive style.

Biggs' Yankee upbringing in rural surroundings infused him with a certain spirit of self-righteousness, along with a sense of patriotic mission, that demanded the defense of basic American values. This personal obligation was further intensified by the Protestant ethic that glorified the Christian principles of sympathy, cooperation, and helpfulness.⁵⁴

Nowhere was there a sector that seemed as far removed from the chauvinistic perception of the American ideal as its cities. Urban slums that had traditionally remained beyond the boundaries of the central city inhabited by the respectable classes had, by the 1870s and 1880s, begun noticeably to spread.

The growth of industrialization had brought with it the "immigrant invasion" of massive numbers of Europeans. The northern industrial cities absorbed the majority of these immigrants; most were illiterate peasants whose religions, languages, and cultures made quick assimilation virtually impossible. As the tenement slums they lived in proliferated, these foreigners came increasingly into contact with the inhabitants of the better districts. At a time when Americans had just begun to fear the disruptive effects of urban poverty, vice, crime, and corruption, they were faced with an onslaught of foreign laborers which seemed to threaten the very welfare of the nation. Labor uprisings, riots, and bombings added to the concern that unless action was taken social upheaval and collapse could result.⁵⁵

In the New York City exposed to Biggs when he settled there in 1882, the immigrant problem was as obvious and intense as anywhere in America.⁵⁶ His particular response to the situation--his promotion of an ambitious public health program based largely on a foundation of the young science of bacteriology--was carried out over the years with a vigor and tenacity that had its roots in the Yankee-Protestant values inculcated in him during his youth. Basic to his efforts too was the assumption, implicit in the attitude of the urban Progressive, that broad social and economic reforms were possible, but would not come about as the results of spontaneous voluntarism--thereby necessitating the development of innovative strategies to deal with the novel problems of industrial city life.⁵⁷

Biggs regarded a scientifically based public health program as an essential device for social reform. His emphasis on bacteriology as a major element in such a scheme reflected the appeal of the dramatic discoveries then being made in the field. His expectation that applications of the growing knowledge concerning the behavior of microbes could mitigate some of the damaging effects of industrialization and restore some decency in urban society is indicative of the growing American respect for science.⁵⁸

The technological achievements of science in the second half of the nineteenth century were often dazzling and so stirred the American imagination. Science was beginning to be regarded as the mainspring of progress and the belief developed that the application of its tools, knowledge, and methods to all areas of human activity was possible.⁵⁹ Biggs was young and impressionable when this "scientism" began to permeate

American society. His attendance at Cornell where science was given a major priority further enforced this influence. Not surprisingly, Biggs was attracted to a career in science for it seemed to offer the promise of the power to produce change.⁶⁰

Placed in charge of the laboratory division of the Health Department, Biggs seemingly had the opportunity to employ the science of bacteriology on a massive scale with the possibility of effecting significant social improvement. He acknowledged that personal and general cleanliness were valuable safeguards against infectious disease, but he was convinced that even the most efficient system of plumbing, drainage, sanitary inspection, and regulation could not protect the individual from the elements of contagion. Preventive measures could be effective with an enlightened citizenry, but New York City had a large, poor, non-English speaking population in its tenement districts which were continually packed with "fresh supplies of the most filthy and ignorant classes from all parts of Europe."⁶¹ To circumvent this major obstacle, preventive measures based on a foundation of bacteriology could be implemented by health authorities in a way not so dependent on the collaboration of the public. If such a program occasionally required the exercise of authoritative power, then such was the price that a society must pay to bring about an improvement in those conditions which contribute to a longer and more comfortable life. He was convinced that even the most ignorant of the foreign-born would not be opposed to any rational, scientific procedures, no matter how arbitrary in appearance, and that the Courts would sustain any measures directed to the successful preservation of the public health.⁶² The movement away from traditional practices

was begun with the reassignment of the routine work of disinfection to the Division of Contagious Diseases in January 1894.⁶³

Why the Health Board, which had supported disinfection so generously and had been so reluctant to release funds for bacteriology, now allowed Biggs' division to turn from disinfection to concentrate on bacteriology was not explained, although a number of possible answers suggest themselves. Disinfection was a preventive measure that had grown from the miasmatic concept and was closely associated with it. This theory of disease origin was, however, becoming discredited as the 1880s and early 1890s witnessed one discovery after another of the specific pathogens responsible for a variety of infectious ailments.⁶⁴ As there was a fairly receptive element in the upper echelons of the city's Health Department, a greater shift in emphasis towards bacteriology is understandable.⁶⁵ Furthermore, this move was largely an administrative one, since the responsibility for disinfection in the tenements was not terminated but was relocated to another unit.⁶⁶ Nevertheless, the move represented a significant departure for the New York City Health Department and gives strong indication of having been influenced and orchestrated by Biggs.

Having one administratively burdensome task removed, Biggs could devote more effort to his goal of encouraging a more scientific approach to public health. To effect this metamorphosis he realized that it would be of immense tactical value to enlist the cooperation of local practitioners.

In May 1893, Biggs appeared before a number of New York's most distinguished physicians in what was the first of many attempts to court

their assistance or, at least, their toleration.⁶⁷ Relations between the doctors and the Health Department were generally affable, despite some occasional skirmishes over the failure of some physicians to report contagious diseases.⁶⁸

The medical profession, at the time, was splintered in an embittered internal conflict between the regulars and irregulars (essentially the homeopaths and eclectics) over a host of issues revolving around claims of scientific legitimacy, public acceptance, and licensing.⁶⁹ Even with a united front it is doubtful that the physicians would have been involved in any significant battle with the Health Department; as long as the municipal agency limited its activities to preventive measures there were no vital areas of friction between the two.

Biggs began by explaining to the representatives of the medical profession that the purpose of the municipal laboratory was "to limit the extension of the contagious diseases and to improve and increase the facilities for their management and cure," and that an essential ingredient for its success was their support. Whether the revelation that the Health Department was anticipating the extension of its services to the province of "management and cure" rankled any of the assembled practitioners was not recorded. In any case, to soothe any offended sensibilities and to quell any fears that his laboratory would impose on the jurisdiction of the private physician, Biggs made it a major thrust of his presentation to give assurances that there would be a minimal amount of interference with the work of the doctors and that the domain of private practice would be infiltrated only when it was absolutely unavoidable. Medical inspectors from the laboratory division working in the

field were given orders that, when a physician was treating a case, they were not to examine the patient nor interfere in any way, except if department rules were being violated. The doctors were assured that any complaint they made to the Board of Health would be given full consideration, but were asked not to make the protests public.⁷⁰

Biggs wisely had Dr. Joseph Bryant by his side throughout the evening. The Health Commissioner, who had been involved as a liaison between the medical profession and the Health Department for a number of years and had the support of both, made assurances that "medical proprieties would be observed."⁷¹ The physicians indicated a general support for the laboratory and cautiously pledged their cooperation.

In the course of his discussion Biggs disclosed that efforts were already underway to combat diphtheria.⁷² The preventive measures taken against this ailment were the first major offensive of the bacteriological laboratory and were to be the single greatest cause of its reputation.

The disease's history is a complex one to trace, as it was not established as a clinical entity until the nineteenth century. A number of pathological conditions affecting the throat and adjoining tissue, and known by such terms as sprue, cymancha maligna, putrid sore-throat, angina, croup, and quinsy, were undoubtedly diphtheria.⁷³ Hippocrates might have described it and it almost certainly existed from the sixth century. It was likely the cause of an epidemic which ravaged New England and the Middle Atlantic states as "throat distemper" from 1735 to 1740, that killed over 20 percent of the population under fifteen years of age. A number of epidemics occurred in various parts of northern and

western Europe and North America during the 1840s, and by the middle 1850s these reached pandemic proportions.⁷⁴

Diphtheria was classified by the Health Department as a zymotic disease and its morbidity and mortality statistics were generally included along with those of scarlatina and measles, the three ailments sharing a common predilection for the young.⁷⁵ Little attention was paid to these until the epidemic years of 1874 and 1875 stimulated interest in the etiology of diphtheria and the means for its control. The consensus of opinion expressed in medical journals and the press was that the disease originated from filth, although microorganisms were allowed some secondary role by some in its production. Stricter sanitary measures by members of the household, as well as careful attention to the integrity of plumbing and sewage, were believed to be the best means of defense.⁷⁶ The Health Department's responses were limited to the issuing of a leaflet to the families of the afflicted with simple instructions on sanitary precautions and the reporting of a study conducted under its auspices.⁷⁷

The incidence of diphtheria, although sporadic, continued to climb during the 1870s, creating a host of speculation as to its origins.⁷⁸ Medical opinions varied from the traditional miasmatic to the Germ Theory, and to such views that it was an inherited condition, an inoculative ailment arising from abrasions in the skin, and even that it was caused by potatoes. A Times article of 1880 summarized the state of uncertainty, and the wide division of beliefs as to whether diphtheria was caused by bacteria, a parasitic fungus, or by foul air from sewers and cesspools, with the observation that "whether the disease is or is not contagious is still mooted."⁷⁹

The therapeutic measures widely employed against diphtheria were aimed primarily at cleansing or dissolving the exudate or, so-called, false membrane, which formed in the throat of its victims; favorite remedies included applications of sulphates, lactic acid, potassium chlorate, and iron mixed with materials like vinegar and glycerin.⁸⁰ Several physicians reported good results from blistering various parts of the body of the diphtheria sufferer and ventured the hypothesis that when the skin broke it drew away the tenderness from the throat region.⁸¹

At the conclusion of a meeting of the New York Academy of Medicine prompted by the disturbing incidence of deaths in the city--diphtheria fatalities rose almost 40 percent in 1875--a frustrated Dr. J. Lewis Smith characterized the best-known remedies as "powerless against diphtheria."⁸² Almost a decade later at a similar gathering under similar circumstances--diphtheria had increased 60 percent in the previous two years--it was admitted that no effective medication had been found and that the best that could be done was to provide the patient with clean facilities, good nursing, and properly regulated temperature. The spread of the disease could be limited only by isolation of the infected, a problem complicated by the refusal of any city hospital to admit known cases of diphtheria.⁸³

The discovery of an effective medication against any ailment is generally an outgrowth of a better understanding of its etiology and mode of transmission. Lacking a consensus on either, some basic research devoted to the case of diphtheria was in order. It was unlikely, however, considering the state of American institutions, that such work would come from these shores.

With few exceptions, notably Johns Hopkins and Harvard, American universities were not granted the resources to pursue experimental studies not linked to some obvious and immediately applicable practical advantage. Private, institutional, or government support for research, for the same pragmatic reasons, were not forthcoming.⁸⁴ Local boards of health had not yet broadened the scope of their work to include the fundamental study of the disease process, nor did they have the trained personnel to conduct such investigations. Bacteriological methods were primarily employed by those few municipal and state health departments outfitted to do so, for testing the efficacy of sanitary devices and procedures, most typically those for water purification.⁸⁵

European laboratories had made the fundamental discoveries in bacteriology and it was assumed that they would continue to do so. A most revealing commentary on the public's perception of the capabilities of American scientific research was the Times editorial regretting the fact that Pasteur had turned his attention to rabies and suggesting that he best direct his energies to the study of diphtheria. Nowhere, and this during a period when nationalistic pride was openly and willingly expressed, did the author even entertain the possibility that an American institution should undertake the effort.⁸⁶

Some decisive studies, basic to the understanding of diphtheria, had, in fact, already been made in European laboratories.⁸⁷ Loeffler, a student of Koch, published in 1884 the results of a series of extensive bacteriological investigations in which he identified a certain bacillus, as described inconclusively a year earlier by Klebs, as of probably pathogenetic importance in diphtheria.⁸⁸ Further investigations

by Roux and Yersin, published in 1888, confirmed the presence of a bacilli with the cultural and morphological characteristics described by Loeffler, and verified that healthy animals inoculated with pure cultures developed symptoms entirely similar to those of humans with diphtheria.⁸⁹ By 1891, as the result of combined clinical and bacteriological studies conducted in Europe and in this country, there was almost complete agreement that the conditions for the proof that a certain microorganism was responsible for a certain disease--its constant presence in the lesions of the disease, its isolation in pure culture, reproduction of the ailment by inoculation of pure cultures, and similar symptoms in the experimentally and naturally diseased animal--had been met with the so-called Kelbs-Loeffler bacillus.⁹⁰

The identification of the causative agent of diphtheria did not arouse unusual attention in the lay or medical press, nor did it immediately affect the practice or teaching of medicine.⁹¹ The researchers were relatively obscure and their work did not clearly suggest any method of treatment.⁹² Welch was one of the few to realize the implications of the findings, i.e., that a positive means for diagnosis was at hand, but wondered "whether practitioners of medicine will be in a position to take advantage of this."⁹³ Welch could not have anticipated that within two years a public program for diphtheria diagnosis would be launched in the city he had left, and under the aegis of a man he had helped to train.

Biggs' contribution to the introduction of bacteriological diagnostic services as a proper function of municipal government stemmed from his confidence in such scientific methods and his certainty that they could be easily implemented.⁹⁴ A major part of his success in this

endeavor resulted from his choice of Dr. William Hallock Park to develop the practical means for implementing this pioneering program.

Park had begun to establish himself in otolaryngology and, by his own admission, had little interest in bacteriology when, in 1892, he paid a social call on Dr. T. Mitchell Prudden, one of his favorite professors at the College of Physicians and Surgeons.⁹⁵ In the course of conversation Prudden expressed uncertainty that the Klebs-Loeffler bacillus was the cause of diphtheria--founding his opinion on bacteriological examinations he had made on throat samples from children in several New York asylums and hospitals.⁹⁶ Drawing from his readings on the topic, Park disagreed, whereupon Prudden offered him a scholarship (\$125.00 every three months)--a scarce commodity at Columbia, where research was barely encouraged--if he would study the problem in his laboratory. Park's only training in bacteriology had been what he learned from the two weeks' course he had with Prudden while a medical student.⁹⁷ For the next two years Park worked in his mentor's laboratory in the late afternoon after dividing his time between four hospitals where he served as Attending Laryngologist in three and Assistant Attending Surgeon in the other. It was while making his daily rounds at the wards of the Willard Parker Hospital (a New York City Health Department facility) that he collected the material for his studies.⁹⁸

Park was curious as to why so many cases clinically diagnosed as diphtheria, with the typical pseudomembranous inflammation (false membrane) showed no Klebs-Loeffler bacilli upon bacteriological examination.⁹⁹ He prepared smears from the false membranes of 159 patients and discovered that only 54 showed the presence of the bacilli--these being

"true diphtheria"--while the remaining 105 cases, usually with streptococci infections, he labelled "pseudodiphtheria." His follow-up on these cases showed that true diphtheria had a mortality of about 47 percent, while pseudodiphtheria was fatal less than 6 percent of the time. Park concluded that bacteriological diagnosis of diphtheria was a reliable and quick test (results never taking over 24 hours), and pointed out that

As the early detection of diphtheria is important for the general health, and as this disease occurs most frequently and is most dangerous among the crowded poor who are unable to pay for special examination, it would seem peculiarly the business of the Boards of Health to undertake it. In small cities some central place could be selected where the necessary appliances could be kept, in large cities several would be necessary. From these laboratories a properly equipped man could be called to make the cultures and give the bacteriological diagnosis.¹⁰⁰

Biggs was impressed by Park's studies, their implications, and his suggestions. Consequently, in January 1893, he recommended to the members of the Board of Health that the department begin immediately to employ bacteriological examinations for the diagnosis of diphtheria and that Park be appointed special inspector for this work. A major emphasis in Biggs' appeal was that departmental costs would be lowered. Based on Park's findings, it was projected that at least one-third of all cases maintained and treated at the department's expense as diphtheria were in fact pseudodiphtheria, a condition that did not warrant hospitalization. Furthermore, under the regulations then in effect, a large number of cases of what certainly were pseudodiphtheria were being repeatedly visited by inspectors and were having their rooms, clothing, etc., disinfected after convalescence. Bacteriological tests could establish within hours whether a particular individual had pseudodiphtheria, Biggs noted, and thereby relieve the Health Department of further action

and expense.¹⁰¹

The members of the board certainly realized, in formally approving Biggs' recommendation in May 1893, that the department was entering into a new, and potentially controversial, area of public health service. To a department that had to fight for every dollar and that was traditionally understaffed, the savings envisioned must have been an important consideration. Biggs, furthermore, was riding the crest of his success from the cholera incident.¹⁰² Finally, there were two key people in positions of influence in the Health Department who were especially amenable to change, i.e., President Wilson, a controversial figure but one nonetheless who had demonstrated a desire to be associated with innovation, and Dr. Joseph Bryant, long a supporter of bacteriology in public health.¹⁰³

Park was appointed Bacteriological Diagnostician and Inspector of Diphtheria. Under his direction "culture outfits" consisting of two tubes, one with a swab for taking samples of exudate from the throat of the patient and the other containing culture medium, were left at a number of pharmacies throughout the city.¹⁰⁴ Circulars were sent to every physician explaining the importance of distinguishing between true and false diphtheria and informing them that they could obtain, free of cost, culture tubes and instructions for their use at certain druggists. The tubes were to be left at the pharmacy where they would be picked up each night by messenger. The physicians were promised that by noon of the next day the diagnosis would be ready; they had only to telephone the laboratory to get the results.¹⁰⁵

Great precautions were taken in this venture to avoid offending

the medical profession upon whose cooperation its success hinged. Doctors were assured that the procedure was to aid them in the difficult task of diagnosis, and was entirely voluntary. Even when department inspectors found cases resembling diphtheria in tenements, they would "request permission" before taking a swab inoculation if an attending physician were present.¹⁰⁶

As Park was aware, many of New York's private practitioners were schooled, as was he, on the concept that diphtheria was a filth-related disease, and were thus reluctant to avail themselves of the Health Department's diagnostic service.¹⁰⁷ No opinions were expressed in the local medical periodicals on the innovation during the first few months of its introduction, although there is evidence that it was well received by a significant portion of the medical community.¹⁰⁸

The professional journals generally editorialized only on those Health Department policies that irritated physicians; the absence of commentary can be viewed as a passive form of approval or, at least, tolerance. Considering that the service of bacteriological diagnosis was provided gratis, was optional, and discreet--it would be taken advantage of by the doctor without the patient's awareness of his dependence on an outside agency--there was no cause for complaint.

Initially all laboratory examinations were conducted by Park, but as the work grew Alfred L. Beebe (a department chemist) was assigned to assist him and was given the title Inspector of Bacteriology. Beebe and special inspectors (shifted from other divisions of the Sanitary Bureau) were taught to make inoculations and were sent to physicians who had reported tentative cases of diphtheria based solely on symptomology.

The inspectors were told to request that the physician allow a throat culture to be taken.¹⁰⁹

While carrying out a huge amount of tedious laboratory work with little assistance, Park also kept careful records so as to be able to coordinate the diagnostic information with the eventual outcome of each case. Of the 1,625 cases where Klebs-Loeffler bacilli were found and the consequences known, the total mortality was 27 percent, compared to 2 percent in the 450 cases with no bacilli, thereby substantiating Park's earlier study at the Willard Parker Hospital and giving further justification for bacteriological examinations and the Health Department rule that pseudodiphtheric individuals need not be kept under supervision.¹¹⁰

Another matter which attracted Park's attention were the indications from the studies of others that the pathogenic organisms persisted in the throat after the disappearance of the exudate and following the patient's apparent recovery. Cultures were made at short intervals after the disappearance of the false membrane in 605 cases until free of diphtheria bacilli. In 301 cases the bacilli persisted for over three days--of these it lasted for one week in 176 cases, for three weeks in 12 cases, and over one month in 10 instances.¹¹¹ Biggs learned of these results and by the summer of 1893 convinced the Health Department to establish the rule that negative cultures would be required for the official release of convalescent patients from hospitals and from home isolation.¹¹² Physicians were informed via a circular, later published in the Medical Record, that their patients were to remain isolated and under observation until bacteriological examinations--mandatory in

confirmed cases of diphtheria--proved that they harbored none of the pathogens.¹¹³

More startling than the revelation that recovered victims of diphtheria could still carry its contagion was the discovery that virulent diphtheria bacilli could be found in a small proportion of healthy people, some with a history of contact with the disease, some without.¹¹⁴ The finding of the well carrier state was of great theoretical importance. One of the chief factors hampering greater acceptance of the Germ Theory was the sudden occurrence of disease in persons who had no apparent contact with others similarly affected.¹¹⁵ The clear identification of human factors helped to resolve this mystery.¹¹⁶

Park's first research effort as a public health figure was a landmark work in the bacteriology of diphtheria.¹¹⁷ The complete details of his study were made available to interested public health workers and physicians in the Scientific Bulletin, published by the Health Department and intended as the first of a series.¹¹⁸ A second issue was put out in 1895 but, for reasons not explained, it was the last.¹¹⁹ For the next several years most of the laboratory's published material could be found in the Health Department's Annual Reports and/or local medical journals, particularly the Medical Record, Medical News, and the New York Medical Journal.

The diphtheria investigation had the greatest impact of any single piece of research done by the laboratory and in its intent and methodology was archetypical of the more productive work that would be done in succeeding years. The unstated, but obvious, driving force was the quest for utility, a search for the means to bridge the gap between

the growing information on the fundamental nature and pathogenic behavior of microorganisms and the productive use of this knowledge in the service of the public well-being. Park had earlier noted, in reference to diphtheria, "that the knowledge obtained is far in advance of its practical application."¹²⁰ A major portion of the municipal laboratory's energies and resources would, in the Baconian tradition, be directed to narrowing this interval.

The laboratory was to be a workshop, altering, adapting, and refining the basic discoveries of others in order to devise workable procedures for the battle against infectious diseases. Park, who made no pretense of ever being able to make spectacular, basic discoveries of monumental proportion, accepted this role, and in this regard was always generous in his citations and in his willingness to give credit to other researchers for prior work.¹²¹ His style became that of the bacteriological laboratory so that none of its personnel would ever be the accused in a priority battle.

A new relationship between government, in the guise of the Health Department, and the individual was in the process of being established as a consequence of the laboratory's findings. In the past, public health sanitary services were directed towards preventing the spread of disease through manipulation of the environment. The science of bacteriology offered the hope of better health through procedures which required a more direct contact between the citizen and the municipal bureaucracy. The intermediary role of the physician in this association was not yet well defined and so added another dimension as to what portended to be a difficult mutual adjustment. The rule requiring negative

laboratory tests to free diphtheritics from compulsory isolation, although well intended and rational, and while difficult to enforce, suggested the restrictive possibilities inherent in the metamorphosis to scientific public health.

The guidance of the laboratory during these initial years and the nature and extent of its activities were largely due to Biggs and Park. The roles of each were well defined. Biggs acted as the scientific overseer, the administrator, the statesman, representing the division and promoting its programs to the Board of Health, the medical profession, and the public.¹²² Although he was one of a small circle of physicians with firsthand experience and formal training in bacteriology, he preferred to leave the practical work of the laboratory to Park.¹²³

Park welcomed the opportunity to conduct research and by background and disposition seemed well suited for the task. Born and raised in New York City, he attended public schools and must certainly have had some exposure to the filth and overcrowding, as well as an awareness of the general state of health, in the tenement districts. He was taught the virtues of hard work and a realistic approach to problem-solving by his father, a successful merchant. Park was inspired to use his talents to assist the less fortunate by the models of several of his relatives who had been missionaries in the Far East.¹²⁴ In this post-Darwinian era he would not join those who sought to investigate the basic evolutionary mechanisms through the study of bacteriology. His associates were in complete agreement that he had enormous patience and a dedication to detail that the tediousness of practical, less theoretical, laboratory work demanded.¹²⁵

The assumption of responsibility for the routine diagnosis of an infectious disease by a public agency, as introduced by Park and Biggs, inaugurated a procedure that was quickly adopted by other health departments. The Klebs-Loeffler bacillus was generally conceded to be diagnostic of diphtheria, even if not necessarily the cause. The influence of the New York program resulted, therefore, not so much from its indications of the scientific soundness of the bacteriological examination, but from its demonstration that such a service could be best performed, and with relative ease, by a municipal laboratory.¹²⁶ Within two years health departments in Philadelphia and Massachusetts were operating similar programs and within a few years every large city in the United States was providing comparable assistance.¹²⁷ These state and local laboratories, organized specifically to provide public facilities for bacteriological diagnosis, quickly expanded their involvement to a whole range of activities involving disease control.¹²⁸ It would not be an exaggeration to credit the New York City laboratory, and the initiative of Park and Biggs, with accelerating the emergence of public health laboratories throughout the country.

Decades later, when tributes were paid to the laboratory division, reference was almost inevitably made to the work of 1893. Incorrect allusions to it as the "first municipal laboratory in the world" probably stemmed from its having been the first of the genre to have maintained a systematic and long-running program of diagnosis and experimentation.¹²⁹

The association of laboratories with public health departments already existed in Europe in a variety of forms. In France, the National

Academy of Medicine in Paris, recognized as the highest scientific authority in medicine and hygiene, formed part of the sanitary commission under the general direction of the Minister of the Interior; in Belgium there was a similar arrangement between the Royal Academy of Medicine and the government. In both cases the scientific organizations did consultative work on special health problems, occasionally requiring laboratory investigations. In neither instance was there a designated unit for bacteriology; in both countries the laboratories were primarily depended upon to conduct routine testing of tainted milk and meat samples.¹³⁰

In England the development of laboratory methods for public health had begun in the middle of the nineteenth century under John Simon, Medical Officer of the Privy Council. In 1870 Parliament began the practice of granting two thousand pounds annually to individual researchers for "auxiliary scientific investigation." A number of these grants were for bacteriological studies, but they were the only government-sponsored activity in public health research for nearly fifty years with any continuity.¹³¹ Medical Health Officers were given little encouragement to do research and while some studied laboratory methods in the early 1890s so as to be able to conduct food analysis, such interest was short-lived and gave way to the growing emphasis on vital statistics and epidemiology.¹³² By the last decade of the nineteenth century the most important source of financial backing for the encouragement of laboratory methods derived from bacteriology was farsighted businessmen with colonial investments who were particularly concerned with tropical diseases. Once created, it became relatively simple for such privately endowed laboratories to adapt to the production of medications and to be

able to offer diagnostic services as subsequent discoveries in bacteriology made both technically feasible. These commercial enterprises fulfilled a need so that in England there was no great stimulus for the development of public bacteriological laboratories.¹³³

Germany too had no publicly supported local laboratories of bacteriology that can be considered as having any paradigmatic significance in the history of New York City's specialized division.¹³⁴ Germany did, however, provide the basic institutional model. Biggs had studied for a number of months in German laboratories following his graduation from medical school and from this experience, as well as his personal and academic associations with Welch and Prudden, he was certainly familiar with the scientific work of the Imperial Health Office.¹³⁵ This institution, created and supported under the auspices of the national government, had established laboratories of hygiene and chemistry in 1879 to serve as its research arm. In 1880 laboratories of bacteriology were added and Robert Koch appointed their director. These laboratories were conceived specifically for the purpose of carrying out health research designed to produce knowledge useful for the protection of the general population. Although Koch left the position in 1885 for a professorship at the University of Berlin's Hygienic Institute, the nature of the research he had helped initiate at the Health Office was continued.¹³⁶

Biggs realized that the exact German pattern of a public health bacteriological research center endowed by the national government was unlikely to be mirrored in America where federal support for the experimental medical sciences had been sporadic and half-hearted.¹³⁷ For this reason Biggs had to modify the model of the bacteriological laboratories

of the Kaiserliches Gesundheitsamt to the municipal level.¹³⁸ This was accomplished by incorporating the laboratory branch directly within the structure of the New York City Health Department. Such an arrangement had to be particularly pleasing to Biggs, a man with a strong sense of purpose and abundant self-confidence. Not only would this reorganization put scientific medicine at the disposal of the Department, but it would also permit him to determine the very direction of the laboratory's activities. To his credit, and with the propitious assistance of the cholera episode, he was able to make this transformation and set into motion an ambitious program which served to shorten the gap between discovery and application.

Another aspect of the German public health system that served as a model for Biggs was its socially oriented point of view. In the years following the upheavals of 1848, a number of German physicians and laymen began to spread an awareness of the relation of health to social problems. Industrialization and the hardships brought by urbanization prompted many to urge the government to assume a greater role of responsibility for the health of its citizens, particularly the laboring classes in the cities. Virchow, for one, advocated the establishment of a national health agency to provide free medical care for all those who could not afford to pay for it.¹³⁹ The social economics of poor health was also noted by reformers such as Lorenz von Stein, who considered it obvious that the low state of health of the lower classes doubled the public burden of relief for the poor, an expense absorbed primarily by the upper classes.¹⁴⁰ Von Pettenkofer also emphasized the economic losses to the business community from the death and illness of laborers

and pointed out the damaging effects that poor national health had on the family unit and on the level of social morality and general decency.¹⁴¹

With the encouragement of Birmarck, the German system of public health became one in which the central and state governments assumed more and more of the functions of protecting the individual from disease and reducing the spread of sickness once it appeared. A major purpose of this policy was to dampen the appeal of views similar to those of the earlier reformers which often advocated drastic political and/or social changes as a prerequisite for the improvement of the nation's health. To guarantee the success of this endeavor, the German states depended on the enforcement of health rules by medical police.¹⁴² Although health regulations were often not precise and were poorly disseminated so that they were "unknown to the mass of the people," the apparent success of the authoritarian features of the system was not lost on outsiders.¹⁴³ Biggs, who had become aware of the German public health program through his friendships with Prudden and Welch, observed it firsthand during his almost yearly trips to Europe. What he saw was a system that employed the latest scientific knowledge on the nature of infectious disease to better the public's health and which did not necessitate ambitious social policies nor disturb the political status quo.¹⁴⁴ Health procedures based on direct bacteriological intervention into the lives of only those who were ill minimized social agitation and thus appealed to Biggs' conservative nature.

The English system that Biggs perceived on these visits abroad also served a paradigmatic function in shaping his views on the structuring of a public health strategy. The public medical services available

in this country, where the hardships of modern industrialization were first realized, grew out of the crusades against preventable diseases which occupied so much of the attention of social reformers beginning in the 1840s. The health regulations that emerged were originally part of the Poor Laws but eventually were separated from those laws concerning relief when local Boards of Health were established. Nonetheless, the health system was firmly committed to the purpose of "alleviating the misery in the houses of the poor" who could then "have a better prospect of recovering their health and the means of providing for their subsistence and that of their families."¹⁴⁵ Although the English means for enforcement of regulations were not as ostensibly authoritarian as those of the German states, the strength of Parliament stood behind health laws so that, as a contemporary observer noted, even though sanitary laws "encroach upon the inviolability of the home" and deprive the Englishman of a "good part of his liberty," he "submits readily to the laws" since he has been convinced that they can "safeguard . . . him from the inconvenience and perils inherent to life in communities."¹⁴⁶ The British health system thus stood as a model to Biggs of the aspirations of a public health program and an example of the real possibility of its success.¹⁴⁷

In the summer of 1894 Biggs traveled to Europe. In London he was welcomed as an American disciple of progressive public health and presented an address before a British Health Congress which attracted considerable attention. His talk on the effectiveness of New York's diphtheria program led to a resolution calling on local and national authorities to create the facilities for the implementation of

bacteriological diagnosis.¹⁴⁸ Within months the Metropolitan Board of London (with supervision over London's contagious disease hospitals), and a few local health boards acted on the suggestion.¹⁴⁹

Biggs' reputation also brought him invitations from German laboratories where--in an exchange symbolic of what was occurring in the trans-Atlantic flow of medical information--he told of the practical method for diphtheria control begun in this country and in return was informed in detail of the results of critical investigations undertaken at European research centers.¹⁵⁰ At the Institute for Infectious Diseases, Biggs was familiarized with the antitoxin studies in progress and from conversations learned that four hundred cases treated with sera produced there under the direction of von Behring, Ehrlich, Wasserman, and Kossel were showing encouraging signs; he also learned that Roux was successfully using diphtheria antitoxin in some Paris hospitals.¹⁵¹ Biggs, characteristically avoiding delay, cabled Park that antitoxin was successful and that toxin production should immediately begin so that animals could be cultivated as soon as possible.¹⁵² The cable served to initiate the process of thrusting the New York City Health Department's laboratory into a position of responsibility for the manufacture of a therapeutic medication and, consequently, of accountability for the direct treatment of the ill. Biggs was certainly aware of the implications of his order to Park and, considering his self-confidence and social views, was prepared to stand behind them.

At the International Congress of Hygiene at Budapest in September, Roux, of the Pasteur Institute, presented evidence of his success with serum therapy at a number of children's hospitals in Paris that was

extensive and well controlled as to make the use of diphtheria antitoxin a virtual fait accompli.¹⁵³ The response of the New York press was explosive as Roux's announcement confirmed the campaign the papers had been waging since late summer. In August the Times reported the trip that Biggs, the "well known bacteriologist of the Health Department," had taken to Berlin and shared his enthusiasm for antitoxin treatment. The paper then noted that a program of antitoxin production would be costly and that it could only be manufactured in sufficient quantities for disposal to the poor by municipal or State authorities.¹⁵⁴ Over the course of the following weeks the public was informed, via articles and editorials, of the safety and effectiveness of the serum treatment for diphtheria.¹⁵⁵

When Commissioner of Health Cyrus Edson, acting on Biggs' request, appealed to the Board of Estimate for \$30,000 for the laboratory to begin large-scale antitoxin work, he was turned down. The refusal, although considered unconscionable by the press and perhaps, in retrospect, insensitive as well, was not simply blind frugality.¹⁵⁶ A substantial portion of the American medical community was not yet convinced of the efficacy of antitoxin since they had not had the opportunity to test it first-hand and because of the haunting memory of the failure, just years earlier, of Koch's tuberculin and the shattering of professional reputations as the result.¹⁵⁷ New York City was also at the time under the leadership of Mayor William L. Strong who, along with his police chief Theodore Roosevelt, was attempting to rid the city of the remnants of Tammany waste and who had promised the electorate his attention to economy.¹⁵⁸

Luckily the small fraternity of bacteriologists was a tightly-knit one and unofficially presided over by Prudden. Always a friend of the laboratory, he personally paid for the removal of eighty tons of coal from a local coal house and bought four horses to be stabled there and cultivated with toxin produced by Park at the tenement house laboratory.¹⁵⁹ When news of this situation reached the New York Herald, its editors began a campaign to raise funds to assist the effort through popular subscription; the paper initiated the drive with a \$1,000.00 contribution.¹⁶⁰

Although working out of miserable facilities, undermanned, and inadequately financed, Biggs had the advantage of complete freedom of action for his laboratory division and the blessings of his superiors as long as the city did not have to foot the bill. What emerged was a unique interaction of public and private resources. Diphtheria toxin produced in the municipal laboratory was used to treat horses stabled at privately owned quarters (arrangements were made to house the animals at the New York College of Veterinary Surgeons) with the expenses borne through the philanthropy of a local newspaper, a college professor, and citizen donations.¹⁶¹ The monies collected by the Herald Fund were administered by an Advisory Board of Physicians, with the actual use of the funds under the direction of two of its members, Park and Biggs.¹⁶²

Biggs was not satisfied with the awkward arrangements nor the city government's refusal to finance what he considered a project of obvious benefit to the public health.¹⁶³ The Chief Inspector adopted an ingenious stance in a report prepared by him and Prudden (then Consulting Pathologist to the Division of Bacteriology, Pathology, and Disinfection)

and presented to the Board of Health on December 5. The document claimed that there was an enormous demand for antitoxin and only small supplies of legitimate sera from German pharmaceutical companies had reached the New York City area. Highly expensive preparations were already being advertised and sold by local pharmacies, the majority of which were inert and therefore potentially fatal to those who depended on them exclusively for cure. The only logical way to overcome this dangerous situation, Biggs and Prudden concluded, was to fund the laboratory so it could manufacture diphtheria antitoxin.¹⁶⁴ The product would be scrupulously tested for purity and would be mass produced by competed bacteriologists, thereby driving the bogus agents off the market and putting the crucial material within the grasp of the city's poor.¹⁶⁵ Considering that Biggs had become somewhat of a media hero--portrayed as the brave knight of science locked in combat with the Philistines in City Hall--and that it was politically expedient to be associated with a life-saving program that had received the general approval of prominent members of the medical community, it was not unexpected when the Board of Estimate approved an appropriation of \$30,000 for the bacteriological laboratory, in late December, for the production of antitoxin.¹⁶⁶

The laboratory had meanwhile already moved to more spacious quarters at the Criminal Court Building.¹⁶⁷ Larger facilities were needed as a greater number of physicians were availing themselves of the free diagnostic service.¹⁶⁸ More examinations were also being made as the result of the instructions now given to the twelve Medical Inspectors assigned to the laboratory to routinely take "trial" cultures of those persons caring for diphtheria cases and for all school-aged children in

those families.¹⁶⁹ The rationale for the precaution, an outgrowth of the discovery of the carrier state, illustrates the speed with which practical applications were derived from research findings and put into effect during these early years.

The new quarters served as a showcase as the division of bacteriology had achieved a national reputation from its introduction of the diagnostic service.¹⁷⁰ Public health officers and physicians from almost every state came to the facilities for personal instruction in laboratory techniques and administration.¹⁷¹

In addition to new surroundings the division secured some needed clerical help and a few laboratory assistants and its first full-time research worker (other than Park), Dr. Anna W. Williams, appointed with the title Assistant Bacteriologist.¹⁷² Women physicians faced considerable professional and social handicaps which made it extremely difficult for them to establish successful private practices.¹⁷³ Poorly paying Board of Health positions were consequently often filled by female doctors; Williams was the first of many to find employment in the department's laboratory. As a graduate of the Women's Medical College of New York in 1891, she had some formal training in bacteriology and had attracted Biggs' attention while doing volunteer work at the municipal laboratory. She left her position as Instructor in Pathology and Hygiene at her alma mater and quickly adapted to the problem-solving approach of the division.¹⁷⁴

In her first year Dr. Williams carried out two investigations assigned by Biggs. In one, she examined some milk and cheese specimens sent from other cities and determined that the bacilli found in both were

not, as feared, the microbes of diphtheria.¹⁷⁵ In the other, she confirmed the suspicion that the practice of schools of collecting pencils each night and redistributing them at random the following day was a dangerous one, considering the habit of children of holding pencils in their mouths and her laboratory studies which showed that diphtheria bacilli could easily be transmitted via this route.¹⁷⁶

Williams also aided in the preparation of antitoxin sera, the first supply of which was made available on January 1, 1895. The plan devised by Biggs for its utilization showed clearly his intent of broadening the scope of municipal public health services to include the prevention and cure of infectious diseases, with special emphasis on protecting the poor, and with the bacteriological laboratory as the focal point of the entire design.¹⁷⁷ Antitoxin was supplied free to all public institutions and to private practitioners for use among the poor on the condition that reports of cases so treated be forwarded to the Health Department. In addition, it would be administered without charge to the impoverished by Medical Inspectors attached to the laboratory division.¹⁷⁸ The remedy was also put on sale in over one hundred pharmacies in the city where it could be purchased by physicians for their more prosperous patients with the price fixed by the Health Department and the druggist given 10 percent on the sale as commission.¹⁷⁹

With the first systematic production of antitoxin in this country underway and with the number of bacteriological examinations increasing, the demands made upon the division were enormous. In February 1895 the staff was augmented by the appointment of an Assistant Pathologist, an Assistant Chemist, four assistant Bacteriologists, and several

laboratory assistants.¹⁸⁰ Biggs had complete control over personnel and sought whenever possible to hire individuals who had some background in bacteriology. Unlike Europe (particularly Germany), where research commanded considerable prestige and universities and state-run institutions offered generous compensation and excellent facilities as enticements, the municipal laboratory paid only \$1,200 per year and did not have any reputation as a training ground for the launching of a research center nor the attraction of a giant figure as its mentor.¹⁸¹ Graduate programs in bacteriology were just beginning and established physicians, who could earn up to \$20,000 yearly in practice, were not easily tempted. Besides, few of them had the requisite experience.¹⁸² Biggs' source of professional manpower, therefore, was narrowed down to young physicians from those medical schools which provided laboratory training in bacteriology.

The profiles of the three Assistant Bacteriologists hired in 1895 and retained beyond that year were similar. Alexander Lambert and Charles Fitzpatrick were recent graduates of the College of Physicians and Surgeons (perhaps recommended by Prudden) while John S. Billings, Jr., received his medical degree from the University of Pennsylvania.¹⁸³ As members of the laboratory staff they were required only to put in three hours a day, thus allowing each of them time for private office hours and/or hospital work.¹⁸⁴ Fitzpatrick and Lambert were given the task of assisting in antitoxin production and Billings, who had published some research papers while serving his residency at Johns Hopkins Hospital, was assigned to experimental work.¹⁸⁵

In the early part of 1895 the responsibility for the production

of smallpox vaccine was transferred to the bacteriological laboratory. The Criminal Court facilities were already becoming strained so that Biggs requested additional space. By October the laboratory division was separated into a Hospital Laboratory (so called because of its nearness to the Willard Parker Hospital) located in the upper stories of the Disinfecting Station and a diagnostic laboratory. The former was placed under the direction of Park and contained separate rooms for antitoxin production and experimental research; the latter remained in the Criminal Court building and was to serve as the quarters for routine diagnostic work under its head, Alfred Beebe.¹⁸⁶

In order to meet the demand for antitoxin sera and to raise funds to further extend the experimental activities of the laboratory, Biggs--with a good sense of timing considering the early successes of the treatment program and its favorable publicity--convinced the State legislature to pass legislation authorizing the Health Department to sell its surplus antitoxin.¹⁸⁷ The bill, signed on March 26, 1895 by Governor Morton, actually amended an 1874 law which had allowed for the sale of excess smallpox vaccine; it read:

Resolved, That the Division of Pathology, Bacteriology, and Disinfection, be instructed to offer for sale any surplus of diphtheria antitoxine [sic] over that required for the treatment of cases of diphtheria occurring in the Health Department hospitals, in the public institutions, and among the poor of the city¹⁸⁸

The excess antitoxin produced by the bacteriological division generated considerable income, in large part due to its excellent quality, for which the laboratory gained a national and international reputation.¹⁸⁹ Its local use by physicians, hospitals, and department inspectors produced considerably favorable statistical evidence that the

treatment was effective.¹⁹⁰

Part of the reason for the overall drop in diphtheria mortality may have been the prophylactic use of antitoxin. Park had ended his monumental report on diphtheria with the pessimistic note that because of the existence of the carrier state, the isolation of the ill and disinfection were inadequate and that extermination of the disease was not possible unless new means to combat it were acquired.¹⁹¹ When Biggs learned that von Behring had some indications from a small number of cases that the antitoxin could be used immunologically, the means seemed available. All the children in a Mount Vernon branch of the New York Infant Asylum were inoculated with serum brought from Europe by Biggs when an epidemic broke out there in October 1894.¹⁹² The children were, in reality, guinea pigs for an inadequately tested procedure but, luckily, all survived. With his typical boldness, and some disregard for the normal requisites of rigorously controlled scientific verification, Biggs expanded the parameters of public health authority by ordering inspectors to begin the general use of immunizing injections beginning in January 1895.¹⁹³ Acting on the belief of the division head that no tradition or precedent could restrain the employment of scientific measures for the community well-being, the medical staff immunized the inmates of various public institutions and as many tenement dwellers (especially the families of diphtheria sufferers) as they could over the next few years.¹⁹⁴

To publicize the successful results of serum therapy and to gain the support of physicians for a program that both knew was a potential source of irritation to them, Biggs, and occasionally Park, made

appearances before medical groups and sought public support through pieces in popular magazines.¹⁹⁵ Their efforts had a catalytic effect on the American acceptance of diphtheria antitoxin and the development of municipal bacteriological laboratories, the two being often intimately related.¹⁹⁶ In Philadelphia, for example, a division of bacteriology was created in 1895 primarily for the purpose of manufacturing anti-toxin.¹⁹⁷ The program it established for distribution of the curative material, like those emerging from other health departments throughout the country, was modeled on the New York precept that a government agency has the right and responsibility to make therapeutic medications available at a moderate price and to provide them free to the poor.¹⁹⁸

The laboratory became a mecca for health officials from America and abroad who came to learn Park's procedures for the production of anti-diphtheria serum.¹⁹⁹ The British Laryngological, Rhinological, and Otological Association symbolized the shift of focus from across the Channel to across the Atlantic for the practical applications of fundamental research when, at a London meeting in July 1895, it was decided to await news from America before deciding on the advisability of utilizing antitoxin.²⁰⁰

The city laboratory's diphtheria management program did not proceed long before meeting some resistance from the medical community. The professional journals generally took a cautious stance on serum therapy, preferring to wait for further evidence before making a commitment.²⁰¹ Following occasional reports of deaths and severe reactions following inoculations, some serious doubts were expressed on the efficacy of the cure.²⁰² The chief spokesman was Dr. Joseph Winters,

Attending Physician to the Health Department hospitals. At a stormy meeting of the New York Academy of Medicine, Winters denounced the antitoxin treatment that he had observed at Willard Parker Hospital and claimed that the favorable results were contrived since some of those treated did not show clinical signs of diphtheria and that the medication had damaging effects on the kidneys, nervous system, and blood.²⁰³

Because of the close association of antitoxin with the municipal laboratory, clinical objections to the medication unleashed a more fundamental hostility to both bacteriologists and the expanding domains of the laboratory's services. The diagnostic program, previously sacrosanct, was assailed as occasionally unreliable and its inspectors accused of taking unnecessary swabs and of interfering in privately treated cases.²⁰⁴ It was admitted that clinicians were generally reluctant to accept the help of bacteriologists, although few went so far as the practitioner who classified bacteriology as a "cult."²⁰⁵ The fact that most bacteriologists were also physicians hardly mattered, since what was objected to was what seemed to be a lowering of the position of the private practitioner in the professional pecking order; it was regarded as insulting and patently absurd that doctors should accept the "dictum" from laboratory workers that all their patients with Klebs-Loeffler bacilli should be treated with antitoxin.²⁰⁶

As was inevitable, the volatile question surfaced as to what was properly to be the jurisdiction of public health services and what was exclusively within the domain of the private physician. An editorial in the Medical News delicately broached the matter soon after the laboratory division had begun its massive production and distribution of

antitoxin sera. The city laboratory was praised for its initiative but was categorized, wishfully rather than realistically, as a helpful governmental agency temporarily fulfilling a vacuum until that time when doctors would have learned bacteriological techniques, since "it cannot take from the work of the individual physician the tasks that legitimately fall to him."²⁰⁷ Some practitioners, in fact, had already begun their own personal warfare against the municipal laboratory by failing to report diphtheria cases on the mistaken notion that its inspectors would intervene and begin antitoxin treatment.²⁰⁸

Within three years of the 1892 cholera episode, the New York City Health Department's bacteriological laboratory had leaped from its origins as a hastily conceived expedient to the vanguard of a movement to transform the staggering eruption of knowledge in bacteriology into publicly exploitable procedures for the improvement of community health. Biggs' vigorous leadership and tactical maneuvering had produced the means for the laboratory's economic self-sufficiency and had gained the general endorsement of health officials, the press, socially concerned doctors, and, judging by the lack of evidence to the contrary, acceptance by the public.

Battle lines were, however, forming between the municipal laboratory and its visionary leader on the one flank and certain segments of the medical community on the other. The issue was one of territoriality and its economic and social consequences, and was thus rife with incendiary potential. As one physician sarcastically prophesied, "When a government . . . undertakes the job of providing free examinations, free disinfections, etc., it must expect some friction before the state of perfected paternalism is reached."²⁰⁹

NOTES

¹Winslow, The Contributions of Herman Biggs to Public Health, p. 8; Ann. Rep., Bd. of Health, 1892, pp. 172-179.

²Ibid., p. 34. Instructions were issued to all inspectors to be exceptionally vigilant, the result being that from August through October close to 1,200,000 pounds of suspicious meat, fish, fruit, vegetables, and milk were seized and destroyed; over 300,000 pounds alone were disposed of during the week the cholera-ridden ships first entered New York's harbor. Wells which, through seepage, might have been contaminated with sewerage were closed and orders were issued to clean old vaults, school sinks, depressed gutters and yards, and the Croton watershed was carefully watched. Tenement owners were directed to repair defective waterpipes, roof leaders and sinks, and to clean roofs and water tanks. Medical inspectors were instructed to conduct house-to-house visits to hunt down any cases of infectious disease and to give the ill and their families instructions on the sanitary handling of food and drink, and to urge the isolation of the sick. See ibid., pp. 34-35; Weekly Report, II, nos. 31-43 (1892), 4-5.

³The paper's continual outrage at the horrendous condition of New York's streets and tenements had become, over the years, a virtual crusade. Now that a rapid clean-up had brought noticeable improvement, the Times's editors, with the confidence of the vindicated, implied a connection between the phenomenon and the absence of a local epidemic. See Times, September 28, 1892, p. 4.

⁴Ann. Rep., Bd. of Health, 1892, pp. 35, 48-49.

⁵Ibid., pp. 180-182.

⁶Times, September 14, 1892, p. 2.

⁷See pp. 29-30; Winslow, Life of Biggs, p. 96.

⁸Ann. Rep., Bd. of Health, 1892, pp. 5-8; 1893, p. 7. The only other bureau was the Bureau of Records. It had the responsibility of maintaining registration of marriages, births, deaths, of granting burial permits, of investigating unusual forms of deaths, and of filing all vital statistics. See ibid., 1892, p. 8, and 1893, p. 8.

⁹Biggs, "The Organization, Equipment, and Method of Work of the Division of Pathology, Bacteriology, and Disinfection of the New York City Health Department," Trans. of N.Y.A.M., 2nd series, X (1893), 303-304; Times, May 16, 1892, p. 8; September 11, 1892, p. 2.

¹⁰Winslow, The Life of Herman Biggs, p. 99; Ann. Rep., Bd. of Health, 1892, pp. 48, 168.

¹¹Ibid., p. 49; Biggs, Trans. of N.Y.A.M., 2nd series, X (1893), 308-310.

¹²Ann. Rep., Bd. of Health, 1892, p. 48. The numbers and qualifications of the personnel assisting Biggs in his program of disinfection varied over the first few months as the Health Department worked on the problem of absorbing the new division into the existing bureaucracy. In late September 1892 the department's estimate of expenditures for the Division of Pathology, Bacteriology, and Disinfection included yearly salaries of \$1,200 each for twelve physicians to serve as Medical Inspectors, \$1,080 each for four lay disinfectors, and \$900 and \$600 for two laborers. See Board of Aldermen, Proceedings, CCVII (July 5, 1892-September 29, 1892), p. 318 (hereinafter cited as Bd. of Ald., Proceedings). By May 1893 Biggs reported that he headed a force of twenty-five employees engaged in the work of disinfection, only four of whom were Medical Inspectors. Less inspectors were needed, it appears, as it was agreed that as long as inspectors from the Division of Contagious Diseases had to visit the homes where infectious conditions were reported, they would distribute circulars on the methods of disinfection and check on later visits that the work had been carried out. Only if the instructions were ignored, or when a final complete disinfection of the quarters was deemed necessary, was an inspector summoned from Biggs' division. See Biggs, Trans. of N.Y.A.M., 2nd series, X (1893), 304, 307, 312.

¹³Ibid., p. 308; Bolduan, Over a Century of Health Administration in New York City, p. 36; Ann. Rep., Bd. of Health, 1892, p. 168.

¹⁴Ibid.

¹⁵Park, speech delivered to the Society of American Bacteriologists on February 15, 1939, p. 1 (typed); Ann. Rep., Bd. of Health, 1893, p. 306; Winslow, The Life of Herman Biggs, p. 96. A small amount of routine diagnostic work on samples sent from suspected cholera patients had been performed at this tenement laboratory; the bulk of the testing, however, had been carried out at the Carnegie laboratory. See ibid.

¹⁶Bd. of Ald., Proceedings, CCVII (July 5, 1892-September 29, 1892), p. 318; New York Herald Tribune, February 25, 1934, p. 4; Ann. Rep., Bd. of Health, 1892, pp. 171-180.

¹⁷Ibid., 1895, p. 37; Dr. Morris Schaeffer, speech delivered at the cornerstone setting of the Public Health Laboratory Building, April 5, 1968, p. 1; Ann. Rep. Bd. of Health, 1895, p. 37; Bd. of Ald., Proceedings, CCSV (July 2, 1894-September 18, 1894), p. 191; Wade W. Oliver, The Man Who Lived for Tomorrow (New York: E.P. Dutton and Co., Inc., 1941), pp. 109-110.

¹⁸Biggs, Am. Jnl. of Med. Sci., n.s., CV (January 1893), 71.

¹⁹The job of reform was a difficult one, as neither the upstate Republicans nor Tammany Democrats had intentions of disturbing the status quo, despite overwhelming evidence presented by a Select Senate Committee on the seriousness of New York City's situation. Its annual mortality from 1844 to 1853 was almost 34 people per 1,000 population, a high figure even for that period and the worst of any large city in the United States. Baumgartner, p. 558; Rosen, A History of Public Health, p. 244; Bolduan, Over a Century of Health Administration in New York City, p. 13; Biggs, Trans. of N.Y.A.M., 2nd series, XII (1895), 430; Walsh, I, p. 241.

²⁰Ibid., p. 242; Rosen, A History of Public Health, p. 244; Duffy, A History of Public Health in New York City, 1866-1966, p. xxi.

²¹Stephen Smith, pp. 49-151; Richard Hofstadter, William Miller, and Daniel Aaron, The American Republic, I (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1959), pp. 654-655.

²²Bolduan, Over a Century of Health Administration in New York City, p. 13; New York City Board of Health, Address to the Public by the Board of Health, p. 1.

²³Shryock, Medicine in America, Historical Essays, p. 128.

²⁴Ann. Rep., Bd. of Health, 1866, pp. 10-11; 1868, p. 10.

²⁵Ibid.

²⁶Ibid., 1866, p. 10.

²⁷The Health Department's use of contagion destroying agents was in keeping with an ancient practice. The often employed technique of purification by the burning of sulfur (the gas released being sulfur dioxide) was regarded during Hippocrates' time as an antidote against plague; its origins go back even further into antiquity as evident from the following from Homer:

But Odysseus knew his own mind. "The first thing I want," he retorted, "is a fire in this hall." Eurycleia did not disobey him. She made him a fire and brought the sulfur, with which Odysseus thoroughly fumigated the hall, the house, and the courtyard outside. From Homer, The Odyssey, trans. E. V. Rieu (Baltimore: Penguin Books, 1946), p. 340. French experimenters, in the last quarter of the eighteenth century, were first to demonstrate the ability of a specific substance consistently to prevent and treat a specific disease, wheat bunt. Carl A. Lawrence and Seymour Block, Disinfection, Sterilization, and Preservation (Philadelphia: Lea and Febiger, 1968), pp. 3-5. General disinfection with chlorine and nitrous vapors were tested in isolated cases but were not greeted with general acceptance, nor was the use of chlorine compounds, as tried in some English and French hospitals,

to prevent gangrene epidemics. Ibid., pp. 5-6; James C. Smyth, An Account of the Experiment to Determine the Effect of the Nitrous Acid in Destroying Contagion (London: J. Johnson, 1796), pp. 8-16, 36-48. By 1830 the American physician Oliver Wendell Holmes reported success in halting infection by washing the hands in chloride of lime, and by 1847 Semmelweis had begun to insist that medical students wash their hands in chloride of lime on leaving the autopsy room before visiting their patients. Iodine, first used in wounds in 1839, was applied topically during the Civil War by some military physicians. Lawrence and Block, p. 6. Pasteur's demonstration in 1862 that fermentation and putrefaction were due to the action of microorganisms served to accelerate interest in disinfection. The cause of the effluvia from decaying matter was identified, a discovery which, in turn, suggested a revolutionary possibility: find the physical or chemical means to hamper the action of these minute living entities and you eliminate their poisonous emanations, the instrumentalities of infectious disease, suffering, and death. H. Chick and C. H. Browning, "The Theory of Disinfection," A System of Bacteriology in Relation to Medicine, Medical Research Council (London: H.M. Stationery Office, 1930), I, 179. Joseph Lister, acting on Pasteur's findings, brought attention to the germicidal properties of carbolic acid for direct use with dressings on wounds, in the form of a spray to purify operating rooms, and as a solution to sterilize surgical instruments. Ibid.; Bulloch, p. 235; Welch Papers, II, 419-420.

²⁸Acting on the assumption that the scourge could arise in the filthy localities inhabited by the poor, workers, accompanied by Sanitary Police, sprinkled lime and charcoal dust freely along gutters, alleys, yards, and on garbage boxes and dirty cellars. Entering the homes where cholera was suspected, they tossed disinfectants--sulphate of iron and chloride of lime typically--into waterclosets, privies, halls, and bedrooms, and ordered that all bedding soiled with discharge be burned. When evidence existed that recurrent cases had occurred in a certain tenement, all tenants were removed, windows and chimneys closed, and chlorine or sulfur dioxide released. No one was allowed to enter for twelve hours. The inhabitants on occasion resented the intrusion, but since disinfection was credited with preventing the spread of the disease, their objections were ignored. Ann. Rep., Bd. of Health, 1866, pp. 18, 22, 39.

²⁹Ibid., p. 18. All testing was conducted by department chemists who used the ability of a material to get rid of odor as the sole criterion for determining its disinfecting capabilities. Ibid., 1869, pp. 45, 577; 1871-1872, pp. 117-120; 1872-1873, pp. 86-89; 1874-1875, pp. 234-256.

³⁰Ibid., 1866, p. 206; 1868, p. 3; Times, June 13, 1867, p. 2. The Health Department showed considerable pride over the years in the growing number of miles of streets it treated, the amounts and kinds of chemicals its used, the number of personal items it had purified, and the multitude of dwellings it fumigated. Ann. Rep., Bd. of Health, 1866, pp. 22, 208, 209; 1867, p. 11; 1868, p. 47; 1869, pp. 573-574; 1870-1871, pp. 74-75, 117-120; 1872-1873, pp. 86-89; 1874-1875, pp. 234-240.

In an eight-month period in 1874, 5,436 premises were disinfected and 2,568 miles of street were treated at a cost (including materials and labor) of \$7,196. See *ibid.*, pp. 235, 238. While these figures are open to some suspicion considering the department's desire to appear prudent with public dollars, the procedures for disinfection were relatively inexpensive and would seem to justify its assessment that they were "most valuable auxiliaries in preserving the public health and preventing the spread of disease." *Ibid.*, 1870-1871, p. 26.

³¹*Times*, June 13, 1887, p. 2; July 25, 1868, p. 2.

³²Chick and Browning, p. 179; Claude E. Dolman, "Robert Koch," *Dictionary of Scientific Biography*, VII (New York: Charles Scribner's Sons, 1973), pp. 423, 425; James Dewars, *Sulphurous Acid as a Fumigant* (Scotland, 1866), pp. 1-14.

³³*Welch Papers*, I, 572; Massachusetts State Board of Health, *Disinfection* (1879), p. 2.

³⁴*Ibid.*, pp. 1-2; Health Department of the City of Brooklyn, *Memorandum on Disinfection* (1873), pp. 1-3; Chicago Health Department, *Report of the Health Department of the City of Chicago on the Germicidal Action of Zincic [sic] Chloride* (New York: M. Thalmessinger, 1881), pp. 3-7; Alexander C. Abbott, *The Development of Public Health Work in Philadelphia* (1909), pp. 18, 21.

³⁵Dolman, p. 423.

³⁶Raymond, *N.Y. Med. Jnl.* (September 24, 1892), 351; Chick and Browning, p. 179; Bulloch, p. 235. Koch's work led the way and served as a model for the host of researchers in America and Europe who began to employ his rigorous bacteriological methods to test the germ-inhibiting capabilities of alleged disinfectants. For an example of a substantive piece of such research see, Sternberg, "Experiments to Determine the Germicidal Value of Certain Therapeutic Agents," *Am. Jnl. of Med. Sci.*, CLXX (April 1883), 327-343. Steinberg tested twenty-four commonly used substances and found that none of them (including carbolic acid, which had already been characterized as ineffective by Koch) could be administered effectively as a general germicide.

³⁷*Report of the Committee on Disinfectants of the American Public Health Association* (Baltimore: American Public Health Association, 1885), p. vii. Much of the turmoil was semantic. The term "disinfection" had been used loosely and interchangeably with others as "antiseptic" and "deodorizer," to signify any chemical which would destroy or mask odors or eliminate infection. Raymond, *N.Y. Med. Jnl.* (September 24, 1892), 351. In any case, the committee, under the general leadership of Sternberg (then a surgeon in the United States Army) and consisting of a small number of public health physicians--including Dr. Victor S. Vaughan (A member of the Michigan State Board of Health), Dr. Albert R. Leeds (from the New Jersey State Board of Health), and

Dr. Joseph H. Raymond (Health Commissioner of the City of Brooklyn)-- was granted facilities for conducting its study at the biological laboratories of Johns Hopkins University. The members examined the literature of disinfection, abstracted and tabulated their findings, and integrated it all with laboratory research and, within a year, released their conclusions. See Report of the Committee on Disinfectants of the American Public Health Association, pp. vii-viii; Victor C. Vaughan, M.D., "Disinfectants, Preliminary Reports of the Committee on Disinfectants of the American Public Health Association. Disinfection with Mineral Acids," Medical News, XLVII, no. 3 (July 18, 1885), 62. The results of these studies were published in medical journals and issued in a number of forms by the American Public Health Association, which offered to sell them at cost to state or local health boards for "distribution among the people." Sternberg, Disinfection and Individual Prophylaxis against Infectious Disease (Concord: Republic Press, 1886), p. 3; Sternberg, "Disinfectants. Preliminary Report of the Committee on disinfectants of the American Public Health Association. The Metallic Sulphates," Medical News, XLVII, no. 8 (August 22, 1885), 204-205.

³⁸Ibid.; Committee on Disinfectants of the American Public Health Association, Disinfection and Disinfectants (Baltimore, 1885) p. 4; Sternberg, Disinfection and Individual Prophylaxis against Infectious Disease, passim; Report of the Committee on Disinfectants of the American Public Health Association, pp. 3-129.

³⁹Sternberg, "Preliminary Reports of the Committee on Disinfectants of the American Public Health Association," Medical News, XLVII, no. 10 (September 5, 1885), 261; Disinfection and Individual Prophylaxis against Infectious Disease, p. 261; Committee on Disinfectants of the American Public Health Association, Disinfection and Disinfectants, p. 4. The public, health authorities, and private practitioners were admonished by Sternberg not to equate unpleasant scents with disease. Writing at a time when the Germ Theory was not well accepted in this country, he proclaimed that "bad odor is not injurious in itself; is is a epiphenomenon which does not necessarily give the measure of the hurtful properties of the air, or of any substance whatever." See Disinfection and Individual Prophylaxis against Infectious Disease, p. 7.

⁴⁰Ibid., p. 13; Report of the Committee on Disinfectants of the American Public Health Association, p. 123; Lawrence and Block, p. 7; Dolman, p. 431.

⁴¹"Contagion and Disinfection," Medical News, LI, no. 17 (October 22, 1887), 476-477; Sternberg, Disinfection and Individual Prophylaxis against Infectious Disease, pp. 13-17; Report of the Committee on Disinfectants of the American Public Health Association, p. 123. Koch's reliance on the ability of a substance to destroy anthrax spores as the indication of its being a legitimate disinfectant was too harsh a criterion. Chick and Browning, p. 179. Most pathogenic bacteria are not able to transform themselves into resistant spores and, besides, those of anthrax are a particularly tenacious form.

⁴²A. C. Abbott, M.D., "Germicidal Value of Some of the Vegetable Acids," Medical News, XLVIII, no. 2 (January 9, 1886), 33-36; "Aspitol: A New Disinfectant," Medical News, LI, no. 7 (February 12, 1887), 180; "Results of Treatment for Diphtheria in Three Oedenberg Hospitals," Medical News, LII, no. 3 (July 16, 1887), 75; "Corrosive Sublimate in the Treatment of Diphtheria," Medical News, LII, no. 7 (August 13, 1887), 185; "Acid Solutions of Sublimate as a Disinfectant," Medical News, LII, no. 19 (November 5, 1887), 543; Times, September 21, 1892, p. 5.

⁴³Times, July 12, 1887, p. 8; Ann. Rep., Bd. of Health, 1889, p. 17; 1890, p. 16. It was proudly noted that when terminal fumigation of infected rooms was carried out with sulfur dioxide, the gas was generated in the manner recommended by the American Public Health Association. Ibid., p. 45.

⁴⁴Ibid., 1892, pp. 168-170; Biggs, Monthly Bulletin, I, no. 3 (March 1911), 54; Winslow, Life of Biggs, p. 99.

⁴⁵Demonstrating a firm grasp of techniques and materials, the investigators exposed several types of bacteria--including those of typhoid fever, cholera, and diphtheria--to various dilutions of the liquid, for varying lengths of time, and then transferred them to nutrient culture media to determine their growth, if any. Ann. Rep., Bd. of Health, 1892, pp. 190-193.

⁴⁶Ibid. Biggs' own research in 1885 had shown sulfur dioxide to be effective in stopping the growth of microorganisms, but only when the gas was introduced in pure form, in airtight receivers, and under pressure--circumstances that could not be duplicated in tenement dwellings. See Biggs, Medical News, LI, no. 25 (December 17, 1887), 702-706.

⁴⁷Biggs, Trans. of N.Y.A.M., 2nd series, X (1893), 328.

⁴⁸Ibid., pp. 304-306; Biggs, "Sanitary Measures for the Prevention of Tuberculosis in New York City and Their Results," JAMA, XXXIX (December 27, 1902), 1637.

⁴⁹Biggs, Trans. of N.Y.A.M., 2nd series, X (1893), 304-306.

⁵⁰Rosenkrantz, pp. 60-61.

⁵¹Dolman, pp. 426-427; Biggs, Am. Jnl. of Med. Sci., n.s., CV (January 1893), 63-72; Ann. Rep., Bd. of Health, 1892, pp. 168-180; 1893, p. 13.

⁵²Biggs, Trans. of N.Y.A.M., 2nd series, XII (1895), 420-421.

⁵³Winslow, Life of Biggs, *passim*.

⁵⁴Hofstadter, The Age of Reform (New York: Alfred A. Knopf, 1955), pp. 7, 11, 203-204; Hofstadter (ed.), The Progressive Movement, 1900-1915 (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1963), p. 8; Mann, p. 78; Blake McKelvey, The Urbanization of America, 1850-1915 (New Brunswick: Rutgers University Press, 1963), p. 162.

⁵⁵Hofstadter, Age of Reform, p. 236; Roy Lubove, The Progressives and the Slums: Tenement House Reform in New York City, 1890-1971 (Pittsburgh: University of Pittsburgh Press, 1962), pp. 42-43, 54-55; Robert H. Wiebe, The Search for Order, 1877-1920 (New York: Hill and Wang, 1967), pp. 12-13, 38-39. Fear of the effects of poverty in ante-bellum America, and the intemperance, disease, and crime associated with it, led to the formation of voluntary associations to aid the poor. Typical was the Association to Improve the Condition of the Poor, in New York City, which personified the "Christian-middle-class impulse." Lubove, "The New York Association for Improving the Condition of the Poor: The Formative Years," Sociological Quarterly, XLIII (July 1959), 314.

⁵⁶Winslow, Life of Biggs, pp. 45-58.

⁵⁷Wiebe, pp. 14-15; Hofstadter, Age of Reform, passim.

⁵⁸Winslow, Life of Biggs, pp. 38-42.

⁵⁹Daniels, pp. 290-291. The well-known American sociologist Lester Frank Ward considered the accumulation of scientific knowledge an essential ingredient in rational social planning; he himself had a solid reputation as a botanist and became chief paleobotanist for the U.S. Geological Service in 1883. Hofstadter, Social Darwinism in American Thought, rev. ed (Boston: The Beacon Press, 1958), pp. 69-77. Howard S. Berliner, in a recent article, speaks of the "scientism" that permeated American society by the 1880s as perhaps the most distinctive aspect of American life at the time. He accounts for the popularity of science, in part, because of its use as a device by the middle class to separate themselves, via the professions, from the lower classes. Berliner, "A Larger Perspective on the Flexner Report," International Journal of Health Services, V (1975), 573-575.

⁶⁰Winslow, Life of Biggs, pp. 33-44; Hofstadter and Smith, p. 594; Daniels, p. 290.

⁶¹Biggs, "Preventive Medicine in the City of New York," British Medical Journal, II (September 11, 1897), 637; Biggs, JAMA, XXXIX (December 27, 1902), 1637. By contrast, Biggs pointed out, in the "better class of tenements" where English was spoken the inhabitants were able to follow simple instructions. See ibid.

⁶²Ibid., pp. 1636-1637; Biggs, British Medical Journal, II (September 11, 1897), 637; Biggs, "Sanitary Science, the Medical Profession, and the Public," Medical News, LXXII (January 8, 1898), 48-49.

⁶³The "methods" of disinfection, i.e., operation of the plant on East Sixteenth Street, remained under the supervision of the Bacteriological Laboratory--as the division was beginning to be referred to, although officially still the Division of Pathology, Bacteriology, and Disinfection. Ann. Rep., Bd. of Health, 1894, pp. 14, 54; Bd. of Ald., Proceedings, CCSV (July 2, 1894-September 18, 1894), p. 190.

⁶⁴Rosen, A History of Public Health, p. 314.

⁶⁵See p. 95.

⁶⁶The procedures of disinfection and fumigation continued to be regularly employed in New York City and by health departments throughout the country and abroad in the last decade of the nineteenth century and well into the early years of the twentieth. See Cassedy, p. 114; Abbott, The Development of Public Health Work in Philadelphia, pp. 21, 27; Ohio State Board of Health, Disinfection and Disinfectants (1908), pp. 3-10; Illinois State Board of Health, Practical Disinfection, 2nd ed. (Springfield, 1906), pp. 2-27; Major Harrison and the Department of Health (Chicago, 1904), p. 7; Arthur A. Guerard, M.D., and Robert J. Wilson, M.D., "The Use of Formaldehyde Gas as a Disinfectant for Dwellings, Vehicles, and Household Goods," Medical News, LXXIV, no. 19 (May 13, 1899), 581; Department of Health of the City of New York, Disinfection and Disinfectants (New York, 1899), pp. 1-16; "Methods of Disinfection Recommended by the Department of Health of the City of New York," American Journal of Nursing, I, no. 8 (May 1901), 546-553. Reliance on purification was sufficient to warrant the marketing of a variety of disinfectants and disinfecting dispersing gadgets by a number of companies. See Times April 20, 1893, p. 11; May 8, 1893, p. 9; June 14, 1893, p. 11; June 21, 1893, p. 2; George H. F. Nuttall, Hygienic Measures in Relation to Infectious Disease (New York: G. P. Putnam's Sons, 1893), pp. 16-17, 23-25, 46-50. Then, in 1906, Dr. Charles Chapin, Superintendent of Health of Providence, Rhode Island, read a paper to the Section on Hygiene and Sanitary Science of the American Medical Association. Chapin characterized as a "fetich" terminal disinfection, a popular procedure with health officials. Research conducted under his direction had shown that pathogenic bacteria and their spores seldom retained their vitality after leaving the body and that consequently inanimate objects (fomites) were highly unlikely causes of the spread of disease; the real sources of infectious diseases were human "carriers." He further ventured the view that reliance on disinfection had actually hampered scientific progress by "encouraging beliefs in discredited theories." Chapin's conclusions were not met with approval by most of the public health physicians in attendance who were reluctant to abandon disinfection. See Chapin, "The Fetich of Disinfection," JAMA, XLVII (August 25, 1906), 574-578; Bureau of Municipal Research, Making a Municipal Budget, Functional Accounts and Operative Statistics for the Department of Health of Greater New York (New York: Bureau of Municipal Research, 1907), p. 112. His views, however, prevailed, for over the next few years the procedure was used less and less as it gave way to specific, less costly immunological advances. Samuel Rideal and Eric Rideal, Chemical

Disinfection and Sterilization (London: Edward Arnold and Co., 1921), p. 9; Park, Public Health and Hygiene, 2nd ed. (Philadelphia: Lea and Febiger, 1928), p. 224. A last-ditch effort to resurrect the practice in 1916 by the New York City Health Department showed terminal disinfection to be of "negative value." B. F. Knause, "Disinfection as a Factor in the Control of Communicable Diseases," New York City Health Department Reprint Series, no. 43 (March 1916), pp. 7-8 (hereinafter cited as Reprint Series).

⁶⁷Times, May 19, 1893, p. 5; Biggs, Trans. of N.Y.A.M., 2nd series, X (1893), 303.

⁶⁸Ann. Rep., Bd. of Health, 1867, p. 43; 1870, p. 27; N.Y. Med. Jnl., XLVI (November 12, 1887), 550; Duffy, A History of Public Health in New York City, 1866-1966, pp. 40-41.

⁶⁹Ibid., pp. 177-178. The New York Medical Society, composed of "regulars," even had problems with its compatriots. Although the New York society was a leading force in the formation of the American Medical Association, the national organization, in 1882, had refused to accept the credentials of its delegates because of the adoption of a revised code of medical ethics by the New York group, thereby touching off a rupture between the two that was to last nearly twenty-five years. See Walsh, I, pp. 142-143.

⁷⁰Biggs, Trans. of N.Y.A.M., 2nd series, X (1893), 303-304, 317.

⁷¹Ibid., p. 318; Times, May 19, 1893, p. 5; N.Y. Med. Jnl., XLVI (November 12, 1887), 550.

⁷²Biggs, Trans. of N.Y.A.M., 2nd series, X (1893), 306, 311-312, 317-324.

⁷³Ann. Rep., Bd. of Health, 1874-1875, p. 564; Park and Bolduan, "Mortality," The Bacteriology of Diphtheria, ed. G. H. F. Nuttall and G. S. Graham-Smith (Cambridge: University Press, 1908), p. 575; A. M. Pappenheimer, "The Diphtheria Bacilli and the Diphtheroid," Bacterial and Mycotic Infections of Man, 4th ed., ed. James G. Hirsch (Philadelphia: J. B. Lippincott Comp., 1965), p. 469.

⁷⁴Ibid.; F. Loeffler, "The History of Diphtheria," The Bacteriology of Diphtheria, p. 15; Times, November 28, 1876, p. 2.

⁷⁵Ann. Rep., Bd. of Health, 1866, p. 138; 1867, pp. 114, 142; 1870-1871, p. 230; 1871-1872, p. 149. Diphtheria had the lowest mortality rates of the three; however, if membranous croup and quinsy are considered synonymous with it, the ailment's destructive power becomes impressive. Combining the 1873 figures for diphtheria and croup, 1,121 New Yorkers succumbed to the ailment (83 percent of whom were under five years of age, 15 percent of whom were between five and ten), which thus was responsible for about 3.9 percent of the total deaths, due to all

causes, for that year. Considering its virulence, of the 789 cases reported as diphtheria, 446 of them died, a mortality of 57 percent. Ibid., 1873, pp. 40, 120-121.

⁷⁶Times, January 30, 1875, p. 8; March 10, 1876, p. 8; Medical Record, X (January 16, 1875), 41-42, 57-58; "The Prophylaxis of Diphtheria," Medical Record, X (December 25, 1875), 857-858.

⁷⁷Two local physicians were hired by the Health Board to research the "pathogeny of diphtheria," for which the Board of Estimate and Apportionment appropriated \$2,000. Their findings, based on some simple microscopic work with diphtheria lesions, took up fifty-seven pages of the Annual Report for 1874, but produced nothing of practical value. Bolduan, Over a Century of Health Administration in New York City, p. 19; Times, February 17, 1875, p. 10; Ann. Rep., Bd. of Health, 1874-1875, pp. 656-712.

⁷⁸Ibid., pp. 561-562; 1878-1879, pp. 4-5; 1893, p. 10; Times November 18, 1874, p. 2; November 28, 1874, p. 2; January 30, 1875, p. 8; November 28, 1876, p. 2.

⁷⁹Ibid., March 10, 1876, p. 8; December 29, 1878, p. 4; January 24, 1879, p. 4; December 3, 1880, p. 4; Erwin F. Smith, "Diphtheria, Not a Sewer-Gas Disease," Medical News, XLIX (July 10, 1886), 43. A New York State Board of Health study, released in 1881, attributing diphtheria to neglect among the poor in the proper handling of sewerage and refuse, led to the drawing up of a petition by one hundred prominent New Yorkers asking for an investigation by the city Health Board into the cause and cure of effluvia. In Times, January 9, 1881, p. 1. The subsequent disclosure that the disease was as prevalent among the rich as the poor, and that one wealthy family had lost four children, must have been rather unsettling to this group. See ibid., February 20, 1881, p. 1.

⁸⁰Park, "The History of Diphtheria in New York City," American Journal of Diseases in Children, XCII (December 1931), 1439; C. E. Biltington, M.D., "Local Treatment in Diphtheria," Medical News, LI (March 26, 1887), 360-361; "Hydrogen Peroxide in Diphtheria," Medical News, XLIX (October 9, 1886), 405; "Potassium Iodide in Diphtheria," ibid., p. 404; Medical Record, V (March 15, 1870), 52-53; Times, December 31, 1883, p. 3.

⁸¹Ibid., August 24, 1879, p. 10; February 15, 1881, p. 4; February 20, 1881, p. 5. A testimony to the failure of the curative measures available was the frequent necessity of the employment of the emergency measure of inserting a tube into the trachea (tracheotomy) or larynx (intubation) to prevent the diphtheritic individual from choking to death on the thick exudate produced by his diseased tissue. Park, American Journal of Diseases of Children, XLII (December 1931), 1439; Bolduan, Over a Century of Health Administration in New York City, p. 21; "The Results of 1,881 Cases of Diphtheria and 1,000 Tracheotomies," Medical News, LI (September 24, 1887), 362.

⁸²Ann. Rep., Board of Health, 1874-1875, pp. 561-562; Times, March 10, 1876, p. 8.

⁸³Ibid., April 10, 1887, p. 10.

⁸⁴Shryock, Medicine in America, Historical Essays, pp. 79-85; Charles Weiner, "Science in Higher Education," Science and Society in the United States, pp. 176-183; see above, p. 15. After the Civil War the Department of Agriculture's interest in veterinary medicine prompted it to give some support to basic biological research. The National Board of Health followed and, while it established the practice of providing government aid for research at universities, it was short of funds and lasted only from 1879 to 1883. See Duffy, ibid., p. 131. A study on diphtheria conducted under its auspices concluded that the disease was caused by microscopic plants that hooked onto the white blood corpuscles. Times, October 14, 1881, p. 2. Laboratories for the study of infectious disease were created by the United States Marine Hospital Service beginning in 1887, but they too got little support from a Congress more concerned with research in agriculture where the results were obtained quickly and the advantages more obvious. See Rosen, A History of Public Health, p. 333; Duffy, Science and Society in the United States, p. 131; The American Foundation, Medical Research: A Midcentury Survey (Boston: Little, Brown, and Company, 1955), I, 641; Marks and Beatty, pp. 267-268.

⁸⁵Rosenkrantz, pp. 101-103; Cassedy, pp. 54-56. One of the more ambitious attempts by a public health agency to investigate diphtheria was conducted by the Michigan State Board of Health in 1883, with the findings released in a reprint the following year. The recommendations of the study were based on the responses of hundreds of American physicians to a series of questions concerning their observations on the nature of diphtheria and its effects on its victims. References to the literature on the topic were exclusively to European sources. See Michigan State Board of Health, Present Knowledge Respecting Diphtheria (Lansing, 1884), pp. 44-66.

⁸⁶Times, August 28, 1887, p. 4.

⁸⁷The birthplace of modern laboratory research was Germany. In 1824 the noted physiologist Purkinje was given a laboratory upon accepting a professorship at Breslau. In the following year Liebig started a facility for experimentation in physiology at Leipzig opened to students and independent investigators, which had enormous influence on the creation and organization of future public scientific research centers. The first laboratory for the study of disease was set up under Virchow in 1856 by the Prussian government as an incentive to gain his return to Berlin; by its emphasis on experimentation to supplement clinical and anatomical observations it served as the model for subsequent pathological laboratories in Germany and other countries. See Welch, Annual Report of the Board of Regents of the Smithsonian Institute, pp. 495-499; Prudden, Sketches and Letters, p. 55; Corner, p. 27. Von Pettenkofer had been involved in hygienic investigations for almost thirty

years when he was granted an institute for this exclusive purpose by the Bavarian government that was opened to students and researchers in 1878. Welch, Annual Report of the Board of Regents of the Smithsonian Institute, p. 500. The studies of Lister on antiseptic surgery, the findings of Pasteur on the role of microorganisms in infectious diseases, and the discoveries of Koch, stimulated the German Government to look beyond the university and to create the Imperial Health Office, with a number of large and generously supported laboratories. Pasteur's many triumphs, particularly his demonstration of a treatment for rabies, led the French Academy to open subscriptions for the Pasteur Institute, inaugurated in 1888. Others in this pattern of large research centers included the Institute for Experimental Medicine, established in St. Petersburg in 1890, and the Institute for Preventive Medicine, founded in London in 1891 by private philanthropies and renamed the Lister Institute in 1903. Crookshank, p. 1; Welch Papers, III, 74; Dolman, p. 423; Horace W. Magoun, "Development of Brain Research Institutes," Science and Society, ed. Norman Kaplan (Chicago: Rand McNally and Company, 1965), p. 180; Corner, pp. 9, 27.

⁸⁸Frederick W. Andrews et al., Diphtheria (London: H.M. Stationery Office, 1923), pp. 47-57; Welch and Abbott, "The Etiology of Diphtheria," Bulletin of the Johns Hopkins Hospital, II (February-March 1891), 25.

⁸⁹E. Roux and A. Yersin, "Contribution à l'étude de la Diphthérie," Annales de l'Institut Pasteur, II (December 1888), 631-636.

⁹⁰Flexner and Flexner, pp. 202-206; Prudden, "Studies on the Etiology of Diphtheria," Medical Record, XXXIX (April 18, 1891), 449; Welch and Abbott, Bulletin of the Johns Hopkins Hospital, II (February-March 1891), 25, 28, 30-31; Times, April 28, 1890, p. 2. For a detailed discussion on the history of diphtheria research see F. Loeffler, The Bacteriology of Diphtheria, pp. 1-52, and Welch, "Bacteriological Investigations of Diphtheria in the United States," Am. Jnl. of Med. Sci., n.s., CVII (1894), 427-461.

⁹¹"The Spread of Diphtheria," Medical News, LI (November 12, 1887), 573.

⁹²Park, American Journal of Diseases of Children, XLII (December 1931), 1440.

⁹³Welch and Abbott, Bulletin of the Johns Hopkins Hospital, II (February-March 1891), 31.

⁹⁴According to his biographer, Chapin had contemplated employing bacteriological methods for diphtheria diagnosis in 1890, in Providence, but was unable to find a workable technique. See Cassedy, p. 72.

⁹⁵Park, Address of Dr. Park at Dedication of New York City Laboratories Bearing His Name (October 6, 1936), p. 1 (mimeographed); Welch Papers, II, 230.

⁹⁶Prudden, "On the Etiology of Diphtheria: An Experimental Study," Am. Jnl. of Med. Sci., n.s., XCVII (April-May 1889), 329-350.

⁹⁷Wade W. Oliver, The Man Who Lived for Tomorrow (New York: E. P. Dutton and Co., 1941), p. 55; Park, American Journal of Diseases of Children, XLII (December 1931), 1440; Park, Address of Dr. Park at Dedication of New York City Laboratories Bearing His Name, 1936, p. 1.

⁹⁸Ibid., Oliver, pp. 55-57.

⁹⁹Welch and Abbott, Bulletin of the Johns Hopkins Hospital, II (February-March 1891), 26; Prudden, Medical Record, XXXIX (April 18, 1891), 445.

¹⁰⁰Park, "Diphtheria and Allied Pseudo-membranous Inflammations," Medical Record, XLII (August 6, 1892).

¹⁰¹Bolduan, "Laboratory Research, Its Influence on Health Administration," p. 4; Biggs, Report to the New York City Health Department on the Use of Bacteriological Examination for the Diagnosis of Diphtheria (London: Witherby and Co., 1894), pp. 1-2, 4; Park and Alfred Beebe, "Diphtheria and Pseudo-diphtheria. A Report to Hermann M. Biggs, M.D., Pathologist and Director of the Bacteriological Laboratory, on the Bacteriological Examination of 5,611 Cases of Suspected Diphtheria, with the Results of Other Investigations on the Diphtheria and Pseudo-diphtheria Bacillus," Scientific Bulletin, No. 1 (1894), 1-2, 4.

¹⁰²Ibid., p. 2.

¹⁰³See above, pp. 29, 31-34. Bryant resigned his position in March 1893 to become the personal physician of President Grover Cleveland. He was succeeded by Dr. Cyrus Edson, who continued in Bryant's footsteps as a progressive administrator. Duffy, A History of Public Health in New York City, 1866-1966, pp. 97, 100.

¹⁰⁴Ann. Rep., Bd. of Health, 1893, p. 11.

¹⁰⁵Ibid., pp. 5-6; Times, June 21, 1893, p. 4.

¹⁰⁶Biggs, Trans. of N.Y.A.M., 2nd series, X (1893), 303-306, 312.

¹⁰⁷Park, American Journal of Diseases of Children, XLII (December 1931), 1440; "Dr. William Hallock Park," Medical Violet (New York: New York University Medical School, 1936), p. 47.

¹⁰⁸Welch Papers, II, 230; Park and Beebe, Scientific Bulletin, No. 1, p. 3; Ann. Rep., Bd. of Health, 1893, p. 11. From its beginnings in May 1893 to the end of the year, 2,623 bacteriological examinations were conducted, although it is not clear how many were from private physicians and how many from cases admitted to hospital wards. Ibid.

¹⁰⁹Ibid.; Park and Beebe, Scientific Bulletin, No. 1, p. 3.

¹¹⁰Ibid., pp. 12-13; Welch Papers, II, 248; Ann. Rep., Bd. of Health, 1893, pp. 73-75.

¹¹¹Ibid., pp. 90-93; Park and Beebe, Scientific Bulletin, No. 1, pp. 27-31.

¹¹²Winslow, The Contributions of Hermann Biggs to Public Health, p. 8; Biggs, Report to the New York City Health Department on the Use of Bacteriological Examination for the Diagnosis of Diphtheria, p. 7.

¹¹³"Health Department--Circular to Physicians," Medical Record, XLIV (December 23, 1893), 832; Ann. Rep., Bd. of Health, 1893, p. 68. The rule was to be enforced in all cases where the ill resided in boarding houses, tenements, and hotels, but not private homes. Ibid.; Biggs, Report to the New York City Health Department on the Use of Bacteriological Examination for the Diagnosis of Diphtheria, p. 7.

¹¹⁴Park and Beebe, Scientific Bulletin, No. 1, pp. 37-42; Ann. Rep., Bd. of Health, 1893, pp. 99-105.

¹¹⁵A Dr. Beverly Robinson, in 1893, argued that while the Klebs-Loeffler bacilli were normally present in diphtheria, repeated epidemics occurred in remote villages with no outside contact. He maintained that decaying material brought the poison into existence. Winslow, The Contributions of Hermann Biggs to Public Health, pp. 8-9; Times, July 29, 1893, p. 1.

¹¹⁶Rosen, A History of Public Health, p. 319; Welch Papers, II 251.

¹¹⁷When Park presented his paper on diphtheria in Budapest before the Eighth International Congress of Hygiene and Demography, as the leader of the American Committee on Diphtheria, he referred to Park's findings on a great number of occasions. Ibid., pp. 229-264; Oliver, pp. 91-95.

¹¹⁸Scientific Bulletin, No. 1 pp. 12-54.

¹¹⁹Scientific Bulletin, No. 2, (1895).

¹²⁰George W. McCoy, "Introduction" to proposed history of the research laboratory by Bolduan, October 1936, p. 3 (mimeographed); Park, "Diphtheria and Other Pseudo-Membranous Inflammations," Medical Record, XLIII (February 11, 1893), 161.

¹²¹Park and Beebe, Scientific Bulletin, No. 1, pp. 16-18, 23, 26, 29, 32-36, 39, 49, 53-54. Small-scale investigations on the bacteriology of diphtheria were underway at Johns Hopkins University and Hospital under Welch, at the Carnegie Laboratory and Bellevue Hospital, at

¹²²Winslow, Life of Biggs, pp. 92-152.

¹²³As a customary form of respect to the laboratory director, Biggs' name appeared on the diphtheria research report of Park and Beebe, although it was clear that he was not actively involved in the study; this formality, however, was soon dropped. See Scientific Bulletin, No. 1, p. 12.

¹²⁴Oliver, pp. 15-22.

¹²⁵Anna W. Williams, "A Life Time in the Laboratory," 1936, recollections written for Bolduan's proposed history of the laboratory, pp. 1-2; Bolduan, "An Early Helpful Lesson from Dr. Park," 1936, essay probably intended for use in his laboratory history, pp. 1-2; Dalldorf, p. 14.

¹²⁶Winslow, The Contributions of Hermann Biggs to Public Health, p. 8; "New Laboratories Bldg. Opens: Will Continue to Lead in Research and Development of New Techniques," Inside Health, XVI (April 19, 1968), p. 3; Rosen, A History of Public Health, p. 334; Prudden, Sketches and Letters, pp. 289-290; Bolduan, "Laboratory Research, Its Influence on Health Administration," pp. 9-10; Sternberg, Practical Results of Bacteriological Researches, p. 3; Pappenheim, Bacterial and Mycotic Infections of Man, p. 472. The easy-to-use culture outfits devised by Park were crucial in making the procedure workable, since only a small minority in the medical field had any training or experience in bacteriological techniques; the firm that manufactured the outfits for the laboratory reported selling over 10,000 of them outside of New York. Ann. Rep., Bd. of Health, 1893, p. 14; Welch Papers, II, 326.

¹²⁷Rosen, A History of Public Health, p. 334.

¹²⁸Ibid.; Welch Papers, I, 676.

¹²⁹Inside Health, XIII, no. 7 (April 29, 1966), 2; Bull. of N.Y.A.M., XLIV, no. 6 (June 1969), 560; Times, September 12, 1942, p. 11.

¹³⁰Palmborg, pp. 220, 266-267, 295.

¹³¹G. S. Wilson, "The New Organization of Public Health Laboratory Services," Modern Trends in Public Health, ed. Arthur Massey (New York: Paul B. Hoeber, Inc., 1949), p. 523; Sir John Charles, Research and Public Health (London: Oxford University Press, 1961), p. 89.

¹³²Ibid., pp. 93-94.

¹³³Wilson, p. 524; The Wellcome Physiological Research Laboratories (London, 1903), pp. 9-33.

¹³⁴Palmborg, pp. 355-367.

¹³⁵Winslow, Life of Biggs, p. 65.

¹³⁶Rosen, "Patterns of Health Research in the United States, 1900-1960," Bulletin of the History of Medicine, XXXIX (1965), 208; Dolman, pp. 423-425.

¹³⁷See n. 84.

¹³⁸Biggs, Trans. of N.Y.A.M., 2nd series, XII (1895), 420-421

¹³⁹Rosen, "What is Social Medicine?" Bulletin of the History of Medicine, XII (September-October 1947), 675-682; Gertrud Kroeger, The Concept of Social Medicine as Presented by Physicians and Other Writers in Germany, 1779-1932 (Chicago: The Julius Rosenwald Fund, 1937), pp. 5, 12-13.

¹⁴⁰Ibid., pp. 19-20.

¹⁴¹Von Pettenkofer, "The Value of Health to a City. Two Lectures, Delivered in 1873, by Max Von Pettenkofer," trans. Henry Sigerist, B. of History of Medicine, X (November 1941), 600-609.

¹⁴²Rosen, Centaurus, V (1957), pp. 97-105.

¹⁴³Ibid.; Palmberg, pp. 355-402.

¹⁴⁴In 1893 von Behring remarked happily that the work of Koch had made it possible to concentrate on the study of disease without having to take into account social factors and policies. Rosen, Bulletin of the History of Medicine, XII (September-October 1947), 675.

¹⁴⁵Ibid., p. iii; Sidney and Beatrice Webb, The State and the Doctor (London: Longmans, Green, and Co., 1910), pp. 1-6.

¹⁴⁶Palmberg, p. iii.

¹⁴⁷England has long and justly been regarded as the birth-place and home of sanitary science. English methods in sanitation have been the models for the world. No other country has had in modern times so high a standard of public health and such low death-rates. These conditions have, without doubt, largely contributed in placing the British nation foremost in civilization, and have assisted much in laying the foundation of, and in building up, the British empire . . . Biggs, "Sanitary Science, the Medical Profession, and the Public," Medical News, LXXI (January 8, 1898), 44.

¹⁴⁸Winslow, Life of Biggs, pp. 108-109.

¹⁴⁹Ibid., p. 108; Ann. Rep., Bd. of Health, 1894, p. 90.

¹⁵⁰Loeffler, working in the laboratories of the Imperial Health Office, had first observed that animals suffered from tissue damage far from the site of inoculation of diphtheria bacilli but that none of the pathogens could be found in these distant areas. His conclusion that the bacteria produced a poison (toxin) was verified by Roux and Yersin of the Pasteur Institute in Annales de l'Institute Pasteur, III (1889), 273. In 1890 von Behring and Kitasato, in a classical paper, reported that repeated doses of chemically weakened toxin caused animals to produce substances (antitoxins) which neutralized the toxins. Furthermore, these antitoxins could be extracted from the blood serum of treated animals and be injected into others who were then protected against otherwise lethal doses of the bacterial poison. Although their work was with tetanus, they predicted that the same procedure could be effective in treating diphtheria in man and elaborated on this in a paper published a week later. See Pappenheimer, p. 469; E. Behring and S. Kitasato, "Ueber das Zustandekommen der Diphtherie-Immunität und der Tetanus-Immunität bei Thieren," Deutsche Medicinische Wochenschrift, XVI (1890), 1113-1132; Welch, "The Treatment of Diphtheria by Antitoxin," Transactions of the Association of American Physicians, X (1895), 312-313. Further study to determine the best methods for the production of safe, effective serum was undertaken by von Behring, Ehrlich, Aaronson, and a host of other researchers in German laboratories and by Roux in France. See ibid.; Rene J. Dubos, "The Evolution of Medical Microbiology," Bacterial and Mycotic Infections of Man, p. 11; Biggs, "Some Experiences in the Production and Use of Diphtheria Antitoxin," Medical Record, XLVII (April 20, 1895), 481-482.

¹⁵¹Ibid., p. 481; Andrewes, p. 127; Biggs, Monthly Bulletin, I (March 1911), 55.

¹⁵²Park, American Journal of Diseases of Children, XLII (December 1931), 1442; Prudden, Sketches and Letters, p. 11.

¹⁵³"Statistics of Serum Therapy in Diphtheria," JAMA, XXIII (November 17, 1894), 770; "Diphtheria at the Congress of Hygiene," JAMA, XXIII (September 22, 1894), 479; Andrewes, p. 127; Biggs, Medical Records, XLVII (April 20, 1895), 481.

¹⁵⁴Times, August 27, 1894, p. 9.

¹⁵⁵Ibid., September 6, 1894, p. 4; September 20, 1894, p. 4; September 23, 1894, p. 4; September 30, 1894, p. 4; October 15, 1894, p. 4. Certain physicians in Boston and Philadelphia had somehow gotten hold of German antitoxin, reportedly as early as February 1894, and were using it with good success in their practices. See ibid., October 28, 1894, p. 4. Welch reported use of the medication at the Philadelphia Municipal Hospital, See ibid., November 11, 1894, p. 4.

¹⁵⁶Ibid., August 24, 1894, p. 4; August 27, 1894, p. 9; September 16, 1894, p. 4; December 3, 1894, p. 4.

¹⁵⁷"Diphtheria and the Antitoxin," JAMA, XXIII (November 21, 1894), 803-804.

¹⁵⁸Duffy, A History of Public Health in New York City, 1866-1966, p. 239.

¹⁵⁹Prudden, Sketches and Letters, p. 45; Times, December 2, 1894, p. 16; December 3, 1894, p. 4.

¹⁶⁰New York Herald, December 10, 1894, p. 4 (hereinafter cited as Herald).

¹⁶¹Ibid., December 15, 1894, p. 2; Times, January 5, 1894, p. 4; Prudden, Sketches and Letters, p. 85.

¹⁶²Oliver, p. 107; Ann. Rep., Bd. of Health, 1894, p. 17.

¹⁶³The amount collected through the Herald was impressive, although, considering the publicity it received, not magnificent, and not enough to finance the program Biggs envisioned. The fund total amounted to \$7,496 when it was terminated in late 1895. Herald, November 26, 1895, p. 6.

¹⁶⁴"Diphtheria Antitoxin in New York," N.Y. Med. Jnl. (December 15, 1895), 757; "Purity of Antiseptics," JAMA, XXXIII (December 15, 1894), 923. The basis of Biggs' argument seems well founded. The desperation of those with dying children and the well-publicized miraculous abilities of the European cure had offered the possibility of enormous profits and had spurred on a minor industry in the New York area. A horse could be purchased for \$40 and be treated and stabled for three months at a cost of \$35. At the end of that time the animal was bled and could furnish 900 grams of serum, enough for 450 doses. With doses selling at \$5 each, and in certain instances for up to \$20, the profit margin was astronomical and therefore a tremendous enticement. See "Diphtheria and the Antitoxin," JAMA, XXIII (December 15, 1894), 923; Times, October 15, 1894, p. 4; December 13, 1894, p. 1. Most of the antitoxin turned out by well-intentioned capitalists was inert or harmful and was sold along with the spurious preparations foisted on druggists by unscrupulous entrepreneurs. See ibid., December 3, 1894, p. 1; December 15, 1894, p. 4; December 21, 1894, p. 4; December 27, 1894, p. 5. The substantial sale these materials enjoyed is understandable in light of diphtheria's horrible toll. During the year 1894, 2,359 New Yorkers died of the malady, the vast majority being children under five years of age, many of whose lives were snuffed out by suffocation. Ann. Rep., Bd. of Health, 1894, p. 9.

¹⁶⁵N.Y. Med. Jnl. (December 15, 1895), 757; JAMA, XXXIII (December 15, 1894), 923.

¹⁶⁶Times, August 27, 1894, p. 9; September 6, 1894, p. 4; November 24, 1894, p. 9; December 2, 1894, p. 16; Prudden, Sketches and

Letters, p. 11; Biggs, British Medical Journal, II (1897), 630; "Diphtheria and the Antitoxin," JAMA, XXIII (December 22, 1894), 960. The editors of the Journal of the American Medical Association reported, incorrectly, that Biggs and other "young men" at the Board of Health were bearing the expenses of making antitoxin out of their own pockets. See "The Antitoxin of Diphtheria at New York City--Cost of Plant," JAMA XXIII (October 29, 1894), 993; Park, American Journal of Diseases of Children, XLII (December 1931), 1442.

¹⁶⁷Oliver, pp. 103-104.

¹⁶⁸The average number of daily bacteriological examinations in 1893 was 14.6; in 1894 it increased to 36.1. Ann. Rep., Bd. of Health, 1894, pp. 13, 89.

¹⁶⁹Ibid., p. 14.

¹⁷⁰See, for example, the address given before the Mississippi Valley Medical Association, in J. C. Culbertson, M.D. "Diphtheria: Its Specific Diagnosis," JAMA, XXI (November 4, 1893), 699.

¹⁷¹Ann. Rep., Bd. of Health, 1894, p. 14. Doctors occasionally were given samples of culture tubes and swabs to demonstrate the simplicity of the procedure to hometown authorities. "Diphtheria," JAMA XXIII (December 1, 1894), 846. Nearby, the Brooklyn Department of Health, on March 1, 1894, instituted a Bureau of Bacteriology, Pathology, and Disinfection, and set up a diphtheria program identical--right up to the wording on its circulars for patients--to that in New York City. See "Practical Application of Bacteriology to Health Board Work Regarding Diphtheria," JAMA, XXII (June 9, 1894), 895-896; "Brooklyn Board of Health Regulations Against Diphtheria," JAMA, XXIII (November 3, 1894), 699.

¹⁷²Ann. Rep., Bd. of Health, 1894, pp. 13, 89.

¹⁷³Unfortunately for women physicians there was an overabundance of doctors in the latter years of the nineteenth century, so that competition was keen even before the distaff professionals began to enter the field. They had trouble getting into hospitals and when they did they found that internships and residencies were seldom available to them. Furthermore, they were regarded as strange creatures who were attempting to enter a man's vocation, and were ridiculed for it. See Shryock, Medicine in America, Historical Essays, pp. 185-189; Esther Pohl Lovejoy, Women Doctors of the World (New York: The Macmillan Company, 1957), passim.

¹⁷⁴Ibid., p. 122; Winslow, Life of Biggs, p. 95.

¹⁷⁵Times, August 3, 1894, p. 4; Ann. Rep., Bd. of Health, 1894, pp. 68-69.

¹⁷⁶Ibid., pp. 70-73; "Slates and Pencils a Means of the Spread of Infectious Diseases," JAMA, XXI (December 13, 1893), 991.

¹⁷⁷Biggs, "Preventive Medicine: Its Achievements, Scope, and Possibilities," American Medicine, VII (June 4, 1904), 946-950; Times, January 5, 1895, p. 4; Bolduan, Over a Century of Health Administration in New York City, p. 26; Biggs, Medical Record, XLVII (April 20, 1895), 481.

¹⁷⁸Biggs, "The Serum-Treatment and Its Results," Medical News, LXXV (July 22, 1899), 97; Ann. Rep., Bd. of Health, 1895, p. 37; Biggs, British Medical Journal, II (1897), 630.

¹⁷⁹Ibid., p. 631.

¹⁸⁰Ann. Rep., Bd. of Health, 1895, pp. 37-38.

¹⁸¹Bd. of Ald., Proceedings, CCXXIII (July 6, 1896-September 29, 1896), p. 306; Shryock, American Medical Research Past and Present (New York: Commonwealth Fund, 1947), p. 59.

¹⁸²Ibid., p. 62.

¹⁸³Who's Who in New York City and State, 1905 (New York: L. R. Hamersly Comp., 1905), p. 531; Medical Society of the County of New York, Medical Directory of the City of New York, 1896 (New York, 1896), pp. 40, 58 (hereinafter cited as Med. Dir., N.Y.); ibid., 1905, p. 82. Billings was the son of the prominent archivist and author John Shaw Billings. Billings senior was the head of the Institute of Hygiene at the University of Pennsylvania from whose medical school his son graduated in 1892 after having spent two years at New York's College of Physicians and Surgeons. Who's Who in New York City and State, 1905, pp. 124-125; Shryock, American Medical Research Past and Present, p. 64.

¹⁸⁴Ibid., pp. 125, 802; Med. Dir., N.Y., 1896, p. 90; 1899, p. 84; Oliver, p. 134. Those who chose to be employed by the municipal laboratory during these early years apparently did not do so solely to supplement their incomes. There appeared to have been a genuine interest in experimental investigation among the young doctors; it was not unusual for the laboratory to stay open into all hours of the night. See ibid.

¹⁸⁵Who's Who in New York City and State, 1905, p. 125; Park, "The Preparation of the Diphtheria Antitoxin, and Some of the Practical Lessons Learned from the Animal Experiments Performed in Testing Its Value," Medical Record, XLVII (April 20, 1895), 485; John Sedgwick Billings, "The Leucocytes in Croupous Pneumonia," Johns Hopkins Hospital Bulletin, V (November 1894), 105-113; Billings, "The Leucocytes in Malarial Fever," ibid., V (October 1894), 89-92; Billings, "Therapeutic Use of Extract of Bone Marrow," ibid., V (November 1894), 115-119.

¹⁸⁶Ann. Rep., Bd. of Health, 1895, p. 39; 1896, p. 9.

¹⁸⁷Bolduan, Over a Century of Health Administration in New York City, p. 26; Schaeffer, p. 3; Times, January 5, 1895, p. 4.

¹⁸⁸Ibid., March 27, 1895, p. 8; New York State Laws, 118 sess., chap. 165, March 26, 1895, pp. 197-198.

¹⁸⁹Bolduan, "Laboratory Research, Its Influence on Health Administration," p. 9. The potency of an antitoxin is, to a considerable extent, dependent on the strength of the toxin used in its preparation. By the simple expedient of experimenting with various culture media under varying conditions, Williams was able to improve on the techniques of Roux and Yersin and come up with a highly potent product in considerably less time. See Park, Medical Record, XLVII (April 20, 1895), 485-486. Also, while conducting some routine examinations of cultures Williams isolated a strain of diphtheria bacillus which was found to elicit an amazingly powerful toxin. Oliver, pp. 112-113. Samples were sent to laboratories throughout the world. Such was its reputation that in 1936 the director of the Pasteur Institute wrote that the particular strain was "encore employé dans tous les laboratoires lorsqu'on veut obtenir une toxine tres active." See letter from D. Louis Martin to Charles Krumwiede, Director of the Bureau of Laboratories of the New York City Health Department, September 8, 1936, p. 1 (photocopy).

¹⁹⁰Times, April 5, 1895, p. 5; October 17, 1895, p. 4; Ann. Rep., Bd. of Health, 1895, p. 9; "Serum Therapy--The Treatment of Diphtheria," N.Y. Med. Jnl. (January 5, 1895), 30-31. By April 1895, Medical Inspectors attached to the laboratory division had used antitoxin in 255 tenement cases of which 40 died, a mortality of 15.7 percent. Of the fatalities, 15 died within 12 hours of treatment, an indication that these cases were already in the terminal stages. Even so, the results were impressive. See "The Discussion to the New York Academy of Medicine Concerning the Treatment of Diphtheria with Antitoxin," Medical News, LXVI (April 13, 1895), 419; Times, April 15, 1895, p. 5. The total deaths attributed to diphtheria dropped about 31 percent from the previous year--894 less died in 1895 than in 1894--and the ratio of mortality to total cases reported was reduced about one-third. Ibid., October 17, 1895, p. 4; Ann. Rep., Bd. of Health, 1895, p. 9, "Diphtheria in New York City," Medical News, LXVI (April 6, 1895), 386-387.

¹⁹¹Scientific Bulletin, No. 1, p. 53.

¹⁹²Medical Violet, p. 48; Park, The Clinical Use of Diphtheria Antitoxine, Paper read at the Annual Meeting of the Massachusetts Medical Society, June 12, 1895, pp. 19-20; Park, American Journal of Diseases of Children, XLII (December 1931), 1442.

¹⁹³Ibid.

¹⁹⁴Biggs, British Medical Journal, II (1897), 631, 637; George A. Peck, M.D., "Immunization against Diphtheria with Antitoxin," Medical Record, XLVII (April 20, 1895), 486; Park, The Clinical Use of Diphtheria Antitoxins, pp. 5, 20, 22.

¹⁹⁵Ibid., p. 1; Biggs, Report to the New York City Health Department on the Use of Bacteriological Examination for the Diagnosis of Diphtheria; Biggs, Medical Record, XLVII (April 20, 1895), 481-484; Park, ibid., pp. 485-486; Biggs, "Antitoxine in Diphtheria," Maryland Medical Journal, XXXVI (February 6, 1897), 295-298; Biggs, "The New Treatment of Diphtheria," McClure's Magazine, IV (March 1895), 360; Winslow, Life of Biggs, p. 116.

¹⁹⁶Edward Brewer, M.D., "Six Cases of Diphtheria Treatment with the Antitoxin," Medical News, LXVI (January 19, 1895), 70-74; L. Wolff, M.D., "The Value of the Antitoxin-Treatment Illustrated by Two Cases of Diphtheria," ibid., LXVI (February 9, 1895), 162; "The Antitoxine Treatment of Diphtheria," N.Y. Med. Jnl. (February 9, 1895), 183-185; "The Treatment of Diphtheria Antitoxine," ibid. (November 9, 1895), 605; Rosa Engelmann, M.D., "Observations and Statistics upon the Use of Antitoxin in One Hundred Cases of Diphtheria," JAMA, XXVI (February 22, 1896), 374-376.

¹⁹⁷Henry W. Bettmann, M.D., "Diphtheria: Its Bacterial Diagnosis and Treatment with the Antitoxin," Medical News, LXVII (July 6, 1895), 5; Alexander, The Development of Public Health Work in Philadelphia, p. 25.

¹⁹⁸"Free Antitoxin for the Poor," Medical Record, XLIX (March 21, 1896), 416; Baumgartner, p. 561; "A Board of Health Circular on Diphtheria," JAMA, XXVI (January 4, 1896), 43. The Brooklyn Board of Health copied the New York City service right on down to the requirement that physicians provide personal and medical information on their patients for whom they wished to receive free antitoxin. See ibid.

¹⁹⁹Bolduan, "Laboratory Research, Its Influence on Health Administration," pp. 10-11; Prudden, Sketches and Letters, p. 11; Corner, p. 4.

²⁰⁰"The Antitoxin Treatment of Diphtheria," N.Y. Med. Jnl. (August 24, 1895), 248.

²⁰¹William A. Galloway, "Conservative Views on Diphtheria," Medical Record, XLVII (March 23, 1895), 379; "The Treatment of Diphtheria with Antitoxin," Medical News, LXVII (July 13, 1895), 45-46.

²⁰²Times, April 1, 1895, p. 1; April 2, 1895, p. 13; April 4, 1895, p. 4; April 5, 1895, p. 4; April 6, 1895, p. 1; "The Brooklyn Death from Diphtheria Antitoxine," N.Y. Med. Jnl. (April 13, 1895), 469; "Damaged Diphtheria Antitoxine," ibid. (April 6, 1895), 436; A. Siebert, M.D., "Some Noteworthy Toxic Effects of the Antitoxin

Treatment," Medical Record, XLVII (January 19, 1895), 78-79; "A Death Alleged to be Due to Diphtheria Antitoxin," ibid., XLIX (April 18, 1896), 557-558; G. M. Wells, M.D. "A Case of Diphtheria Treated with Antitoxin: Subsequent Death from Acute Ascending Paralysis," Medical News, LXX (January 9, 1897), 49-51.

²⁰³Joseph Winters, "Society Reports," Medical Record, XLVII (April 20, 1895), 501. Because of his prominent position, Winter's denunciation evoked considerable attention, and rebuttals, and slowed down the acceptance of antitoxin in New York, and perhaps beyond as well. See Park, The Clinical Use of Diphtheria Antitoxine, pp. 7, 8, 16; Medical News, LXVI (April 13, 1895), 420; Samuel Armstrong, M.D., "Objections to the Antitoxine Treatment of Diphtheria," N.Y. Med. Jnl. (April 13, 1895), 471. Winters renewed the attack the following year, 1896, but received far less attention as his charges of the toxic effects of sera were wildly excessive. See Times, May 22, 1896, p. 5. Furthermore, a general consensus had emerged on the safety of diphtheria antitoxin, which was gaining wider and wider use. See Louis Fischer, M.D., "A Plea for More Extensive Use of Antitoxine in Diphtheria," N.Y. Med. Jnl. (November 30, 1895), 679-683; ibid. (December 7, 1895), 710-715.

²⁰⁴"Bacteriological Diagnosis," Medical Record, XLVIII (November 23, 1895), 754-755.

²⁰⁵"A Critical Analysis of Dr. Winters' Clinical Observations on the Antitoxine Treatment of Diphtheria," N.Y. Med. Jnl. (June 20, 1896), 816; Armstrong, ibid. (April 13, 1895), 471.

²⁰⁶Ibid.

²⁰⁷"The Relation of the Bacteriological Diagnosis and New Treatment of Diphtheria to Laboratory Instruction," Medical News, LXVI (January 19, 1895), 77. The editor's argument was rather discursive and desperate. At one point the municipal laboratory was attacked on the grounds that it was the type of institution certain to be swallowed up by political corruption. See ibid.

²⁰⁸Times, September 29, 1895, p. 10.

²⁰⁹"The Health Department and the Examination of Tubercle Bacilli," Medical Record, XLVIII (October 19, 1895), 574.

CHAPTER 3

EXPANDING HORIZONS

The bacteriological laboratory of the New York City Health Department had in only a short time after its inception established a model for the municipal control of diphtheria and, in the process, generated a moderate amount of opposition. These early years were made even more hectic by the almost simultaneous launching of an ambitious anti-tuberculosis strategem by Biggs that was to be widely emulated and which would be the target of controversy and attacks overshadowing those surrounding the diphtheria program.

Biggs had been a student at Cornell in 1882 when he learned of Koch's electrifying announcement that he had positively identified a specific bacillus as the causative agent of tuberculosis.¹ Having previously decided on a career in medicine, and with an already keen interest in the infant science of bacteriology, he devoted a major portion of his A.B. thesis to the discovery and to consideration of its long-range public health implications.²

Koch's findings were the logical culmination of a series of advances in tuberculosis research made during the nineteenth century.³ One difficulty--in addition to the general tendency of considering signs such as jaundice, dropsy, and fever as diseases rather than as symptoms, so that all those with blood-spitting, cough, and fever were loosely grouped as "consumptives"--was that the disease assumed a variety

of clinical forms, attacked various parts of the body, and had consequently come to be known by a variety of names.⁴ Rene Laennec, a French physician, building on the anatomical observations of members of the Paris school of medicine, comprehended the protean nature of tuberculosis and recognized the characteristic lesion (the tubercle) as the unifying element of this single pathological entity.⁵ Neither Laennec nor his successors at the French Academy of Medicine who confirmed his findings had more than the vaguest of notions as to the origin of the infection.⁶

Little further progress was made until Jean-Antoine Villemin, a French army surgeon, became convinced from observations of soldiers that tuberculosis was contagious. He demonstrated that morbid material taken from the area of the affected tissue would induce the disease when inoculated into susceptible organisms. Tuberculosis was transmissible and was not the result of bad heredity nor, as some believed, did it originate from misery or emaciation; it was caused by a specific agent which multiplied in the victim and which was communicated to healthy persons by direct contact or through the air.⁷

Villemin's work was greeted with indifference since rigorous evidence for the causal relationship between microorganisms and pathological conditions had not yet been demonstrated; the literature that did arise was predominantly that of detractors who remarked on the unlikelihood of invisible living creatures playing any part in the disease process. The consensus that tuberculosis was due to some innate susceptibility was tenaciously held so that the landmark findings of Villemin evoked no immediate practical applications.⁸ Although in a minority,

supporters of the germ etiology hypothesis took up the cudgels and sought to discover the exact tubercle-inducing pathogen. The French Academy of Medicine and certain Parisian medical authorities acknowledged Villemin's discovery and half-heartedly encouraged him to pursue his research further. It was, however, in a number of German laboratories that the systematic search for the elusive perpetrator of the "white plague" was most determinedly conducted.⁹

The German pathologist Julius Cohnheim and Carl Salomonsen, a Danish pathologist, published a collaborative work on tuberculosis in 1877 that supported the concept of the parasitic origin of the disease. By introducing tubercular tissue into rabbits' eyes, the two were able to watch the day-by-day cycle of the disease and substantiate its infectious character.¹⁰ During that same year Welch was welcomed into their university laboratory at Breslau--where Cohnheim, although Jewish, had gained a professorship through his efforts as the virtual founder of experimental pathology--and was familiarized with the work underway. The two scientists befriended the American who, according to his biographers, became tremendously "enthusiastic when he saw his first example of general tuberculosis in a guinea pig."¹¹

Welch's observation of experimentally induced tuberculosis was not his first experience with consumption, which had gradually become a major cause of illness and death in America.¹² During the colonial period, the more devastating conditions of cholera, smallpox, and yellow fever had received the greatest attention while tuberculosis, which progressed through the community more slowly and less dramatically, was not generally recognized as an entity. Moreover, its infectious

character, although suspected by some, was usually denied.¹³ In 1834 there appeared the first book published in the United States on the malady. Its physician author, Samuel George Morton, gave an elaborate clinical discussion of tubercle lesion and was generous in his praise of Laennec with whose work he was clearly quite familiar. Morton emphasized the value of the stethoscope and percussion technique in diagnosis and gave a long account of the variety of contemporary methods of treatment, i.e., iodine, digitalis, sarsaparilla, narcotics, prussic acid, cupping, tonics, blistering, diet, fumigation, inhalation of pure air, etc. Although noting that some authors insisted on the contagious nature of consumption, the American doctor saw no evidence in his experience for such a view.¹⁴

As the epidemiology of phthisis (consumption) came under greater scrutiny, there evolved a general recognition among physicians that, like other diseases, it too went through epidemic cycles and that it was, in fact, a single pathological condition. This consensus, however, was of no immediate benefit in providing cures or relief from the debilitating effects of the affliction. Public health authorities and sanitarians were frustrated by their lack of understanding as to what triggered the ailment and how it was transmitted. The inciting factors in the etiology of tuberculosis were hypothesized as being so varied and nebulous in nature as to be beyond the capacity of medical science to control.¹⁵

Unable to combat tuberculosis successfully, a few communities in the early nineteenth century did strive to gather relevant morbidity and mortality data. In Boston, where a particularly determined effort

was made to provide reliable statistics, the average annual mortality rate of consumption varied from 142 to 223 per 1,000 annual deaths (from all causes) during three ten-year periods (approximately) from 1811 to 1839.¹⁶ Lemuel Shattuck of the Massachusetts Health Department drew attention to the appalling prevalence of pulmonary tuberculosis and the futile struggle of public health officials to cope with the problem. In a prophetic statement, considering subsequent events in New York City, he declared:

Sufficient facts are known to show that from one-fourth to one-seventh of all the deaths in the Northern and Middle states, and perhaps throughout the whole Union, and the civilized world are caused by consumption. The frightful mortality is to be arrested, if at all, by means of prevention rather than cure of the disease after it has once been started. Were a competent individual to write a popular treatise explaining the various causes of this disease, and the proper precautionary measures to be taken to prevent its attacks, to be read and observed by the people, its mortality might be greatly reduced.¹⁷

Shattuck's plea fell on deaf ears; for the succeeding few decades there was to be no meaningful progress in the United States in gaining a sounder understanding of the etiology or modes of transmission of consumption or in the devising of public health procedures to contend with the illness that had already reached plague-like proportions.¹⁸

Villemin's experimental conclusions, lambasted or treated with general indifference in Europe, were scarcely entertained in American medical journals or texts.¹⁹ In a monograph of 1875 purporting to present an exhaustive account on the most reliable and professionally acknowledged contemporary knowledge on all important scientific and clinical aspects of phthisis, the author, the highly regarded Dr. Austin Flint, professor of medicine at the Bellevue Hospital Medical College, presented nothing of any substance differing from theories and recommendations

advocated decades earlier.²⁰ The same author, in the edition of 1881 of his popular medical textbook, did make reference to the studies of Laennec and Villemin, and to the then-current investigations undertaken by Klebs and Cohnheim to identify the "specific tuberculous poison," but nevertheless gave greater credence to the adherents of the more entrenched dogma.²¹

The process of making headway against firmly rooted beliefs was made especially difficult by a perception of the disease peculiar to the nineteenth century. Tuberculosis had come to be regarded, by physicians as well as laymen, as an ethereal, poetically delicate condition which mainly affected those of a sensitive nature and which carried off its victims to a painless, romantic death. The illness did not make its appearance abruptly, its lesions were not noticeable, and its recipients were alert up to the end. The association of the disease with genius--Moliere, Voltaire, Shelley, Keats, Chopin, Rousseau, and the Brontes, to name a few, were sufferers--added further to its mystique. Consumption had, in fact, become a useful device in Victorian literature to elicit sympathy; the very image of the withering female "going into decline" symbolized the era's ideal of feminine gentility.²² The concept that the illness was initiated by tiny, loathesome, living creatures which entered the body and irreverently tore apart human tissue was understandably anathema to the spirit of the Romantic Age.

The most devastating attack against such sentimentality was levelled on March 24, 1882, when Robert Koch delivered his lecture, entitled simply "Ueber Tuberculose," to the Berlin Physiological Society and startled his audience with the news of his discovery of the specific

causative agent of tuberculosis, the so-called tubercle bacillus. Within three weeks his paper appeared in print so that French and German laboratories, particularly the latter, were soon successfully duplicating his patiently explained procedures and were easily verifying his conclusions.²³ In these same institutions--representing the spectrum of university, government, and privately supported laboratories, but most ambitiously in the Imperial Health Department by Koch's disciples--investigations were launched for purposes of learning more about the microbe's methods of dispersal and portals of entry; in short, the search was begun for an effective method of prevention by immunization.²⁴

In America, Koch's work received scant attention in the press and professional periodicals but was welcomed enthusiastically by some progressive physicians and one professional journal. The editor of the Medical News categorized the evidence for the identification of the Tubercle bacillus in "Die Aetiologie der Tuberculose" as "conclusive and among the great facts of modern science."²⁵ The discovery seemed to warrant the belief that the day would soon approach when the means for the determent of the widespread ravages of consumption would be found.²⁶

Amid continuing reports of the work done in European laboratories there emerged a conservative backlash which neutralized the initial, although limited, optimism.²⁷ The editors of the Medical Record confessed that they were skeptical regarding some of Koch's work and doubted whether there was any real significance to his findings. To support their contention they noted that Baumgarten in Germany had found microbes in tubercular lesions differing from the tubercle bacilli and furthermore disclosed the failure of some unidentified New York

investigators to detect any of Koch's microorganisms despite their having carefully duplicated his techniques.²⁸ The view of Virchow, the most formidable opponent of the theory of the infectious nature of tuberculosis, were presented and the doubts he cast on the specific role of the tubercle bacillus before the Berlin Medical Society were cited as "the words of the master."²⁹

Indicative of the American attitude towards the results of Koch's research was that at the October 1882 annual meeting of the American Public Health Association--a group whose membership of health officials, private physicians, and academicians concerned with the public well-being would have, one would expect, a keen interest in such matters--only passing mention was made of the work done in Berlin.³⁰ To the extent that physicians in this country were aware of the discovery of the tubercular germ, their general disposition was one of skepticism or disbelief.³¹

One pocket of support for the microbial origin of consumption was Bellevue Medical College. Here professors Janeway and Flint--the latter a convert despite his earlier hesitation--enthusiastically accepted Koch's findings and passed them on to their students.³² Their young colleague Welch had already made it a practice to demonstrate Villemin's proof of the inoculability of tuberculosis to his classes and now, using Koch's methods, he was able to isolate and stain the tubercle bacillus. The results were shown to fellow instructors and to Welch's eager young student Hermann Biggs. Exposed to this environment at such a receptive point in his medical education, it was not surprising that Biggs would take such an interest in tuberculosis in later years nor

that he made reference to it in his thesis written only months later at Cornell.³³

Over the course of the next few years, however, the hopeful predictions of Biggs and others that dramatic advances in community control of consumption would soon be forthcoming were to prove unfounded. There did not develop from any quarters workable means for the application of the information that had emerged from the Imperial Health Department. Koch himself had concluded his famous lecture before the Berlin Physiological Society with an invitation to anyone who wished to employ his discoveries from the general well-being.³⁴ He took no direct part in such efforts in the immediately succeeding years.³⁵

Much of the doubt that had greeted Koch's discovery of the tubercle bacillus, particularly in American medical circles, had dwindled by the late 1880s as thousands of cultural and inoculation experiments verified the existence and pathogenic capabilities of the microorganism, and as the identities of the specific microbes causing other infectious diseases were rigorously substantiated.³⁶ Consumption was no longer a vaporous, tender condition with a poetic appeal that almost redeemed its tragic consequences, but rather a devastating symbol of much that was unkind in the contemporary world.³⁷

Among those who had grown impatient with the failure of society to take advantage of what research had uncovered, one of the most outspoken was Charles V. Chapin. In his monograph, What Changes has the Acceptance of the Germ Theory Made in Measures for the Prevention of Consumption?, he answered the question posed by his title in the negative; nothing had been done. It was up to physicians to insure that

tuberculosis would not decimate the human race, but they had as yet not acted. Chapin demanded that doctors accept their role as educators in matters of health and teach people about the true, infectious nature of tuberculosis, inform parents on how to rear healthy, more resistant children; he urged disinfection of the clothing and sputum of consumptives, and discouraged contact with tuberculosis victims.³⁸

Chapin's suggestions were taken up, in part, in New York by Biggs and Prudden in their capacity as consulting pathologists to the city's Health Department. Prudden had been an early, but cautious, supporter of Koch and had written some scholarly and popular pieces on the intricacies of the tuberculosis problem.³⁹ The younger and, by nature, impatient Biggs apparently had a more active policy in mind, the registration of all tuberculosis cases. Fearing--and correctly in view of subsequent happenings--that such a proposal would evoke the opposition of the medical community, Prudden instead convinced his colleague of the wisdom of less provocative procedures.⁴⁰ A hint was given to Commissioner Bryant, who in turn convinced the members of the Board of Health to request officially a statement from its pathologists on the causation of pulmonary tuberculosis accompanied by some suggestions for its reduction.⁴¹ The report (written by Biggs, Prudden, and Henry P. Loomis and submitted on May 28, 1889), was essentially a didactic presentation on the microbial origin and contagious quality of the disease, and concluded that consumption was not inherited, was preventable, and was generally acquired by transmission of the tubercle bacillus from the sick to the healthy. Methods suggested for the prevention of the disease were: inspection of cattle to diminish the chances of tubercular

meat and milk from reaching the markets, the dissemination of information among the public on the infectiousness of the malady, and the disinfection of rooms and hospital wards which had been occupied by phthisical patients.⁴²

To test medical opinion in New York City, Bryant addressed letters to twenty-four prominent local physicians asking their opinion of the report and the advisability of action by the Health Department. He received only a few responses and, with one exception, the belief was expressed that nothing could be gained by the interference of a public agency in the battle against tuberculosis; the Health Board decided therefore to take no action until they could expect more cordial support from the medical profession.⁴³ Bryant went ahead, however, and had printed a large number of leaflets summarizing the essential facts of the report on the communicability of consumption which were then distributed to laymen and doctors throughout the city.⁴⁴

The first steps in public education were barely underway when the spectacular news burst forth that an effective means for the treatment of tuberculosis was at hand. At the Tenth International Medical Congress in Berlin, in early August 1890, Koch stunned his audience when he ended a lackluster address with the casual announcement that he had uncovered a substance which had the strength to retard tubercle bacilli in vitro and in vivo.⁴⁵ Word of the discovery spread quickly; doctors and consumptives hurried to Berlin, filling its hospitals and hotels, in pursuit of tuberculin or, as it was called, "Koch's lymph" (later revealed as nothing more than a glycerinated extract of tubercle bacilli).⁴⁶ Those New York physicians who had made the pilgrimage came back with the

same negative impressions as those who had stayed behind and tested extract samples on private cases.⁴⁷ Sufficient evidence had accumulated, despite some favorable indications, that tuberculin caused serious complications and simply did not live up to its expectations as a potent and safe remedy.⁴⁸ Koch's lymph, although a failure as a curative (the only serious blemish on an otherwise brilliant scientific record), was later discovered to have value in diagnosis.⁴⁹ At the time, however, its disappointing performance left the problem of tuberculosis management in a state of muddled limbo.

The frustration of the failure of tuberculin, the pressure of marital difficulties, and delays in the establishment of the research institute he had been promised, prompted Koch to put his research aside and journey to Egypt. In October 1891 he moved to his new quarters at the Institute for Infectious Disease--generously funded by the German government, but did little in respect to tuberculosis other than defend his previous work and attack the experimental methods of those who he felt too readily condemned the tuberculin cure. By the summer of 1892 his attention, like that of sanitary officials throughout the world, was directed to cholera which had abruptly and devastatingly made its appearance.⁵⁰ Koch, the discoverer of the tuberculosis germ and regarded as the most likely to unravel a means for its suppression, involved himself and colleagues in cholera research and thus, once again, thwarted the hopes of those who anticipated the development of productive anti-tuberculosis contrivances.⁵¹

It was during this period that Biggs--impetuous, buoyant, headstrong, and actively involved in the administration of a diphtheria

program that had been greeted with a generally favorable reaction-- stirred and decided that the time had come for "sanitary authorities to assume a more aggressive attitude" against tuberculosis and that the municipal laboratory was the logical public agency to spearhead the movement. On November 28, 1893, he presented his thoughts to the Health Board in the form of a short, three-page statement.⁵²

The untitled report, the springboard for what was to become an ambitious public health program that would serve as a model for municipal and state bodies throughout the country and which would bring tributes from Koch himself, contained no substantive revelations of any sort. Much as in the earlier collaborative work of 1889, he presented an unpretentious, nontechnical discussion to support the view that consumption was directly communicable and thus of parasitic origin. Here was a compilation of the most commonplace evidence by a man who was a master synthesizer of the efforts of others and whose talents in this direction would manifest the very essence of the New York City Health Department's bacteriological laboratory. The institution, like the tuberculosis report, was contoured by a craftsman, a man of action with the boldness and ability to gather up successfully the achievements of others, extract their substance, and move on to the work of practical application. It was in this mode that Biggs, logically and almost syllogistically, concluded his presentation to the Health Board with suggestions for the implementation of preventive measures against tuberculosis during an era when such possibilities were seldom seriously considered.⁵³

In his account, addressed to Health Board President Wilson, Biggs reiterated his position that the disease which was the most common

and fatal in New York--over 6,000 deaths had been reported in 1892--was communicable and preventable. The belief that tuberculosis was hereditary was denied although--in what is essentially the modern view--he suggested that there might be inherited a predisposition which rendered the individual less resistant once tubercle bacilli entered the body. Cornet's dust theory was much in vogue so that Biggs placed considerable emphasis on the importance of destroying the sputum of consumptives before it had the chance to dry out and release its deadly contagion. Following his declaration that "the time has arrived when the knowledge concerning the causation, extension, and prevention of pulmonary tuberculosis is sufficiently definite to make possible the adoption of important practical measures for its restriction," he recommended that a policy of public education be mounted, that all public institutions be required to transmit to the Board of Health the names and addresses of all consumptives under their care, that private physicians be requested to do the same, and that hospitals be built for the exclusive treatment of consumptives. As to his own division, Biggs suggested that it ought to be provided with the facilities for the bacteriological examination of sputum to assist doctors in diagnosing their patients with pulmonary conditions.⁵⁴

Biggs' insistence on the necessity of acquiring data on consumptives was what he considered the essential first step in the battle against tuberculosis. The German and English models certainly influenced this decision as the health laws of both countries mandated the maintenance of accurate, up-to-date information on disease distribution. In Berlin, for example, since 1872 the Bureau of Statistics had

maintained information for health authorities and the police on "statistics of disease among the poor," "statistics of infectious diseases based on compulsory notification," and "cases of diseases and deaths in the associations of working men." The agency also attempted to keep current data on the "social position, means of subsistence, dwelling and occupation of each inhabitant."⁵⁵ Biggs, likewise, later devised an elaborate scheme of giant city maps coordinated with color-coded cards containing the name, address, age, sex, and occupation of living and dead consumptives.⁵⁶ The exact methods for the social control of the ailment--for which the personal information was presumably the basis--was not yet elaborated; again, though, there is the hint of the German paradigm, for contingencies for coercion through the employment of Sanitary Police and health inspectors were made.⁵⁷

Biggs' proposals served as the basis for a report approved and adopted by the Board of Health on December 13, 1893. Medical sanitary inspectors were to take specimens of sputa in doubtful tenement cases that came to their attention, and whenever requested by physicians for privately treated patients, with the samples to be forwarded to the Division of Bacteriology which would be equipped, following some additional funding, for such work.⁵⁸ A few suggestions presented by Biggs to give greater authority to departmental inspectors to demand sputum specimens in situations where they considered it imperative were incorporated into the anti-tuberculosis program by February 1894.⁵⁹

Research had not produced any treatment for tuberculosis nor were there any indications of an imminent breakthrough. Biggs' plan was

predicated on the notion--for which he did not, and could not, offer any corroborative precedent--that, once consumptives were located, measures could be implemented to reduce the chances of their transmitting their affliction.⁶⁰ The scheme was not a public health panacea but a holding action; its pioneering integration of bacteriological techniques into a systematized campaign against pulmonary tuberculosis was transcended by its greatest novelty, its very existence. Even a "holding action" on a citywide level was a far more ambitious venture than other bodies with community health responsibilities had undertaken.⁶¹ Biggs had called for a more "aggressive attitude," vis-à-vis consumption, and, true to his character, he himself assumed that stance through the enterprising employment by the municipal bacteriological laboratory of procedures made possible by the discovery of the tubercle bacillus.

Basic to the success of the program was the rapid transmission of information on incipient cases to the Health Department. All hospitals, dispensaries, asylums, homes, and other public institutions were notified that they were required to provide weekly reports on all consumptives in their charge. Noninstitutionalized sufferers would be difficult to track down unless the support of the city's physicians could be enlisted and their cooperation, Biggs predicted, would be difficult to obtain.⁶²

Biggs' fears did not seem justified in light of the immediate, published reactions to his early attempts to bring phthisis under the control of health authorities. The suggestions embodied in his report of November 1893 were accounted in detail and endorsed by professional journals only days after their submission to the Board of Health. With

general acceptance by the profession of the communicability of consumption, it was felt that the objections to the involvement of public health agencies in the management of the malady were no longer valid. Furthermore, the successful response to cholera in 1892 and the benefits (both to the health of the patient and reputation of the doctor) of the laboratory's efforts to diagnose diphtheria--at the time only months old--demanded that anti-tuberculosis measures be encouraged and receive the backing of New York's physicians.⁶³

Despite such support, Biggs anticipated great difficulty in the attempt to obtain thorough registration of tuberculosis victims.⁶⁴ A study instigated by the department had shown that a very large proportion of New Yorkers, including even the poorest dispensary patients, carried life insurance policies issued through industrial insurance companies. Such policies stipulated that, if tuberculosis were the cause of death, little or no payment would be given the next of kin. It was obviously not to the advantage of doctors to report tuberculosis as insurance money was often the only source available for the payment of the deceased's medical bills.⁶⁵

Biggs' dilemma was one episode in the battle by a small number of progressive health departments to keep abreast of their local consumption cases. In Michigan, for example, the State Board of Health adopted a resolution, on September 30, 1893, stating that tuberculosis was to be considered an infectious disease and, as such, had to be reported.⁶⁶ In Philadelphia the municipal health board found it a difficult task to locate the source of neighborhood outbreaks and so welcomed the appeal by the Philadelphia County Medical Society and the Pennsylvania Society for

Prevention of Tuberculosis to make registration compulsory. The suggestion was, however, vigorously and successfully opposed by the College of Physicians and the Homeopathic Medical Society.⁶⁷

The opposition of private practitioners to any suggestion that they provide a public health department with the names of their tubercular patients was an outgrowth of concerns touching on such related matters as income, professional status, and the organization of medical care. It was feared that those doctors who complied by registering consumptives would suffer the loss of patients who would resent the public disclosure of their condition, one which carried with it a certain social stigma. Then, too, there was the matter of the exclusionary stipulation of life insurance policies. Furthermore, public health inspectors visiting the homes of those reported ill might give advice or ask questions that would arouse suspicions as to the competency of the attending physician.⁶⁸ Also, once their identity was made known to city officials the possibility existed that consumptives would be removed to public institutions and away from the care of the family practitioner.

During a period when incomes were decreasing due to an overabundance of physicians, and with feeble medical-political leadership on the county, state, and national levels, doctors faced an uncertain future.⁶⁹ With the sudden and extreme economic depression that hit the nation in 1893, one more stress was added. The reporting of data on tubercular patients to the health authorities quite simply promised no discernible benefits to the doctor but, on the contrary, gave every indication of further threatening his means of livelihood.⁷⁰

Biggs suspected that New York's doctors would react like those

of nearby Philadelphia to any hint of mandatory registration and so suggested that physicians be politely "requested" to provide such information on the postal cards ordinarily used for reporting contagious diseases. His recommendation was approved and adopted on February 13, 1894, on the motion of Commissioner Edson; a circular of information was prepared and forwarded to every practicing physician in New York City.⁷¹ The publication reminded doctors that the communicability of pulmonary tuberculosis had been generally accepted by the medical profession all over the world and apprised them of the Board of Health's determination that the time had arrived for active steps to be taken. Physicians were "respectfully requested" to register their consumptive patients and were guaranteed that all such information would be kept confidential and that there would be a minimal amount of inconvenience to the sick.⁷²

Despite such assurances and an appeal for their cooperation in the fight against the entrenched pestilence, it appears doubtful--considering contemporary events in Philadelphia and subsequent happenings in New York--that significant assistance would have been forthcoming from the medical community had Biggs not added an incentive, the free services of the municipal laboratory. Local physicians were advised of the advantages of an early positive diagnosis and were informed that the city laboratory was prepared to place at their disposal the means for the bacteriological examination of sputa samples from their patients. In order to avail themselves of this free service doctors merely had to provide the laboratory with the name, age, sex, and address of the patient, and duration of the illness. The administrative machinery for a unique public health quid pro quo was thereby set into motion: physicians

were furnished with a convenient procedure for bacteriological diagnosis and, in turn, without their having technically conceded the point, registered their consumptive patients.⁷³

Soon after the contrivance was made public it was hailed by the Sun as an effective declaration of war against tuberculosis. Biggs' program was lauded as one of the most important ever taken by a health department and one that was surely to have wide ramifications.⁷⁴ The Times too gave its support after the program was in operation for a few months.⁷⁵

As was true following the introduction of the diphtheria service by the Health Department's bacteriological laboratory, the medical journals again assumed a cautious, but receptive, posture. The availability of an instrumentality for free sputum examination was dutifully reported with no commentary other than that there appeared to be no risk of interference with the work of the practitioner.⁷⁶

The city's doctors, however, remained reluctant or unconvinced. The diagnostic laboratory (recently relocated at the Criminal Court Building) initiated sputum diagnosis on March 1 but by year's end had received only 512 samples during a year in which there were 4,658 reported deaths due to pulmonary tuberculosis.⁷⁷ A further indication of the uphill struggle in which Biggs was engaged in his efforts to introduce the gains of bacteriology to public preventive medicine was that the Health Department still classified pulmonary tuberculosis as a constitutional condition.⁷⁸

Biggs was aware that the success of his tuberculosis crusade was considerably dependent on its receiving favorable publicity. To gain

such support and to foster the image of the laboratory as a vital element in the battle against infectious disease, he addressed medical gatherings, wrote an article in a popular magazine entitled "To Rob Consumption of Its Terrors," which drew wide attention, and supervised the preparation of a number of circulars issued to physicians and the public.⁷⁹

Word of New York's anti-tuberculosis efforts did spread and soon a number of municipal and state public health laboratories throughout the country adopted similar measures.⁸⁰ At an International Tuberculosis Congress Koch made complimentary references to the work undertaken at the municipal laboratory and Joseph Lister wrote to Biggs that he admired the "zeal and efficiency" in his department and wished it could be emulated in England.⁸¹

Despite the imitation and adoration, local physicians remained slow to avail themselves of the services of the bacteriological division. An average of three sputum examinations were carried out daily in 1895 over a twelve-month period during which 5,205 deaths due to phthisis were reported. Although its Annual Report implied that Health Department authorities were pleased, the figures did not indicate the level of activity that Biggs and his associates had predicted and for which they had prepared.⁸² Even the press, an early and consistent champion of the laboratory's tuberculosis program, began to show signs of impatience, and suggested that the public should look to Berlin or Paris for the discoveries that would lead to effective procedures against the disease.⁸³

While efforts against consumption continued unabated, recent breakthroughs against an old enemy, typhoid fever, provided an encouraging diversion for the members of the laboratory staff. This illness had

been a persistent health menace throughout the century. A particularly severe epidemic had ravaged the southern counties of New York in 1811 and lingered through 1813, leaving in its wake a high mortality among residents but especially among soldiers stationed in army camps throughout the region.⁸⁴

The Galenic influence was still a prevailing element in clinical medicine at the time. Typhoid was one of the more malignant of the "fever" diseases and, as was true of members of this category, was regarded as an outcome of certain poorly understood variations in the body humours. The methods of treatment which such an etiological assumption demanded varied--Galen and Hippocrates were freely quoted during the epidemic--although the general plan called for the removal of bilious secretions by various emetics and cathartics. The lance was freely used, bleeding was a popularly employed curative, and narcotics were administered to relieve the excruciating intestinal pain that often accompanied the malady.⁸⁵

A number of the French clinical-pathologists, at the beginning of the century, had begun to build up a sound body of histological knowledge on typhoid based on careful post-mortem examinations. Gradually old beliefs came under attack and by 1829 Louis was able to give a complete clinical picture of the distinguishing lesions that clearly demarcated typhoid as an entity separate from other fevers.⁸⁶

Louis made no attempt to hypothesize on the origin or spread of the disease although others, notably Brettoneau, had begun to raise the possibility that it was caused by some sort of contagion that was transmissible.⁸⁷ This idea had already been firmly expressed in a seldom

cited publication of 1824 by an obscure American, Nathan Smith. Twenty-five years of observations of hundreds of typhoid patients led this practicing physician to the conclusion that the pestilence was contagious, a fact which he considered so evident from its epidemiological pattern that it would hardly be worth mentioning but for the fact that his was not the prevailing view.⁸⁸

Another American, W. W. Gerhard, who had studied in Paris with Louis, further advanced the knowledge of the disease through his study of a large number of typhoid and typhus cases in Pennsylvania hospital wards. The two conditions were fairly similar and often confused with each other until Gerhard painted a detailed picture of their subtle anatomical and symptomatic differences.⁸⁹

At mid-century most physicians regarded typhoid fever as of miasmatic origin, although the idea of its contagiousness had attracted a sizeable number of adherent.⁹⁰ Despite such theoretical advances, nothing of practical value had yet been devised to abate its prevalence or virulence. During the Civil War there were 79,462 cases of typhoid of which 29,336 terminated in death.⁹¹ The methods of treatment were not much different from those that were popular earlier in the century and, if anything, were more brutal and "heroic." Mercury and other irritating cathartics were routinely administered, leeches were highly recommended, and the blistering of the nape of the neck and skull was advocated as a technique that "works wonders."⁹²

Credit for the discovery of the bacterial agent of typhoid fever, one of the first known infections whose parasitic cause was determined, is generally given to Carl Joseph Ebert, who found the bacillus

in the tissues of dead victims and published his findings in 1880.⁹³ Identification of the microbe, nevertheless, brought forth no immediate means for its prevention, diagnosis, or treatment.⁹⁴

Efforts to detect the mode of transmission were begun, on a small scale, following some experimentation that lent credibility to the suspicion that the germ was present in the stool and urine of typhoid sufferers and could survive outside the body. The Lawrence Experiment Station of the Massachusetts State Board of Health, under the guidance of William Thompson Sedgwick, began in 1887 to conduct tests on water purification and to study water-borne bacteria, with particular attention (especially after 1890) devoted to the dissemination of typhoid fever.⁹⁵ When Sedgwick was called upon in 1890 to investigate a local epidemic in Lowell, he conducted extensive tests on the five water systems feeding that town but was unable to isolate typhoid bacilli in any instance.⁹⁶

Such disappointments to the proponents of the germ theory provided the foundation for a compromise: while it was undoubtedly possible to cultivate the bacillus from the stools of typhoid patients with a high degree of consistency, recognition of the infective microorganisms was not regarded as of prime importance in diagnosis or treatment.⁹⁷ No less a figure than von Pettenkofer, the most influential figure in hygiene of the day, insisted that the germ had to pass through a ripening stage in the earth and that its spread depended on a number of geological and climatic phenomena, the social structure of the local inhabitants, and the general physiological condition of the individual.⁹⁸ To demonstrate his point, von Pettenkofer dramatically swallowed a large quantity of virulent bacteria and defiantly survived, apparently with no

serious symptoms.⁹⁹

In New York typhoid continued, as in the past, to be responsible for snuffing out the lives of several hundred people each year, and for causing unbearable pain and the extreme debilitation, although usually temporary, of countless more lucky enough to survive.¹⁰⁰ With the connection between the disease and fecal matter generally conceded, the Health Department and physicians urged that care be taken to inspect plumbing systems and fix leaking pipes.¹⁰¹ Several local epidemics led to the conclusion that contaminated milk was the source of the dispersal of the infection.¹⁰²

Public health efforts to discourage typhoid were hampered by the fact that the disease was difficult to diagnose until it had progressed well along its vicious path. The problem was compounded by the frustrating task of locating cases in tenement areas. The immigrants' distrust, or ignorance, of government and their fear of hospitals led them to conceal their sick from the authorities and to neglect Health Department warnings on the importance of following basic rules for personal hygiene.¹⁰³

Progress, however, seemed possible by 1896; papers published during that year held out the hope that the means for typhoid detection was close at hand. The separate observations of German bacteriologists Pfeiffer and Gruber showed that the blood serum of organisms ill with typhoid fever contained a specific substance which brought about clumping, immobility, and disintegration of the causative microorganism.¹⁰⁴ Although the phenomenon was considered potentially useful in identifying unknown bacteria, its employment as a method for diagnosis was clear.

The inevitable next step was taken by the clinician Ferdinand Widal who devised a simple procedure in which typhoid bacilli in broth cultures were added to the suspicious serum. Agglutination indicated that the typhoid microbe had invaded the patient's system.¹⁰⁵

The European discoveries were quickly seized upon by Biggs who, as throughout his career, kept well abreast of the literature and did not hesitate to act when he felt a reasonable opportunity for success had presented itself.¹⁰⁶ The lead had already been taken, though; the municipal laboratory of Montreal, under its director Wyatt Johnson, was the first agency in the world to offer the Widal test on a public basis.¹⁰⁷ With the free hand he had in determining the policies and practices of his department, Biggs made a similar service available in New York City and placed Williams and Lambert in charge.

The culture station already established in drugstores throughout the city simply added glass slides and suitable holders to their diphtheria and tuberculosis paraphernalia and were supplied with circulars of information regarding the test for typhoid and with the necessary forms for doctors to complete when they left samples. The Health Department then issued announcements to every physician explaining that a free, rapid, reliable diagnostic procedure was available and invited them to avail themselves of it. By early October--only short months after the published revelations of Pfeiffer, Gruber, and Widal--the medical community had at its disposal a readily accessible means for testing those patients with symptoms suggestive of typhoid.¹⁰⁸

The circulars issued by the laboratory on the dependability of the Widal test were somewhat less than candid. One of the reasons

for the rush in implementing the city-wide service was to acquire the data necessary to establish conclusions on the exact value and limitations of the procedure. Of the number of serum samples sent to the laboratory by November 5, 32 had proved, from subsequent clinical histories, to be undoubtedly typhoid fever; of these, 31 had initially given a positive reaction so that Park (who joined Williams and Lambert in this work upon his return) was satisfied that the results obtained by Widal were confirmed and that the clumping of the bacillus with loss of mobility could be considered an accurate indication of typhoid infection. Negative results could not be as heavily relied upon. Of the 200 cases examined between November 5 and January 1 in which complete histories were obtained, 100 of the 140 which proved to be typhoid gave positive reactions when first tested. Consequently, by late December, 1896, experimentation began under Park and his co-workers to refine the Widal technique so that it might be used with a greater degree of accuracy in identifying and excluding the diagnosis of typhoid fever.¹⁰⁹

Here was the type of practically oriented research for which the municipal laboratory was especially well suited. The administrative machinery had already been assembled for the collection of specimens so that over the course of the next three years the laboratory would receive a large number of sera samples on which it could base its conclusions, which thereby--because of the quantitative nature of the study--stood on a substantial experimental foundation.¹¹⁰

The novel and intimate association of diagnostic and research laboratories under the aegis of one department allowed for a convenient interchange of information and materials so that diagnostic findings

could serve as the basis for productive investigations and so that the results of the latter could be expeditiously employed in disease surveillance. In the typhoid work this arrangement was particularly convenient due to the fact that the Widal test was quantitative and not qualitative, as even the blood of healthy persons had some effect on the bacilli. The problem at hand was to determine what dilution of the serum would eliminate the possibility of a positive test with normal blood and yet not prevent the agglutination reaction with the serum of an infected individual. Another factor that had to be considered was that the accuracy of the test seemed to vary according to the length of the illness.

With so many variables the research effort was not an easy one, but benefited, as was the intention, from administrative devices and the unique intimacy of the two subdivisions of the bacteriological laboratory. The requirement that physicians complete detailed forms when they submitted serum samples and the request that they send subsequent samples allowed for an accurate comparison of laboratory results and clinical outcomes. The result was that the researchers were able to arrive at procedural methods which had proven to be statistically most accurate under a variety of circumstances.¹¹¹

In conducting its investigations of typhoid, the Health Department laboratory received considerable assistance from other facilities. The original broth cultures used in testing were sent by Pfeiffer in the summer of 1896. When the question arose as to what effect the serum of patients with diseases other than typhoid fever would have on the Widal test, a large supply of blood samples were made available by several New York hospitals. During the height of a typhus epidemic in Liverpool,

its Medical Officer for Health, Dr. E. W. Hope, quickly complied with Biggs' request and forwarded a shipment of typhus blood.¹¹²

Personal visits were also encouraged and were well received as there seemed to be a sincere sense of community among these early bacteriologists fostered by the recognition that they were members of a scientific discipline that, while no longer in its infancy, was passing awkwardly through adolescence and which sought greater recognition from the public and scientific communities. Anna Williams was sent to Paris in 1896 to receive special training at the Pasteur Institute and Park, a year later, with a personal letter of introduction from Health Commissioner Wilson, was dispatched to Europe on a mission to learn whatever he could from the leading laboratories in Great Britain, France, and Germany.¹¹³

In the midst of all this personal movement the latitude of activities conducted by the laboratory was broadened; in the early part of 1895 the Health Board assigned it the responsibility of supervision of the production of smallpox vaccine.¹¹⁴ During that summer Biggs made an inspection of the method used in England and on the Continent and so, upon his return, introduced the procedure in New York City.¹¹⁵ To his credit, and as was his style, no pretense of originality was made. The Chief Inspector proudly admitted that his division was simply "following the example of all the best German, French, and English vaccine laboratories."¹¹⁶ Such honesty reflected an underlying lack of any conscious sense of competition with other laboratories, as often typified the relations of European institutions.¹¹⁷

If the municipal laboratory's efforts were little more than

"skimming the cream," at least the process was conducted open-mindedly, thoroughly, and with a deep-rooted commitment to the harvesting of pragmatic end products. In this light, Biggs noted that the European-style vaccine was only adopted following successful investigations and that "it is believed, however, that no other virus is tested before issue as fully as that prepared by this Laboratory."¹¹⁸

In his yearly report for 1896 from the Willard Parker Hospital Laboratory (the "Research Laboratory"), Park gave an indication of the diversity and intensity of the work in progress at the location. The routine labors, as he saw them, consisted of the preparation of diphtheria toxin and antitoxin, tetanus antitoxin, tuberculin, mallein (a preparation used for the diagnosis of glanders), and smallpox vaccine as well as the testing of the virulence of diphtheria bacilli from sore throats and tubercle bacilli from milk and human samples.¹¹⁹

The busiest phase of the expanding activities continued to be the diphtheria diagnoses conducted under the immediate direction of Alfred Beebe (with technical assistance from Dr. John S. Billings, Jr.) at facilities where the diagnostic work for tuberculosis and typhoid fever was added.¹²⁰ The outcome of such labors was of interest not merely to the physicians who had sent specimens. When samples sent from mild throat inflammations yielded morphologically-typical Loeffler bacilli, Park ordered that they be sent to the Hospital Laboratory for further testing. Such cultures were then grown and compared with the subsequent histories of the patients; in 25 of 44 such instances detected in a one-year period, the patients developed characteristic diphtheria. The investigation showed that when Loeffler bacilli were found

in secretions from throats showing any signs of inflammation, they should be considered virulent and a potential source of infection. Consequently, the individual should be isolated and treated as a diphtheritic.¹²¹

This study, dependent for its success on the close association of diagnostic and research facilities and the unimpeded exchange of information between the two, coupled with the laboratory's ability as a division of a local governmental agency to gather current data on the subsequent progress of individual cases in the natural habitat of the urban environment, was precisely the type for which the municipal bacteriology laboratory was peculiarly well suited. The experimental methodology, institutional interactions, and urgent, pervasive sense of mission all considered here were the elements in the format in which the laboratory excelled. This multifaceted investigation had no exact precedent and was one that could not have been as effectively conducted in any contemporary institutional structure. Typical too was the rush to get the findings into print so that their practical ramification might be realized as quickly as possible.¹²²

Research of a somewhat more basic nature was also underway--encouraged by the successful model of diphtheria control--to determine whether protective and curative sera could be produced against typhoid, cholera, pneumonia, and a variety of streptococcal diseases. None led to positive developments since many fundamental problems remained to be solved; but in this early optimistic period in a laboratory staffed with young enthusiastic personnel involved in a science that was only a few decades old and which seemed to yield substantial discoveries regularly

and generously, no possibilities were to be left unexplored.¹²³ In the same spirit, and entirely as the result of an internal decision by members of the bacteriological division (official Health Board sanctions for new ventures were seldom sought), a service of rabies diagnosis was launched and rabbits were inoculated with the virus for the purpose of initiating anti-rabic treatment.¹²⁴

The kaleidoscopic range of research efforts in progress and the sheer magnitude of routine diagnostic duties had, by 1896, taxed the meager manpower of the division to the point where it was decided by Park and Biggs that greater efficiency could best be achieved by apportioning the work.¹²⁵ Dr. Alexander Lambert was placed in charge of the preparation of tetanus antitoxin and mallein; experimental sera studies were entrusted to the supervision of Dr. Anna Williams; the various aspects of the preparation of diphtheria toxin and antitoxin were put under the care of Dr. George P. Biggs (Assistant Pathologist), Williams, and James P. Atkinson (a recently assigned chemist); and Dr. Charles Fitzpatrick was dispatched to the diagnostic laboratory to provide expertise and assistance in the examination of sputa from suspected consumptives.¹²⁶ Park shared in the investigations begun on the Widal reaction and functioned as he had, and as he would for over forty years, as a sounding board and general overseer of all operations in the Research Laboratory.¹²⁷

Assignments were apparently based on immediate need and mutual agreement. The senior members, Williams and Park, quite naturally became involved in areas in which they had experience and/or training with the remaining, and generally more routine, work divided among the junior

staff members.¹²⁸ Even so, the allocated roles were only loosely adhered to as the young bacteriologists assisted each other out of necessity, due to the shortage of personnel, and because of simple curiosity in each other's work. The occasional attempt to classify the members of the bacteriological division as diphtheria experts, tuberculosis experts, etc., was done primarily for the sake of appearance and apparently was not taken seriously in the laboratory.¹²⁹

Biggs, as had become his practice, spent little time at the laboratory but vigorously continued to publicize its programs and spread the gospel of applying bacteriology in public health. He made personal appearances before medical groups and published numerous articles in popular and professional publications.¹³⁰ Such activities did not, however, preclude his maintaining a concerned vigil over his department. By late 1896 his efforts resulted in the appointment of four additional Assistant Bacteriologists to provide the manpower to keep pace with the growing demands of the division.¹³¹

The four--Arthur R. Guerard, Philip Hiss, Aristides Agramonte, and Robert Wilson--all young physicians, had all come from medical schools which provided instruction in bacteriology.¹³² That such talent was at all available was in itself a reflection of development that had only recently occurred in the formal preparation of American doctors.

NOTES

¹Lawrence F. Flick, Development of Our Knowledge of Tuberculosis (Philadelphia: Wickersham Printing Company, 1925), p. 657; Richard M. Burke, A Historical Chronology of Tuberculosis (Springfield: Charles C. Thomas, 1955), p. 44; Wain, p. 246; Winslow, Life of Biggs, p. 43.

²Ibid., pp. 39-43.

³Burke, pp. 3-6; Lydia B. Edwards, Carroll E. Palmer, and Anthony M. Lowell, Tuberculosis (Cambridge: Harvard University Press, 1969), p. 5; Lewis J. Moorman, Tuberculosis and Genius (Chicago: University of Chicago Press, 1940), p. ix.

⁴Bloomfield, p. 197.

⁵Eric E. Sattler, A History of Tuberculosis, From the Time of Sylvius to the Present Day, trans. Arnold Spina (Cincinnati: Robert Clarke and Co., 1883), p. 11; Burke, pp. 28-29; Rene Dubos and Jean Dubos, The White Plague (Boston: Little, Brown, and Company, 1952), p. 82. Laennec's views were first expressed in lectures given in 1804 and were later expanded and abated by clinical studies owing much to his invention of the stethoscope in 1816, a device which ushered in modern physical diagnosis. Ibid., p. 82; Edwards, Palmer, and Lowell, p. 6.

⁶Laennec, like most of his contemporaries, did not believe that tuberculosis was infectious or communicable but thought it to be a condition for which many had a hereditary disposition. Bloomfield, p. 201; Burke, p. 46. Another popular opinion was that the tubercle was a cancer-like growth, intrinsic in nature, and not traceable to any detectable source. Edwards, Palmer, and Lowell, p. 6.

⁷Ibid., Dubos and Dubos, pp. 98-100. Villemin's work was reported to the French Academy of Medicine and appeared in its journal that year as "Cause et Nature de la Tuberculose," Bulletin Academie de Medicine, XXXI (1865), 211-215. The most comprehensive account of Villemin's epoch-making efforts and contemporary attitudes concerning them can be found in Flick, pp. 515-644. Villemin's ideas were further developed in his giant monograph, Etudes sur la Tuberculose (Paris: J. B. Bailliere et Fils, 1868).

⁸Dubos and Dubos, p. 100; Bloomfield, p. 210. The members of the French Academy of Medicine had challenged Villemin's conclusions with a series of objections that pro-germ adherents would be faced with for decades and which the latter, despite the existence of concrete evidence of the soundness of their beliefs, would find it difficult to

counter effectively. In light of the fact that tuberculosis seemed to have familial tendencies, how, they asked, could it be contagious when a son might come down with it twenty years after his father's death? Furthermore, they challenged, why was it that more people in immediate contact with tuberculosis sufferers did not contract the ailment as was generally the case following close exposure to victims of recognized contagious maladies like measles and smallpox? Finally, in defiance of the fundamental assumption that tuberculosis was a specific infection, the point was raised that such would not explain why it was so often preceded by pneumonia, bronchitis, and other diseases. Flick, p. 651; Allen Krause, "Before the Bacillus," The Journal of the Outdoor Life, XV (February 1918), 38-40. This article was one of many by Krause--an important figure in the anti-tuberculosis movement in America--that appeared irregularly in the journal between 1918 and 1923 under the collective title, "Essays on Tuberculosis." The pieces generally ran only a few pages each but are compact with helpful information on developments relating to the early battle against the malady.

⁹Ibid.; Bloomfield, pp. 211-221.

¹⁰Ibid., p. 211.

¹¹Flexner and Flexner, pp. 94-99.

¹²"Consumption" or "phthisis" were old terms for pulmonary tuberculosis, the disease's most prevalent form. Nineteenth century statistics generally did not include the non-pulmonary forms of tuberculosis nor list them as separate entities. Edwards, Palmer, and Lowell, p. 7.

¹³Ibid., p. 6.

¹⁴Samuel George Morton, Illustrations of Pulmonary Consumption (Philadelphia: Key and Biddle, 1834), pp. viii, 47, 113-118, 119-160.

¹⁵Edwards, Palmer, and Lowell, pp. 5-9. Consumption was clearly not of miasmatic origin and thus was not considered amenable to the routine sanitary procedures employed against other ailments. A sense of what was regarded as the atypical, baffling behavior of tuberculosis can be gleaned from Morton's text.

Although consumption makes its chief havoc among the poor and the miserable, we often see it invade, without distinction, the abodes of temperance, of refinement and of luxury, and number among its victims the young, the accomplished and the beautiful! The reason is obvious. The midnight application of the student, the imprudence of dress so common among fashionable females, and the various excesses which too often form a part of the recreation of the wealthy, produce those same liabilities to consumption, which, though from different causes, are entailed upon the indigent and the miserable." Morton, p. 164.

¹⁶Lemuel Shattuck, "On the Vital Statistics of Boston," Am. Jnl. of Med. Sci., n.s., I (1841), 393. These figures were comparable to those from New York City, Philadelphia, Baltimore, Providence, and Charleston. During the first half of the nineteenth century, in large cities, the proportion of deaths due to consumption ranged from about 14 to 30 percent. Edwards, Palmer, and Lowell p. 7.

¹⁷Ibid., p. 392.

¹⁸Figures released by the Mutual Life Insurance Company of New York showed the extent of tuberculosis and its fatal consequences. Consumption was the cause of almost 20 percent of all deaths and spared no age group. The statistics further ascribe one-third of all male deaths in New York City to the disease. "Vital Statistics: The Mortuary Experience of the Mutual Life Insurance Company of New York," Sanitarian, VI (1878), 364-365.

¹⁹Dubos and Dubos, p. 100; Krause, The Journal of the Outdoor Life, XV (February 1918), 38-39.

²⁰Flint, Phthisis: Its Morbid Anatomy, Etiology, Symptomatic Events, and Complications, Fatality and Prognosis, Treatment and Physical Diagnosis (Philadelphia: Henry C. Lea, 1875). Compare, for example, ibid., pp. 69-75, to Morton, pp. 40-50, 119-160, for evidence of how little changed in over forty years in the understanding of the etiology of consumption and in the diversified and exotic means suggested for its treatment.

²¹Flint, A Treatise on the Principles and Practices of Medicine, pp. 48-49.

²²Dubos and Dubos, pp. 45-67; Shryock, Medicine and Society in America, 1660-1860, p. 120; Moorman, p. ix; Shryock, National Tuberculosis Association, 1904-1954: A Study of the Voluntary Health Movement in the United States (New York: National Tuberculosis Association, 1957), p. 40. "Consumption" by William Cullen Bryant typified the aura surrounding the disease in its musings on the approaching death of a young consumptive:

Ay, thou art for the grave; thy glances shine
 Too brightly to shine long; another Spring
 Shall deck her for men's eyes--but not for thine--
 Sealed in a sleep which knows no wakening.
 The fields for thee have no medicinal leaf,
 And the vexed ore no mineral of power;
 And they who love thee wait in anxious grief
 Till the slow plague shall bring the fatal hour.
 Glide softly to thy rest then; Death shall come
 Gently, to one of gentle mound like thee,
 As light winds wandering through groves of bloom
 Detach the delicate blossom from the tree.
 Close thy sweet eyes, calmly, and without pain;
 And we will trust in God to see thee yet again.

Poetical Works of William Cullen Bryant (New York: D. Appleton and Company, 1930), p. 54.

To get a more sobering picture of the horrible realities of tuberculosis, of men and women in their early years quietly, but tragically, succumbing to its formidable infectious power, while physicians stood helplessly by as mere recorders of those symptoms--fever, loss of appetite and strength, incessant coughing of thick, yellow sputum--which foretold of the termination of life, see Francis Delafield, "Case Reports of Tuberculosis, 1866-1894," handwritten case histories in the files of the New York Academy of Medicine.

²³Koch's original communication was first published as "Die Aetiologie der Tuberculose," Berliner Klinische Wochenschrift, XIX (April 10, 1882), 221-230. The entire work can be found in translation, with an introduction by Allen Krause; see "The Aetiology of Tuberculosis," trans. Bertha Pinner and Max Pinner, American Review of Tuberculosis, XXV (March 1932), 285-323. Koch's triumph, where others failed, was in large part a tribute to his technical genius and intuition. Identification of the pathogen was complicated by its unusually small size, sparse distribution, limited stainability, epicurean nutritional requirements, and slow growth in vitro. By introducing a slight modification in staining technique, using a culture medium of coagulated blood serum (discovered by Tyndall, the British physicist), and with the patience to wait several weeks for his cultures to mature, Koch had overcome the challenge of the stubborn bacteria's resistance to detection. The thoroughness of his cultural and microscopic work was augmented by the methodology of his animal experimentation in the course of which he developed his famous four postulates. Koch, Berliner Klinische Wochenschrift, XIX (April 10, 1882), 221-228; Dolman, p. 423; Wain, p. 246; Krause, "Robert Koch," The Journal of the Outdoor Life, XV (April 1918), 108-109.

²⁴Krause, "Source of Infection: Cornet's Theory of Dust Infection," ibid., XV (July 1918), 199-204; Krause, "Infection by Tuberculosis: Flugge's Theory of Droplet Infection," ibid., XV (August 1918), 225-230; Dolman, p. 424.

²⁵"The Bacillus of Tuberculosis," Medical News, XL (April 29, 1882), 459.

²⁶Ibid.; "The Bacillus Tuberculosis [:] The Cause of Tubercle," ibid., XL (May 13, 1892), 517.

²⁷"Medical Progress," ibid., XLI (July 22, 1882), 93; "Medical Progress," ibid., XLI (July 29, 1882), 135-137; "The Conversion of Tubercle into a [sic] Inert Foreign Body," ibid., XLIII (December 22, 1883), 687.

²⁸They also reported, happily, that tubercle bacilli were becoming sarcastically known in "pathological circles" as "Koch's bugs." "Koch's Discovery of a Tubercular Parasite," Medical Record, XXI (May 20, 1882), 547-548.

²⁹"Virchow and the Infectiousness of Tubercle," Medical News, XLIII (December 29, 1883), 709-710. Virchow had associated himself with those who denied the unity of consumption. He thought that the cheesy patches found in the lungs were the result of a number of diseases and only in some cases, probably because of inborn tendencies, led to consumption. Because of his preeminence, he became the unofficial leader of the anti-Laennec forces. Krause, The Journal of the Outdoor Life, XV (February 1918), 36; Flock, pp. 472-513; Burke, p. 36. Making a distinction between contagious and infectious illness, he conceded that tuberculosis was, like the "itch," probably among the former but that there was no reason to believe that Koch's tubercle bacilli had any general toxic action or were in any way parasitic. "Virchow and the Infectiousness of Tubercle," Medical News, XLIII (December 29, 1883), 710.

³⁰A good deal of time was spent by the association in consideration of the establishment of a national museum of hygiene. By comparison, when a Dr. Bell of New York related the discovery of Koch and took the grounds that tuberculosis was communicable, no discussion ensued. "Society Proceedings," ibid., XLI (October 28, 1882), 491-497.

³¹"Koch's Discovery of a Tubercle Parasite," Medical Record, XXI (May 20, 1882), 547-548.

³²Flexner and Flexner, p. 119.

³³Biggs had been allowed to begin his studies at Bellevue prior to his having completed all requirements for the bachelor's degree at Cornell. Winslow, Life of Biggs, pp. 39-43, 56.

³⁴"How far parasitology and surgery can utilize the knowledge about the properties of the tuberculosis parasite it is not my duty to define. . . . My studies have been done in the interest of public health, and I hope that this will derive the largest profit from them." Koch, American Review of Tuberculosis, XXV (March 1932), 322.

³⁵When Koch first received his appointment to the Imperial Department of Health he was assigned, by the director Heinrich Struck, the tasks of developing means for the isolation and cultivation of pathogens and of establishing general principles relating to hygiene and public health. Also, months after his basic studies of the tubercle bacillus concluded, he was dispatched to Egypt to uncover the cause of cholera. Dolman, pp. 423-425. Koch did, however, indirectly address the practical implications of his discovery by setting one of his students, George Cornet, to work to study the nature of the transmission of the microbe. Cornet demonstrated that tubercle bacilli were not expelled in normal breathing, thereby offsetting some of the hysteria that had arisen from the fear--based on knowledge of the fact that one of every seven people was consumptive--that one could hardly escape infection when the air was filled with bacilli. He instead proposed the theory that consumption was acquired as a result of the inhalation of bacteria carried in dust

containing dried sputum (Cornet's dust theory). This view became widely accepted after its enunciation in 1888. Bloomfield, p. 217; Krause, The Journal of Outdoor Life, XV (July 1918), 200; Krause, ibid, XV (August 1918), 230.

³⁶R. J. Hall, "On Surgical Tuberculosis," N.Y. Med. Jnl., XLI (January 17, 1885), 62; George Dalton Hays, "The Treatment of Pulmonary Diseases by Gaseous Enemata," ibid., XLVI (July 23, 1887), 91-95; Gilman Thompson, "The Fallacy of the So-Called Hot-Air Treatment of Phthisis," Trans. of N.Y.A.M., 2nd ser., VII (1891), 161; Biggs, "The Sanitary Supervision of Tuberculosis as Practiced by the New York City Board of Health," Am. Jnl. of Med. Sci., n.s., CIX (January 1895), 17; Biggs, "Question III. Through What Avenues Do the Bacilli of Tubercle Find Lodgment in the Lungs? Question IV. What Does Observation Prove Regarding the Likelihood of Bacillary Infection When There is No Constitutional Enfeeblement, Either Inherited or Acquired?" Transactions of the New York State Medical Association, III (1886), 277.

³⁷Dubos and Dubos, p. 66.

³⁸Chapin, What Changes has the Acceptance of the Germ Theory Made in Measures for the Prevention and Treatment of Consumption? pp. 3-7, 11-13, 44-47.

³⁹Prudden, "Occurrence of the Bacillus Tuberculosis in Tuberculous Lesions," Medical Record, XXIII (April 4, 1883), 397-400; Prudden, "On the Occurrence of Tuberculosis of Tubercles in Which the Bacillus Tuberculosis is Not Demonstrable by the Ordinary Method of Staining," ibid., XXIII (May 18, 1883), 517-723.

⁴⁰Winslow, The Contribution of Hermann Biggs to Public Health, pp. 83-85.

⁴¹New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for its Prevention, A Report to Mayor William L. Strong (Albany: Wynkoop Hallenbeck Crawford Co., 1897), p. 3; Biggs, Am. Jnl. of Med. Sci., n.s., CIX (January 1895), 18; Winslow, Life of Biggs, p. 85.

⁴²The complete report can be found as appendix II, in ibid., pp. 392-396.

⁴³New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for its Prevention, p. 4; Biggs, Am. Jnl. of Med. Sci., n.s. CIX (January 1895), 18.

⁴⁴Ibid.; Ann. Rep., Bd. of Health, 1893, pp. 24-25; Prudden, Sketches and Letters, p. 288; Biggs, British Medical Journal, II (1897), 631. The circular, entitled "Contagious Consumption: Rules to be

Observed for the Prevention of the Spread of Consumption," was the first step in what was to become a national, and eventually a worldwide, educational campaign against tuberculosis and paved the way for future literature of the sort. It represented the first decisive attempt made by any health department in the United States, and perhaps in the world, to control tuberculosis by direct public appeal. Winslow, Life of Biggs, pp. 86-87; Wilson G. Smillie, Public Health: Its Promise for the Future (New York: The Macmillan Company, 1955), p. 396; Edwards, Palmer, and Lowell, p. 10. For the sake of accuracy it should be noted that New York's leadership must be shared with Providence. Here too, in the same year, 1889, Chapin distributed thousands of circulars emphasizing the communicable nature of consumption. Cassedy, p. 127.

⁴⁵Koch, "An Address on Bacteriological Research," British Medical Journal, II (August 16, 1892), 383; Gardner Middlebrook, "The Mycobacteria," Bacterial and Mycotic Infections of Man, p. 506. Koch, secretly and without assistance, had begun the search for a cure for tuberculosis in 1886 at the University of Berlin. It was at this school (whose chair of hygiene he had accepted in 1885) that he lectured to public health officials and practitioners from around the world, including Welch and Prudden. Dolman, p. 425.

⁴⁶Ibid., p. 426; Joseph William Stickler, "A Consideration of Some of Professor Koch's Methods of Treating Pulmonary Tuberculosis," Medical Record, XXXIX (January 10, 1891), 44-47; Max Einhorn, "Koch's Method of Treatment for Tuberculosis, From Personal Observations in Berlin," ibid., XXXIX (January 10, 1891), 47-49; C. E. Quimby, "The Treatment of Pulmonary Tuberculosis," ibid., XXXIX (January 17, 1891), 73-76.

⁴⁷Until word of its disappointing performance had spread, physicians rushed to use "Koch's lymph." A certain Dr. Kinnicut had hurried to Prudden's laboratory to get pipettes small enough to measure doses to treat his hospitalized patients so that he could beat Dr. Jacobi in the race to become the first New York practitioner associated with the cure. Prudden, Sketches and Letters, p. 41.

⁴⁸See n. 46, and Karl Von Ruck, "Koch's Method for the Cure of Tuberculosis," Medical Record, XXXIX (May 16, 1891), 578; Ruck, "A Contribution to the Clinical Uses of Professor Koch's Remedy for Tuberculosis," ibid., XXXIX (May 23, 1891), 589-595; "The Lymph Treatment in New York," ibid., XXXIX (January 3, 1891), 21-22.

⁴⁹Middlebrook, p. 506; Spina, p. 152; Krause, "Some Phases of Resistance," The Journal of Outdoor Life, XVIII (February 1920), 33.

⁵⁰Dolman, pp. 426-427.

⁵¹Edward Trudeau, "An Experimental Study of Preventive Inoculation in Tuberculosis," Medical Record, XXXVIII (November 22, 1890), 568. Despite the "lymph" episode, Koch had preferred that he not be depended

on to come up with a preventive or curative. He had prophesied in his 1882 talk before the Berlin Physiological Society that "When the conviction that tuberculosis is an exquisite infectious disease has become firmly established among physicians, the question of an adequate campaign against tuberculosis will certainly come under discussion and it will develop by itself." Koch, American Review of Tuberculosis, XXV (March 1932), 323.

⁵²The "request" for the report was probably initiated by Biggs since his written response was dated the same day the Board allegedly called on him to prepare it. Ann. Rep., Bd. of Health, 1893, pp. 25-27.

⁵³Ibid. Efforts by governmental and voluntary bodies to deal with tuberculosis had already been initiated but were concerned, almost exclusively, with isolating the consumptive and providing him with a pleasant environment while nature took its course. In England, hospitals inspired by religious and philanthropic motives had been built for consumptives at the beginning of the nineteenth century. The first sanatorium was built in Prussia in 1853 and by 1888 France had similar facilities. In the United States private sanatoria were first erected in the 1870s; in 1884 Dr. Edward Trudeau, the "patron saint" of American consumptives, established the first such institution for the poor--the Adirondack Cottage Sanitorium--with funds provided by charitable contributions. Burke, p. 47; Flick, pp. 706-708; Robert G. Paterson, "The Evolution of Official Tuberculosis Control in the United States," Public Health Reports, LXII (1947), 337-338; Milbank Memorial Fund (New York, 1940), p. 7. Trudeau had a small laboratory, associated with his facility, for experimental work, but most such sanatoria did not. Trudeau, "The Treatment of Experimental Tuberculosis by Koch's Tuberculin, Hunter's Modification and Other Products of the Tubercle Bacillus," Medical News, LXI (September 3, 1892), 253-258. The first American voluntary anti-tuberculosis organization, the Pennsylvania Society for Prevention of Tuberculosis, was founded in 1892 (by Dr. Lawrence Flick) but it, like municipal and state health departments, had not yet come up with any innovative public health programs. Edwards, Palmer, and Lowell, p. 11; Burke, pp. 49-50.

⁵⁴Ann. Rep., Bd. of Health, 1893, pp. 26-27; New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for its Prevention, p. 4.

⁵⁵Palmborg, pp. 809, 357, 367-368, 377.

⁵⁶Ann. Rep., Bd. of Health, 1894, p. 96.

⁵⁷Ibid., pp. 96-97.

⁵⁸Ann. Rep., Bd. of Health, 1893, p. 27; Biggs, British Medical Journal, XX (1897), 63; Biggs, Am. Jnl. of Med. Sci., n.s., CIX (January 1895), 19.

⁵⁹Ibid.; Ann. Rep., Bd. of Health, 1894, pp. 93-94; New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for Its Prevention, p. 4.

⁶⁰Biggs, Am. Jnl. of Med. Sci., CIX (January 1895), 17-19.

⁶¹Flick, p. 709; "Tuberculosis and Boards of Health," N.Y. Med. Jnl. (March 3, 1894), 277; "Practical Measures in the Prevention of Tuberculosis," Medical Record, XLIV (October 14, 1893), 501; "Notification of Tuberculosis," ibid., XLIV (November 11, 1893), 640; "Registration of Tuberculosis," JAMA, XXII (March 17, 1894), 401.

⁶²Ann. Rep., Bd. of Health, 1894, pp. 95-98.

⁶³"A Report on Tuberculosis," JAMA, XXI (December 12, 1893), 992; "The Health Department and Pulmonary Tuberculosis," Medical Record, XLIV (December 23, 1893), 817; "Tuberculosis a Contagious Disease," ibid., 831-832. Biggs' efforts were presented to the public in a favorable light in Times, November 30, 1893, p. 8.

⁶⁴It should be noted that he was not the first to stress the importance of local health officials having vital information on consumptives. Shattuck, in 1849, strongly emphasized the value that a register of cases would have in providing local boards of health with clues as to the role of external circumstances in the transmission and causation of the disease. Shattuck, Report of a General Plan for the Promotion of Public and Personal Health . . . Relating to a Sanitary Survey of the State, a report prepared for the Massachusetts Sanitary Commission (Boston: Dutton and Wentworth, 1850), pp. 94, 182. Biggs' goal was to gather up-to-date information on all cases, not only so that medical inspectors could visit each patient but because, like Shattuck, he felt that such data could be used to produce epidemiological maps that would provide graphic aids that would contribute to a better understanding of the modes of extension of tuberculosis and perhaps suggest the measures needed for its suppression. Ann. Rep., Bd. of Health, 1894, p. 96.

⁶⁵Ibid., pp. 98-99. A random investigation of the health histories of a number of patients listed on their death certificates as having died of respiratory diseases other than tuberculosis revealed incidents of previous consumption. Embarrassed doctors were called in to explain such discrepancies. See Biggs, Am. Jnl. of Med. Sci., n.s. CIX (January 1895), 26.

⁶⁶The information was used solely for the purpose of sending the victim information--similar to the circulars distributed in New York in 1889--on how to avoid reinfecting himself and others. N.Y. Med. Jnl. (March 3, 1894), 277. A similar order was passed by the State Board of Health in Washington. JAMA, XXII (March 17, 1894), 401.

⁶⁷Medical Record, XLIV (October 14, 1893), 501; ibid., XLIV (November 11, 1893), 640; "The Proposed Action of the Board of Health in Reference to the Registration of Tuberculosis," N.Y. Med. Jnl. (February 17, 1894), 214-233; Flick, pp. 709-710; JAMA, XXII (February 17, 1894), 222-226, 262-268. The doctors raised the objection that to register consumptives as victims of a contagious disease would be to label them as social outcasts and add further burden to their already miserable lives. One practitioner feared that well-gathered tuberculosis data would create statistics that would evoke panic. Anonymity, he felt, was preferable to the alternative of identifying consumptives who would be "looked upon as peripatetic fountains of danger." Another colleague added that the disease was not hereditary and not at all communicable and could be controlled only by preventing the marriages of tubercular patients. Ibid., pp. 222-226. Although coming from the mouths of residents of the City of Brotherly Love, the protestations of the faction of physicians opposing registration were, one suspects, expressed for reasons other than simple humanitarianism. The outcome was that the Philadelphia Board of Health postponed registration and instead distributed rules on tuberculosis prevention and disinfected the premises in homes where death from consumption had occurred—expedients that the medical profession apparently could tolerate. Flick, p. 710; Annual Report of the Philadelphia Board of Health, 1894, pp. 72-78.

⁶⁸Daniel M. Fox, "Social Policy and City Politics: Tuberculosis Reporting in New York, 1889-1900," Bulletin of the History of Medicine, XLIX (Summer 1975), 177. The early 1890s saw the rise of a variety of occupational groups that sought special privileges in the control of some area of public life. Science had given rise to the "expert," and collectively the "experts" demanded that society recognize them and give them the exclusive right to control in their area of expertise. In light of such a trend, physicians had reason to fear any intrusions by public health workers. S. J. Kunitz, "Professionalism and Social Control in the Progressive Era: The Case of the Flexner Report," Journal of Social Problems, XXII (October 1974), 18-23.

⁶⁹Fox, pp. 177-178; Burrow, passim.

⁷⁰By comparison, the cooperation of doctors with the Health Department's diphtheria program brought them the advantage of a free, or inexpensive, antitoxin medication that led to dramatic recoveries and, consequently, the admiration of fee-paying patients. Moreover, there was no social stigma associated with the ailment so that there was no objection to its being reported. The contrasting reactions of the medical community in New York to the diphtheria and tuberculosis public health efforts is examined somewhat in Barbara Rosenkrantz, "Cart before Horse: Theory, Practice, and Professional Image in American Public Health, 1870-1922," Journal of the History of Medicine and Allied Sciences, XXIX (January 1974), 65-69. Rosenkrantz also detects certain common socioeconomic characteristics among public health supporters which contrast with those of the physicians who opposed them. See pp. 60-61.

⁷¹Ann. Rep., Bd. of Health, 1894, pp. 93-94; New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for Its Prevention, p. 4.

⁷²The operators of all public institutions, on the other hand, were "required" to furnish data on all tubercular patients under their observation. Ann. Rep., Bd. of Health, 1894, pp. 94-95.

⁷³Bottles for collecting sputa, and accompanying forms, were left at the drugstores already used as stations for the distribution and collection of diphtheria culture kits. Sputum samples were picked up by the collectors and examined microscopically at the bacteriological laboratory for tubercle bacilli; a report of the findings was then forwarded to the physician, free of charge. Ibid.; Ann. Rep., Bd. of Health, 1894, pp. 94-95.

⁷⁴The article suggested that Biggs considered his program a temporary one and that compulsory registration was not far off. If accurate, it is quite possible that he "leaked" this statement to test public and professional reaction. Sun, February 15, 1894, p. 2.

⁷⁵Times, April 27, 1894, p. 8.

⁷⁶"Examination of Sputum for Tuberculosis," Medical Record, XLVII (February 16, 1895), 204; "A Circular of Information to Physicians Regarding the Measures Adopted by the Board of Health for the Prevention of Tuberculosis in the City of New York," N.Y. Med. Jnl. (May 15, 1894), 574-575; "Tuberculosis Prevention," JAMA, XXII (May 12, 1894), 723.

⁷⁷A better sense of the tuberculosis problem can be gained from the yearly statistics of 1894 which show that the total of all deaths from the nine most fatal, of those designated as, infectious diseases--smallpox, measles, scarlet fever, diphtheria, whooping-cough, typhoid fever, influenza, cerebrospinal meningitis, and typhus fever--did not equal that of the figure for pulmonary tuberculosis alone. The contrast is even more startling when it is brought to mind that there were no exclusionary provisions in insurance policies regarding these nine ailments and that they were legally reportable; the yearly death toll from these infectious diseases--4,638 people--was surely a more accurate figure than that for phthisis whose devastation went beyond the 4,658 mortalities officially recorded. Ann. Rep., Bd. of Health, 1894, pp. 8, 73-74.

⁷⁸Ibid., p. 8.

⁷⁹Ibid., 1896, pp. 31-32; Biggs, "To Rob Consumption of its Terrors," Forum, XVI (February 1894), 758-762; Winslow, Life of Biggs, p. 136; Biggs, Am. Jnl. of the Med. Sci., n.s., CIX (January 1895), 17-27; New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the

Measures Recently Adopted for Its Prevention, pp. 1-4; Biggs, Trans. of N.Y.A.M., 2nd ser., XII (1895), 420-448.

⁸⁰"The Health Department and the Examination of Tubercle Bacilli," Medical Record, XLVII (October 19, 1895), 574; Biggs, Am. Jnl. of Med. Sci., n.s., CIX (January 1895), 26. Former New York City Commissioner, Dr. Cyrus Edson, insisted on establishing a similar program when he moved on to the New York State Board of Health. Ibid.

⁸¹Letter from Joseph Lister to Biggs, August 8, 1895, pp. 1-2; Prudden, Sketches and Letters, p. 290.

⁸²New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for Its Prevention, p. 6; Ann. Rep., Bd. of Health, 1895, p. 38. Five assistants (two clerks, one collector, and two laboratory aides) had been added to the laboratory staff in anticipation of a growing amount of diagnostic work. Bd. of Ald., Proceedings, CCXV (July 2, 1894-September 18, 1894), p. 191.

⁸³Times, December 15, 1894, p. 4; November 1, 1895, p. 4.

⁸⁴Christopher C. Yates, An Essay on the Bilious Epidemic Fever Prevailing in the State of New York (Albany: H. C. Southwick, 1813), pp. 7-9.

⁸⁵Ibid., pp. 10-48; Review of "An Essay on the Bilious Epidemic Fever Prevailing in the State of New York" (Albany, E. and E. Hosford for the author, 1813), pp. 7-44; David Hosack, Remarks on the Treatment of the Typhoid State of Fever (New York: Van Winkle and Wiley, 1815), pp. 3-11.

⁸⁶Bloomfield, pp. 2-4; Frederick Gay, "The Contribution of Medical Science to Medical Art as Shown in the Study of Typhoid Fever," University of California Chronicle, XVIII, no. 2 (1916), p. 11. Louis' work was translated into English but received little attention from the American medical community. Reginald Heber Fitz, Typhoid Fever at the Massachusetts General Hospital During the Past Seventy-Eight Years. Mortality; Intestinal Haemorrhage; Perforation; Relapse (1902), p. 1.

⁸⁷Bloomfield, p. 5.

⁸⁸Nathan Smith, A Practical Essay on Typhous Fever (New York: E. Bliss and E. White, 1824), pp. 16-17.

⁸⁹W. W. Gerhard, "On the Typhus Fever which Occurred at Philadelphia in Spring and Summer of 1836; Illustrated by Clinical Observations at the Philadelphia Hospital; Showing the Distinction between this Form of Disease and Dothinteritis or the Typhoid Fever with Alteration of the Follicles of the Small Intestine," Am. Jnl. of Med. Sci., XIX (1836), 289-322; Park, "The Bacteriology of Typhoid Fever," Medical News, LXXV (December 16, 1895), 609; Fitz, p. 1.

⁹⁰Elisha Bartlett, The History, Diagnosis and Treatment of Typhoid and of Typhus Fever (Philadelphia: Lea and Blanchard, 1842), passim. An active and effective champion of the contagion concept of infectious disease and, particularly, the transmissibility of typhoid fever was William Budd--British physician, bacteriologist, and sanitary investigator. His studies provided strong evidence that fecal matter was an important source of infection and that milk and contaminated water were likely sources of its proliferation. William Budd, Typhoid Fever: Its Nature, Mode of Spreading, and Prevention (London: Longmans, Green and Co., 1873), pp. 120-147; Gay, University of California Chronicle, XVIII, no. 2 (1916), 12; Dubos, "The Evolution of Medical Microbiology," Bacterial and Mycotic Infections of Man, p. 620; Dolman, "William Budd," Dictionary of Scientific Biography, II, pp. 574-576.

⁹¹Keen, The Annals of the American Academy of Political and Social Science, LXXX (November 1918), 18; Fitz, p. 14.

⁹²Ibid.; W. H. Thomson, "On the Treatment of Typhoid Fever," Medical Record, X (October 30, 1875), 739; "Therapeutic Hints," ibid., XLIV (November 25, 1893), 699; "The Cool Bath in Typhoid Fever," ibid., XLIV (August 26, 1893), 281. Dr. W. H. Thomson, professor of Materia Medica and Therapeutics at the University of the City of New York, was one of those who considered typhoid contagious but likened it to a man on a runaway horse, that is, uncontrollable. Thomson, ibid., X (October 2, 1875), 673.

⁹³Ebert taught histology and embryology at the University of Zurich's school of veterinary medicine and was instrumental in the 1870s, along with Klebs and a small number of others, in bringing the knowledge of bacteria, in which the French had taken the lead, to the attention of German scientists. He had already published some papers in Virchow's Archiv fur Pathologische Anatomie when he began the study of typhoid fever in 1879. He examined twenty-three cases of the disease and in twelve found distinct rod-like organisms which he assumed bore a causal relationship to the inflammatory condition he had observed in the spleen and intestinal lymph nodes they inhabited. Ebert did not actually isolate and cultivate the typhoid bacilli (*Salmonella typhosa*, originally known as *Eberthella typhosea*) and so shares the honors of discovery with Georg Gaffky. Biggs, "The Advance in Our Knowledge of Typhoid Fever," Medical News, LXXV (November 11, 1899), 609; Gay, p. 14; Acknernecht, A Short History of Medicine (New York: The Ronald Press, 1955), p. 167; Gert H. Brieger, "Carl Joseph Ebert," Dictionary of Scientific Biography, V, pp. 276-277. Gaffky was one of the first two assistants (the other was Loeffler) assigned to Koch soon after the founding of the Imperial Health Office. Koch had been able to distinguish and photograph masses of bacilli which he felt caused typhoid but, like Ebert, had found them in less than one-half of the cases he examined. For several years Gaffky experimented with different cultural methods and was finally able to isolate the disease-causing microbes in pure cultures and definitely distinguish them from similar appearing bacilli that were secondary invaders of typhoid-damaged tissues. Gaffky,

"Zur Aetiologie des Abdominaltyphus," Mittheilungen aus dem Kaiserlichen Gesundheitsamte, II (1884), 372-420; Gay, p. 4; Gloria Robinson, "George Gaffky," Dictionary of Scientific Biography, V, pp. 219-220. In 1884 Gaffky was able, for the first time, to grow the typhoid bacilli successfully outside the human body. His improved staining methods made it possible to confirm Ebert's work so that he is often considered a co-discoverer of the germ. Gay, p. 14; Acknerknecht, A Short History of Medicine, p. 67; Biggs, Medical News, LXXV (November 11, 1899), 609.

⁹⁴In New York typhoid fever continued to be responsible for snuffing out the lives of several hundred each year and causing extreme pain and the temporary debilitation of countless more. Ann. Rep., Bd. of Health, 1879, p. 166; 1895, p. 10; 1898, pp. 216-217. The case histories of Dr. Francis Delafield graphically depict the cataclysmic effects that typhoid fever had on those in its clutches and the virtual helplessness of the physician. Delafield, "Case Reports of Typhoid Fever, 1874-1903," two volumes of case histories in the files of the New York Academy of Medicine, passim.

⁹⁵Rosenkrantz, Public Health and the State, Changing Views in Massachusetts, 1842-1936, pp. 99-104. Interest in typhoid fever had become something of a tradition in Massachusetts as Lemuel Shattuck, the pioneer force in the public health movement in that state, had studied under Louis and translated his classical work on typhoid for American physicians. Fitz, p. 2. His successor Sedgwick's major concern was the devising of filtering and straining mechanisms to remove the pathogenic microbe from the state's waterways. A graduate of Johns Hopkins University, Sedgwick taught at the Massachusetts Institute of Technology--while a consulting biologist to the State Board of Health--where he started a short lecture course on bacteriology to those students who were contemplating entering medical school after graduation. Sedgwick, "Investigation of Recent Epidemics of Typhoid Fever in Massachusetts," Massachusetts State Board of Health Annual Report, 1892, pp. 665-742; Paul F. Clark, Pioneer Microbiologists of America (Madison: University of Wisconsin Press, 1861), pp. 109-111.

⁹⁶Rosenkrantz, Public Health and the State, Changing Views in Massachusetts, 1842-1936, pp. 104-105. Biggs, it is recalled, was involved in a similar incident in Plymouth, Pennsylvania in 1885, and with similarly disappointing results. See above, pp. 27-28.

⁹⁷Ibid., p. 104.

⁹⁸Gay, p. 15; Rene Dubos, Louis Pasteur, Free Lance of Science (Boston: Little, Brown, and Company, 1950), pp. 271-272. Von Pettenkofer's views were investigated, and generally confirmed, by a special committee to the Section on State Medicine of the American Medical Association whose report, entitled "Relations of Meteorological Conditions to the Origin and Prevalence of Acute Diseases," appeared in Sanitarian, CCLSVI (January 1892), 3-10.

⁹⁹Dubos, Louis Pasteur, Free Lance of Science, p. 272.

¹⁰⁰Ann. Rep., Bd. of Health, 1879, p. 166; 1895, p. 10. The disease typically caused lung congestion, vomiting, ruptured and perforated organs, soaring body temperatures, blood filled cavities, emaciation, delirium, and often early death. The best a conscientious physician could realistically hope to do was to relieve the suffering. Delafield, "Case Histories of Typhoid Fever, 1874-1903," I, pp. 7-39; II, pp. 3-44; Herbert Morgan, "The Enteric Bacteria," Bacterial and Mycotic Infections of Man, pp. 626-627.

¹⁰¹"Faults of Human Drainage," Medical News, XLVIII (April 3, 1886), 381-382; Times, July 24, 1894, p. 9.

¹⁰²Ibid., February 11, 1895, p. 4; July 26, 1895, p. 4; March 18, 1896, p. 4.

¹⁰³Duffy, A History of Public Health in New York City, 1866-1966, pp. 162-163; Oscar Handlin, The Uprooted (New York: Grosset and Dunlap, 1951), pp. 201-206.

¹⁰⁴R. Pfeiffer and W. Kolle, "Experimentelle Untersuchungen zur Frage der Schutzimpfung des Menschen gegen Typhus abdominalis," Deutsche Medicinische Wochenschrift, XXII (November 12, 1896), 735-737; Biggs, Medical News, LXXV (November 11, 1899), 610; Dubos, "The Evolution of Medical Microbiology," Bacterial and Mycotic Infections of Man, p. 11.

¹⁰⁵Ibid.; Rosen, A History of Public Health, p. 331; Ferdinand Widal, "Sérodiagnostic de la Fièvre Typhoïde," Semaine Medicale, XVI (1896), 259. The latter work represented the practical beginnings of serum diagnosis. Although the test is named after Widal, the real groundwork was done by Gruber and Pfeiffer. Not surprisingly, the Frenchman Widal made no mention of the two Germans in his short paper. See ibid.

¹⁰⁶Park, on the other hand, maintained a spectator's interest, but a personal one, in the early anti-typhoid activities of the laboratory as he had suffered a near fatal attack of the disease in August and did not return to his work until November of 1896. Oliver, pp. 153-155.

¹⁰⁷Biggs, British Medical Journal, II (1897), 630; Frederick Gorham, "Bacteriology and Public Health," A Half Century of Public Health, ed. Mazyck Ravenel (New York: American Public Health Association, 1921), p. 88.

¹⁰⁸Ann. Rep., Bd. of Health, 1896, pp. 30, 232; Biggs, "The Serum-Test for the Diagnosis of Typhoid Fever, with a Description of the Methods Followed and the Results Obtained in its Use in the Laboratories of the Health Department of New York City," Am. Jnl. of Med. Sci., n.s., CXIII (March 1897), 281-283.

¹⁰⁹Ann. Rep., Bd. of Health, 1896, pp. 232-233.

¹¹⁰From 1897 through 1899, the laboratory conducted 4,114 Widal tests. Ann. Rep., Bd. of Health, 1897, p. 38; 1898, p. 83; 1899, p. 72.

¹¹¹Biggs, Am. Jnl. of Med. Sci., n.s., CXIII (March 1897), 283-292; Park, Medical News, LXXV (December 16, 1895), 791-795. The agglutination test for typhoid fever was soon adopted by state and local health departments throughout the country. Charles E. Simon, "The Importance of Laboratory Methods in Diagnosis," Maryland Medical Journal, XXXVI (January 23, 1897), 257-261; Jerome B. Thomas, "Serum Diagnosis of Typhoid Fever, with Reports of Fifty-Seven Cases Tested for the Reaction by Examining Specimens of Dried Blood," Medical News, LXX (April 13, 1897), 422-428; Delaware Bacteriological and Pathological Laboratory, Special Bulletin A (1901), p. 3. European public health laboratories were to employ the technique too but they, as a rule, were not quick to implement diagnostic procedures as were municipal and state laboratories in America. Robert H. Pary, "Health Centers in Their Relation to Social Medicine and Public Health," Modern Trends in Public Health, p. 523; Welch, Public Health in Theory and Practice (New Haven: Yale University Press, 1925), p. 390. The procedure, under the best laboratory conditions, had an accuracy of about 75 percent. Biggs, Am. Jnl. of Med. Sci., n.s., CXIII (March 1897), 290; Park, Medical News, LXXV (December 16, 1895), 795. Physicians were encouraged to send in feces and urine samples, from dubious and convalescent cases, to the laboratory where they were examined by Dr. Alfred A. Hess--a new addition to the laboratory staff--who was assigned the task of devising a technique to differentiate the typhoid bacilli from other related strains from such specimens. The successful result was the "Hess method" which joined the other free diagnostic procedures offered to the physicians of New York City. Ibid., p. 292; Biggs, Medical News, LXXV (November 11, 1899), 611; "The Clinical Value of the Widal Test," Medical Record, LII (December 4, 1897), 826-827; Ann. Rep., Bd. of Health, 1897, p. 38; 1898, p. 83; 1899, p. 72. The diagnostic tests proved to be a boon during the closing weeks of the Spanish-American War, during which time the work of the laboratory doubled as a large number of sick soldiers were stationed in and around the New York area. Ibid., 1898, p. 83.

¹¹²Biggs, Am. Jnl. of Med. Sci., n.s., CXIII (March 1897), 288, 294.

¹¹³Ann. Rep., Bd. of Health, 1896, p. 216; Oliver, pp. 141-152, 157-158. Park's letter of commission introduced him as the Assistant Director of the Hospital Bacteriological Laboratory of the New York City Health Department and requested that all courtesies be shown him. Charles G. Wilson, Letter of introduction to Great Britain, France, and Germany, April 29, 1897. Park visited the Pasteur Institute and spent a few days in Berlin but was unable to meet Koch and Pfeiffer, who were away in India at the time. Oliver, pp. 157-158.

¹¹⁴Ann. Rep., Bd. of Health, 1895, p. 38. The obligation of public health authorities to protect the community from smallpox with preventive inoculations was already a well-established tradition when an 1874 law was enacted to provide the funds for a permanent corps of vaccinators in New York City. Duffy, "Science and Medicine," Science and Society in the United States, pp. 110-114; Wain, pp. 194-195; Minutes of the Proceedings of the National Quarantine Convention, p. 50; President Chandler and the New York City Health Department, 1866-1883, p. 10. The long, fought-out battle over whether human or bovine lymph was most efficacious and safest led to some vacillation, but by 1876 a cow farm in New Jersey came under the direction of the Health Department and served as the site for the manufacture of vaccine. After a number of changes of location the animals were moved to Forty-Fourth Street. M. Guerin, "Progress of Medical Science," Medical Record, V (March 1, 1870), 34; Ann. Rep., Bd. of Health, 1896, p. 234.

¹¹⁵Formerly the serum underlying smallpox vesicles on the backs of animals was extracted and dried on quills or ivory points. The European method was to use the pulp of the vesicle in a homogeneous glycerin mixture. Biggs tested both on children and found that glycerinated pulp provided a higher percentage of successful vaccinations. Ibid., pp. 25, 217, 235.

¹¹⁶Ibid., p. 235.

¹¹⁷Dolman, Dictionary of Scientific Biography, VII, p. 424; Dubos, Pasteur, Free Lance of Science, pp. 341-342.

¹¹⁸Ann. Rep., Bd. of Health, 1896, p. 235.

¹¹⁹Ibid., p. 226. The bacterial origins of tetanus and the basic techniques for the production of an antitoxin were discovered during the mid-1880s. Although the disease still occasionally occurred following childbirth and lacerated wounds, the advent of aseptic and anti-septic surgery had cut down tremendously on its incidence. Ackerknecht, A Short History of Medicine, p. 167; "The Treatment of Tetanus," Am. Jnl. of Med. Sci., n.s., CV (February 1893), 188; Park, "Contribution of Bacteriology to Therapeutics," Pediatrics, IV (November 1, 1897), 390. The manufacture of the antitoxin was complicated by the fact that the toxin was unstable and undependable and the strength of the antitoxin difficult to standardize or control. Using pure tetanus cultures obtained from the British Institute of Preventive Medicine, Park and his associates attacked the problem and conducted 171 separate tests to find the safest procedures for handling the sensitive toxin and yet still managed to send out 3,930 cc. of the curative for the immunization of human patients and animals, free of charge to all public institutions and for sale to physicians at Health Department offices. Ibid., p. 229.

¹²⁰Ibid., pp. 9, 227.

¹²¹Ibid., pp. 227-229.

¹²²Biggs summarized the results of the study, carried out primarily by Park and Williams, in the Annual Report for 1896 and in two nationally circulated medical journals. The object lesson was clear: physicians were presented with strong evidence that, despite their training and past beliefs, they could no longer depend on the diagnostic supposition that diphtheria was always found in conjunction with a false membrane. Practitioners were cautioned by Biggs that they could therefore not do it alone--they needed the assistance of the laboratory and were arrogant to believe otherwise. Biggs, "Some Investigations as to the Virulence of the Diphtheria Bacilli Occasionally found in the Throat Secretions in Cases Presenting the Clinical Feature of Simple Acute Angina," Ann. Rep. Bd. of Health, 1896, pp. 278-281; Biggs, Am. Jnl. of Med. Sci., n.s., CXII (September, 1896), 411-414; Biggs, Transactions of the Association of American Physicians, XI (1896), 249-251.

¹²³Ann. Rep., Bd. of Health, 1896, pp. 31, 217, 231. Some of the enthusiasm for serum treatment was created by developments in this direction at the Pasteur Institute and were instigated by Anna Williams who had been sent there for a few weeks of study. At the Institute, where immunology had become something of a specialty, she was taught the fine points of rabies diagnosis and worked alongside Marmorek, who was involved in investigations on what was thought to be a streptococcus antitoxin. Oliver, pp. 141-152; Dubos, Pasteur, Free Lance of Science, p. 261; Ann. Rep., Bd. of Health, 1896, p. 216.

¹²⁴Ibid., pp. 231-232.

¹²⁵The greatest pressure was on Alfred Beebe who, in performing diagnostic work with his staff of technicians, had time limitations on his efforts that the research people did not. After he was granted two additional laboratory attendants, he complained bitterly that the increase in working force was not enough and that "this work has been very onerous on all concerned during the greater part of the year." Ibid., pp. 215, 225. The work he referred to had accelerated from previous years and seemed to justify his unhappiness. His subdivision in 1896 conducted 10,293 bacterial diagnoses of cases of suspected diphtheria, 13,113 secondary bacterial examinations of specimens from diphtheria convalescents, 1,856 examinations of sputum for the germ of tuberculosis, and 1,643 examinations of samples from healthy throats in infected families. Ibid., p. 214. The exact amount of help Beebe had is difficult to determine. The division of bacteriology listed six laboratory aides (three as assistants, three as attendants) for 1896, but did not make it clear how they were apportioned between the research and diagnostic facilities. Ibid., p. 9; Bd. of Ald., Proceedings, CCSSIII (July 6, 1896-September 9, 1896), p. 306. Considering the tediousness of microscopic examinations and the care that must be taken when conducting diagnoses on which human lives may hinge, even in the unlikely event that all six aides assisted Beebe, the climate in the Criminal Court building laboratory must have been hectic. By way of contrast, the Division of Foods Inspection, Offensive Trades, and Mercantile Establishments had, for the same year, 1896, twenty-five

non-physician inspectors of milk, fruit, meat, fish, offensive trades, and mercantile establishments. Ann. Rep., Bd. of Health, 1896, p. 8.

¹²⁶Ibid., pp. 217-218, 222-223, 233-234.

¹²⁷Ibid., pp. 226-234.

¹²⁸There was precious little expertise among the newly hired Assistant Bacteriologists so that the appointed tasks bore little relation to past histories. Alexander Lambert, for example, had written his graduate thesis at the College of Physicians and Surgeons on the physiological effects of magnesium and while in practice did a study of sunstroke. See Lambert, "Some Investigations Concerning the Physiological Action of Magnesium Salts," (unpublished thesis, College of Physicians and Surgeons, 1888); Lambert, "Sunstroke as It Occurred in New York in 1896," Medical News, LXXI (July 24, 1897), 97-109. Once a member of the Laboratory staff he conducted tetanus experiments, investigations which helped lay the groundwork for a distinguished career in pharmacology. Lambert, "A Study of Tetanus and Its Treatment," N.Y. Med. Jnl. (June 5, 1897), 414-416; Who's Who in New York City and State, 1905, p. 531.

¹²⁹The blood "expert," Billings, for example, had been given the specific job of disproving the allegations of Winters that diphtheria antitoxin had harmful effects upon red blood corpuscles. This he did using blood samples from immunized inmates at the New York Juvenile Asylum, and yet too, also gave some assistance in the examination of diphtheria bacilli cultures. Billings, "The Blood Corpuscles in Diphtheria: With Especial Reference to the Effect Produced Upon Them by the Antitoxin of Diphtheria," Ann. Rep., Bd. of Health, 1896, pp. 297-311; ibid., p. 278. When in 1894 the Health Board submitted its annual money request to the Board of Estimate it distinguished between diphtheria work, tuberculosis work, and research. This was perhaps done with the hope that by identifying the laboratory with specific, well-known diseases, the politicians on their Board would give more generously of the public funds in their command. Bd. of Ald., Proceedings, CCXV (July 2, 1894-September 18, 1894), p. 191. This tack, however, was soon dropped. Ibid., CCXIX (July 1, 1895-September 30, 1895), p. 443; ibid., CCXXIII (July 6, 1896-September 9, 1896), pp. 305-306.

¹³⁰Biggs, Trans. of N.Y.A.M., 2nd ser., XII (1895), 420-448; Biggs, Am. Jnl. of Med. Sci., n.s., CXII (September 1896), 411-414; Biggs and Guerard, "The Use of Antitoxic Serum in the Treatment of Diphtheria under the Supervision of the New York City Health Department, with a Resume of Published Reports on this Subject," Medical News, LXIX (December 12, 19, 26, 1896), 677, 713, 723; Biggs, "Antitoxine in Diphtheria," Maryland Medical Journal, XXXVI (February 1897), 295-298; Biggs, "The Relative Strength of Diphtheria Antitoxin Serum," Lancet (August 22, 1896), 558-559; Biggs, "Discoveries in Bacteriology," The Independent, XLIX (October 9, 1897), 4-5.

¹³¹Ann. Rep., Bd. of Health, 1896, p. 24.

¹³²Guerard and Wilson were graduates of Bellevue Medical College while Agramonte and Hiss were products of New York's College of Physicians and Surgeons. Med. Dir., N.Y., 1899, pp. 11, 64, 76, 83; 1903, p. 85; Who's Who in New York City and State, 1909, p. 671. Biggs had probably come into contact with the former two in his capacity as Professor of Pathological Anatomy (after 1895, Professor of Therapeutics and Clinical Medicine) and heard of the latter two through Prudden. Biographical sketch of Herman Biggs, with annotations in the hand of Biggs, p. 1; Prudden, Sketches and Letters, p. 86.

CHAPTER 4

TIMES OF CONFLICT

One of the newly appointed Assistant Bacteriologists put immediately to work was Arthur Guerard. Biggs had never lost sight of his goal of fighting tuberculosis and was growing impatient with the refusal of public institutions to report cases, as required, with the reluctance of physicians to do so voluntarily, and with the relatively small number of sputum samples sent to the diagnostic laboratory.¹ A communication presented to the Health Board pointing out the dangers of the transmission of consumption and other diseases through expectoration led to the adoption of an anti-spitting ordinance to the Sanitary Code; this, though, was only a minor stopgap as Biggs was making preparations for more drastic actions.² His annual report from the bacteriological laboratory, for 1896, carried the following notice:

The time appears to be rapidly approaching when measures, more active than those now in force, may be properly inaugurated with a view to more efficiently control the spread of tuberculosis in this city. Having in mind its paramount duty as a conservator of the public health, this Department cannot fail to recognize the fact that, while pulmonary tuberculosis is a communicable, and therefore preventable, disease, it is not legally so declared in the Sanitary Code, and that the Department is therefore unable, until after amendments are made to its Sanitary Code, not only to compel its registration in common with other infectious diseases, but to properly care for sufferers from the disease (whose helplessness or ignorance makes them potent factors in the spread of infection). The problem presented is undoubtedly difficult of solution, and no step should be taken without the most careful consideration; but that definite action must soon be taken cannot be controverted.

In taking such action, the Department will not only be fulfilling its plain duty, but it is believed that this will meet with the approbation of the public at large, and of the best element of the medical profession in this city.³

Despite his position that execution of anti-consumption maneuvers would be greeted with general and professional acclamation, Biggs knew that confrontation was inevitable. The basic issue of whether tuberculosis should become a notifiable disease was based on the assumption that it was truly contagious, a view that was still hotly and vociferously contested.⁴ Guerard, accordingly, was assigned the task of providing statistical, epidemiological confirmation of the communicability of pulmonary tuberculosis.

The result of Guerard's mission was a ward-by-ward, street-by-street, building-by-building breakdown of the distribution of consumption in the city.⁵ His findings, released as a product of the bacteriological division, did not contain conclusions arrived at upon the completion of traditional laboratory research techniques. No experimentation was involved, no inductive reasoning was employed, no controls were sought; its purpose was to justify a preconceived belief--the "study" was, quite simply, a polemic.⁶

The data indicated that 42 percent of the deaths from tuberculosis occurred in 23 percent of the homes making up just 5 percent of the total dwellings in the city. Not surprisingly, the centers of infection were chiefly found in overcrowded homes, rear tenements, and dilapidated buildings inhabited by the immigrant poor.⁷

In light of what he considered the overwhelming evidence of the infectiousness and communicable nature of consumption, Biggs was irritated with the influence of old views and prejudices which he felt created the hesitation and trepidation of authorities to exercise some means of sanitary supervision of the malady. Public health officers, in

his view, lacked the "full courage of scientific conviction."⁸

Hoping to redress this situation, Biggs and Prudden submitted a letter, on January 11, 1897, on the status of pulmonary tuberculosis in New York City to Health Commissioner Wilson. After pointing out the need for more treatment facilities for the indigent, it recommended that an amendment be added to the Sanitary Code declaring consumption a communicable disease and that regulations be formulated under which its surveillance could be exercised.⁹ On January 12, the Health Board approved the suggestions and a week later added a section to the Sanitary Code requiring physicians to report to the Health Department the name, address, age, sex, and occupation of every case of pulmonary tuberculosis under their observation.¹⁰

Notification of the existence and location of consumptives would, it was stressed, enable the Department to speed disinfecting units to homes vacated by their deaths or transfers to institutions. Health Department inspectors would direct the removal of infected articles for disinfection and issue orders to the owners of the premises that the quarters be cleaned and renovated. Compliance, it was emphasized, would be enforced, but the assurances were given that the Department would not carry out this policy "among the higher classes of the community, especially those dwelling in private houses." Circulars were to be given to consumptives to inform them of the communicability of their affliction but, again, this would be enforced only when the sufferer resided in a tenement or lodging house.¹¹

Biggs apparently assumed that New York's physicians would not object too strenuously to notification of all tubercular patients if

they received assurances that the "better elements" of society, i.e., their more affluent patients, would not be forced to adhere to the Department's restrictive regulations. The poor, on the other hand--it was conjectured most would agree--required close supervision.¹²

Why Biggs wanted the registration of all consumptives is not entirely clear. Knowledge of the extent and distribution of cases had been of enormous consequence in the diphtheria investigations and, perhaps, it was hoped that similar data would aid in the battle against tuberculosis. Even if no particularly effective line of experimentation had yet suggested itself, the compulsory registration of phthisis victims was deemed a useful preliminary step in any venture by the laboratory division to seek out means to combat the pestilence.¹³

The response of the medical community was rapid, often hostile, and almost unanimous in its opposition to the regulation.¹⁴ A special eight-man committee on tuberculosis of the New York Academy of Medicine hastily increased its membership and met on January 21 to deal with the matter. Readily conceding that the ailment was communicable and that more stringent means were called for to protect the public, the committee nonetheless recommended that the Board of Health delay enforcement of compulsory notification, although it presented no specific justification for postponement.¹⁵

An editorial appearing a few days later in the Medical Record was far less diplomatic. Branding the regulation as "offensively dictatorial," of a "defiantly compulsory nature," and "obnoxious," it predicted--and in fact, brazenly attempted to incite--the opposition of local physicians and their resistance to any efforts to bring about

compliance to the order. Citing some concern for the personal liberty of consumptives, the thrust of the hostility was clearly directed against what was considered meddling in the private physician's management of his patients and the insinuation that, although a professional, he was incapable of encouraging the correct precautionary means to prevent further transmission of the disease.

The hated edict of the Sanitary Code was correctly associated with Biggs and hence the municipal bacteriological laboratory. The editorial noted that the laboratory division had done much good work but accused the members of the Board of Health of seeking public applause at the expense of the medical community by "unduly magnifying the importance of its bacteriological department."¹⁶

The New York County Medical Society followed suit and came out against compulsory reporting after wrestling with the idea of supporting it with the provision that health inspectors be forbidden to visit or have any communication with consumptive patients.¹⁷ Petitions of opposition were drawn up and presented to the mayor by members of the medical profession while the editors of the Journal of the American Medical Association, after professing their support for anything that would aid in the war against tuberculosis, declared themselves in sympathy with the position of New York's doctors.¹⁸

As the battle dragged on there surfaced indications of the animosity certain practitioners held for laboratory investigators. The sentiment was nothing new and was an outgrowth of the belief of clinicians that they were closer to the real source of human disease than experimenters. Laboratory workers were regarded by some as little more than

well-trained technologists who became so involved in scientific abstractions as to lose sight of the real needs of the sick. Furthermore, the scientist was generally unable to provide the quick and simple solutions to medical problems that physicians sought and often seemed to come up with findings that were contradictory to experience or answers that were evasive.¹⁹ In such a vein the editor of the Medical Record bristled at the thought of mandatory rules founded purely on bacteriological research.²⁰ In a letter published in the same journal the medical caste system was evoked by a physician who objected to any interference in his relationship with his patients by "some clever bacteriologist, who is expert with the microscope and test tube, but who has not sufficient knowledge of human nature to secure a living outside the laboratory in which he is engaged."²¹ A Dr. Clinton Walker was certain that pulmonary tuberculosis was not contagious and was convinced that a large number of physicians engaged in medical practice agreed "not including, of course, those whose experience is limited to the four walls of the bacteriological laboratory."²²

Such extreme expressions of acrimony and sarcasm were not typical--at least not publicly so--and there are even some published reports supportive of compulsory registration and the municipal laboratory with which it was linked.²³ The local newspapers too backed the measure and were certain that it would meet with public approval.²⁴ Nevertheless, the mood of the medical community remained, on the whole, adamant and bitter; not a dissenting vote was cast when the New York County Medical Society voted to come out against the compulsory reporting of tuberculosis cases.²⁵

Biggs had, from the start, anticipated an antagonistic reaction from the doctors and was aware of their general suspicions of the competency and motives of the researcher and their distaste for any issuance from the laboratory that seemed to threaten their autonomy.²⁶ A number of circulars of information were released from the laboratory which, while strongly reaffirming the necessity for the notification of consumptives, were of a conciliatory tone. Physicians were informed of the existence of collection centers where they could leave sputum samples for examination and were reminded that this free service could be of tremendous value in helping them in their diagnoses of pulmonary tuberculosis in its early stages. Reassurances were given that there would be no interference with their private cases by any Health Department employees.²⁷ Nevertheless, and as future events would show, the atmosphere had been poisoned and a reciprocal sense of trust which would have been to the mutual advantage of the medical community and municipal laboratory, as well as of benefit to the public health, did not exist.

The intensity of the conflict was largely a consequence of timing. The first positive steps toward improving the level of medical education and the quality of physicians had begun, and a concerted effort was underway by medical groups to improve the prestige of the practitioner and to build public confidence in the profession.²⁸ During such a sensitive period physicians were generally in no mood to be directed by researchers whose methods they did not always comprehend and whose recommendations they did not necessarily trust.

The diphtheria program had irritated some because of its ambitiousness and its implications of the physician's dependence on the

laboratory for accurate diagnoses and for the production of the most effective medication for prevention and treatment; involvement with the Health Department laboratory was, however, essentially voluntary. In the case of tuberculosis registration the doctors were ordered to carry out an activity they despised by an edict which was clearly identified with the chief of the bacteriological division and which, to their thinking, hatched from the municipal laboratory.

Biggs never retreated from his position and responded to the barrage of criticism directed against him and his division in two talks delivered a few days apart in late 1897. In these addresses, in which glowing references to the English and German health systems were made, Biggs called for an increase in the responsibilities and powers of public health authorities and envisioned the laboratory as playing a pivotal role in the scheme. Strong hints were given that the medical profession and Health Department could come to a mutually satisfactory arrangement: allow public health officials to attempt to educate the masses on matters related to communicable ailments, cooperate with their efforts to enforce compulsory reporting, accept the necessity of removing patients from their homes and placing them in public hospitals, and the Health Department, through its bacteriological laboratory, would provide the physicians with "the knowledge of the most recent discoveries in regard to the infectious diseases and the means for their restriction, prevention, and cure." Furthermore, the status and monetary advantages that could be derived were pointed out with the assertion that the laboratory could furnish the general practitioner without charge, "such expert assistance and special information as may be useful to him in clinical work,

which could not be otherwise obtained, excepting at greatly increased trouble and considerable expense."²⁹

The single most important commodity a community possessed, Biggs declared, was the good health of its inhabitants. Drawing his inspiration, one suspects, from the German role model, he asserted that sanitary officials had, to a very great extent, the community's general welfare in their hands and consequently had to be allowed considerable freedom to deal with all matters related to the public health. Infectious diseases were among the most prevalent and detrimental of all the factors standing in the way of the general well-being and therefore had to be given particular attention. Continuing, he noted that effective measures for dealing with contagion could be within the grasp of municipal sanitary authorities if they were furnished the resources to conduct experimental investigations and to provide assistance in diagnosis and disease prevention and treatment. Once this step was completed, Biggs predicted, the only remaining major obstacles to the initiation of productive health services were the ignorance of the public--which however could be largely neutralized by educational campaigns carried out through the distribution of circulars of information among the tenement population--and, more importantly, as was learned, in New York, the lack of cooperation and the intransigence of the medical profession. The physicians were warned that it was inevitable that in certain situations their self-serving motives and the goals of health officials would be widely divergent; however, since the latter had the welfare of the entire population to consider, in Bentham-like terms he proposed that "the greatest good for the greatest number" would serve as the first rule

of action and the views of public health officers would, in such instances, always have to prevail.³⁰ Considering the benefits of a healthy citizenry it followed--unequivocally as Biggs surmised--that sanitary officials had legitimate, autocratic powers that they were duty bound to evoke against hindrances to the attainment of this end.³¹

Coming on the heels of the tuberculosis notification controversy, Biggs' words were taken literally in medical circles and led to a concerted effort to reverse the registration requirements and reorganize the Health Department to the advantage of the city's private practitioners through, among other devices, emasculation of the bacteriological laboratory.

In late January 1898, a bill was placed before the New York State Legislature by Senator Brush proposing to enumerate specifically what diseases the Health Department could require to be reportable--pulmonary tuberculosis, needless to say, was not on the list.³² The Brush Bill, as it became known, had been formulated by a committee of the New York County Medical Society, in the fall of 1897, and had been approved by a majority of its members. Its contentions that consumption was so widespread as to make any attempts at its elimination a "Utopian dream" and that recommendations for its compulsory notification were ludicrous, coming as they had from laboratory men with no experience in treating the sick, were ridiculed in the press.³³ The Times, reflecting the views of the respectable classes, and thus favorably disposed to any procedure that might help to bring about stricter control over the immigrant masses, lashed out against what it considered the "politico-mercenary" attack on the Health Department and labeled the membership

of the New York County Medical Society as the "eminence of disgrace."³⁴ In an effort to have the bill killed Nathan Straus, health commissioner and president of the Board of Health, sought the support of renowned tuberculosis authority Dr. Edward Trudeau, who responded with a long statement to the legislators that characterized the drive to eliminate consumption from the list of reportable ailments as a "return to barbarism."³⁵

A greater menace to the bacteriological laboratory than the provision that would have reduced its access to data on the extent and location of tuberculosis cases was the section of the bill that called for the discontinuation of its production and sale of antitoxins and vaccines; this proposal loomed as a potential threat to its very existence, as its sponsors were well aware.³⁶ The 1895 act of the New York State Legislature that permitted the sale of surplus laboratory antitoxin specified that profits derived in this fashion were to be returned to the municipal laboratory. The antitoxin fund had already made possible the establishment of the expanded research quarters and had provided the revenues to permit an increase in the division's staff.³⁷ Straus pointed out, in something of an exaggeration, that if the bill became law the "splendid Bacteriological Bureau would be nearly abolished and there would be little further use for it."³⁸

In addition to those who participated in the determined maneuver to destroy, or at least enfeeble, the bacteriological division for its encroachments into the orb of the private practitioner, there were also supporters of the Brush Bill who acted on the basis of their personal concern for the financial success of pharmaceutical firms. The brief

of the Special Committee of the New York County Medical Society supporting the legislation maintained that the provision permitting the private sale of laboratory products was contrary to the best interests of the public and was open to abuse should the matter fall into the hands of "unscrupulous persons." Such declarations of concern for the community well-being, unsubstantiated and reeking of hypocrisy, were rejected out of hand by the press.³⁹ Far more candid was the objection expressed to the municipality's apparent encouragement of its bacteriological laboratory to enter into business competition with its private citizens.⁴⁰ Hinting that its involvement with antitoxins and vaccines would encourage the Health Department eventually to manufacture and sell such items as quinine, cocaine, chloroform, and perhaps even sterilized meat and milk, the phantom of creeping socialism was portrayed, with Biggs' laboratory division personified as its fountainhead.⁴¹

Embarrassed by such exaggerated logic, fear tactics, and the association of the medical community with a callous proposal so contradictory to the profession's expressions of concern for the public health, a number of doctors--some of whom were members of the New York County Medical Association and originally supported the bill--openly expressed their opposition to the legislation under consideration in Albany. The health boards of a few hospitals in New York City even sent letters of support to Straus and stressed their appreciation of the laboratory's efforts in suppressing the spread of infectious disease.⁴² Abraham Jacobi--who years earlier had cautioned against "bacteriomania"--warned that, if the work of the Health Department laboratories were restricted, it would be a "great detriment to the health and welfare of the City of

New York."⁴³ On August 7, 1898, Straus received word from Albany that Senate Bill number 5, the Brush Bill, had been killed in committee and would not be recalled.⁴⁴

The Brush Bill was the most calculated and clearly inimical of a series of events occurring, coincidentally, in 1898 which served to impede the laboratory's accelerated development. In August, Biggs married the former Francis Richardson. For the next several years the division of bacteriology played a smaller and smaller part in his life as family matters and professional responsibilities consumed the vast majority of his time.⁴⁵ Consistent with his publicly-stated lament that public health officers were not sufficiently compensated, he increased the hours of his private practice and his hospital associations.⁴⁶ The opening in the fall of 1898 of the medical school born from the merger of Bellevue Medical College and New York University sapped even more of his time and strength as Biggs served the institution in the capacities of Secretary and Professor of Therapeutics and Clinical Medicine and Adjunct Professor of Principles and Practice.⁴⁷ Caring for his two sickly children, his wife's illnesses, and his own failing health drew him even further from any significant involvement in the laboratory's operations.⁴⁸ Whatever new vistas Biggs may have envisioned for the bacteriological division under his guidance, as suggested in two public appearance he made late in 1897, none were to come to fruition.⁴⁹ The man who was the founder, the guiding spirit, the catalyst, the internationally recognized emissary, of the division of bacteriology would no longer launch any laboratory-based innovations, although he was to continue to have a distinguished career in public health administration.⁵⁰

The exact effect of his removal from the daily scene on the subsequent history of the municipal laboratory, in particular, and the development of public health bacteriology, in general, must of course remain moot, especially in light of the impact of other happenings during that period.

The return of Tammany to local power in 1898 brought to an end a four-year hiatus of progressive leadership that paralleled the flourishing of the laboratory--the concurrency having been no mere coincidence. The leadership of Mayor William L. Strong had effectively led to the elimination of some of the blatant, corrupt practices that had become commonplace in certain municipal agencies.⁵¹ Although concerned with economy, so that funds were not as readily available as the laboratory's staff would have preferred, Strong's administration did take care to avoid political interference in Health Department matters, much to the delight of Biggs.⁵² The Tammany sweep in the municipal elections of 1897 augured obstruction to the free-wheeling style of the bacteriological laboratory; Biggs, in fact, seriously considered giving up his director's position rather than work under what he felt would be the disheartening conditions of Tammany rule.⁵³

The Democratic machine lost little time in imposing the spoils system as the new mayor, Robert A. Van Wyck, quickly replaced Health Board president Wilson and Col. George E. Waring, who, as commissioner of street cleaning, had single-handedly overhauled his department and created, out of the chaos he inherited, an efficient work force.⁵⁴ Numerous Health Department supervisory personnel throughout the city were removed and replaced by faithful party adherents as the patronage mill continued to grind out appointments.⁵⁵ An apparent deal between

Tammany boss Richard Croker and his Republican counterpart, Thomas Platt, led to enough relaxation of the rules of the New York City Civil Service Commission to allow for the assignment of hundreds of subordinate positions to the throngs of Tammany place hunters.⁵⁶

By early March, Nathan Straus, who had run afoul of the party machine, was forced to resign as president of the Board of Health. The vacancy was quickly occupied by Van Wyck's choice of Col. Michael C. Murphy--once arrested for his part in a planned invasion of Canada--one of the few Tammany Hall district leaders not yet awarded a political plum, a former Excise Commissioner, and a man with absolutely no experience whatsoever in matters of public health or medicine.⁵⁷

The Health Board too was quickly and completely in the hands of Tammany and over the following four years an increasing number of lower-level positions were filled with the appointees of district leaders.⁵⁸ The offices of various bureaus became the "loafing grounds" for ward politicians whose word often carried more weight than that of the department's own experts. Subordinates with "pull" were able to ignore, or refuse, their duties with impunity; complaints to the Health Board seldom brought any action. The department had become so tainted by Tammany machinations by 1901, and its services so lax and inefficient, that the Times charged it with being a "public disgrace" and no longer a safeguard to the public health.⁵⁹

The sense of demoralization that pervaded the Health Department, from 1898 until the initiation of reforms in 1902, was particularly upsetting to the pre-Tammany veterans who stayed on during these years and managed to carry on some worthwhile work.⁶⁰ Included in this

group were many of the members of the staff of the bacteriological laboratory, the division that had been the least brutalized by Tammany's manpower manipulations. Political appointees to bureaus that dealt with such matters as disinfection and inspection did not require any unusual expertise and had, besides, excellent opportunities--especially inspectors of fruit, fish, meat, and offensive trades--for personal financial gain.⁶¹ Laboratory positions, on the other hand, offered only the remotest possibilities for graft and, then too, "scientific men" were looked upon as something of a special breed, i.e., of superior character and the most reliable protectors of the general well-being.⁶² Furthermore, Biggs had time and again shown himself to be outspoken and could not have been expected to accept passively major intrusions into his department's affairs without loud protestation.⁶³ Nonetheless, the bacteriological division was not impervious to the general erosion of esprit de corps and the widespread demoralization that prevailed from 1898 to 1901.⁶⁴

The effects of Tammany domination were not only damaging but were more extensive than ever before. The new charter of Greater New York went into effect on January 1, 1898, and widened the city's limits to encompass areas that essentially comprise its present boundaries. All the authority, duties, and powers that had belonged to the numerous health boards of the towns and villages now part of the city were conferred upon the New York City Department of Health, which suddenly had three and one-half million people (up from two million) under its jurisdiction.⁶⁵

The sanitary supervision of the various health agencies in the

locations included in the merger had been generally inefficient and inconsistent. In the course of reorganization the Board of Health set as its foremost responsibility the abolishment of nuisances and abominable practices in the outlying boroughs. To keep an eye on what were regarded as offensive trades--gas houses, slaughterhouses, manufactories, certain shops--and questionable sewage disposal methods, the department's inspection force, much to the satisfaction of Tammany's clamoring job seekers, was rapidly expanded.⁶⁶

The municipal laboratory too underwent modification. The confusing separate designations of a Division of Pathology and Bacteriology (Special), and Division of Bacteriology (Regular)--as appeared in the 1896 Annual Report--was done away with as a single Division of Bacteriology, the Fourth Division, joined four other branches in the reorganized Sanitary Bureau.⁶⁷ The number of laboratory aides was doubled to handle the increased load of specimens sent for examination for the detection of tuberculosis, diphtheria, and typhoid fever.⁶⁸

By way of contrast, there was only a 50 percent increase in bacteriologists in 1898 (from eight to twelve) and by the following year there was a reduction to the previous number.⁶⁹ The laboratory's budgetary allowance also did not keep pace with that of other divisions; research was clearly not a priority of the Tammany-controlled Health Department.⁷⁰

The same administration lost no time in courting the favor of certain of the city's businessmen and physicians who--for reasons of pecuniary self-interest--opposed the department's sale of diphtheria anti-toxin.⁷¹ The bait was quickly taken up--despite the defeat of the Brush Bill the previous year--and Assemblyman Collier introduced a bill into

the Legislature in Albany making it illegal for the Health Department to sell its diphtheria antitoxin, or any biological products. Backers of the legislation supported their position on the basis of testimony which alleged that there existed a more effective medication for the treatment of diphtheria and that the antitoxin which was sold was of inferior quality and a potential health hazard.⁷²

In investigating the latter accusation an Assembly committee called before it Dr. John Cosby, a recent Van Wyck appointment to the Health Board, who replied that antitoxin "not fit for use among any class of people" was sold to the Chicago Health Department at a tremendous discount.⁷³ That city's Commissioner of Health, Arthur Reynolds, vehemently denied the charge and personally credited the New York laboratory's antitoxin with having dramatically lowered Chicago's diphtheria fatality rate.⁷⁴

The affair spilled over into the pages of the Philadelphia, Medical Journal, whose editors and contributors found statistics to show that Biggs' figures supporting the effectiveness of antitoxin treatment in New York and Philadelphia (a combined 12.2 percent diphtheria mortality rate) were contrived and that the death rate was more than double that amount (27.6 percent). His response that the journal's assault was "malicious" and "disgraceful" was dismissed with the counterattack that no government agency had the right, in any way, to interfere, directly or indirectly, with the free operation of private enterprise.⁷⁵ Stopping short of an incrimination of wrongdoing, the editors made it a point to note that the horses used for antitoxin production were housed and cared for at an annual fee of \$2,500, in the stables of the New York

Veterinary College, of which Biggs was the president and his cousin the treasurer.⁷⁶

Biggs, in testifying in Albany, appealed to the Assemblymen on the grounds that the sale of excess antitoxin was necessary for the laboratory's very existence and for the continuation of the life-saving services that evolved from its research.⁷⁷ After considering all arguments--including the protest that the laboratory's commercialism discouraged budding pharmaceutical entrepreneurs--the Legislature voted against the Collier Bill.⁷⁸

Undaunted by the outcome, delegates of state and county medical associations, the United States Export Association, and the Drug Trade Section of the Board of Trade, met with Murphy to convince him that he had it within his power to issue a simple order to cease the sale of antitoxin. Clearly confused by it all, the Health Board president vacillated but hinted to the business representatives that they would be satisfied with the decision he would reach.⁷⁹

The Collier Bill, nevertheless, joined the Brush Bill in defeat--to the bacteriological laboratory, however, their failures were Pyrrhic victories. Biggs' involvement in fighting the proposals--coming during years when personal problems, discord with the medical profession, and Tammany's resurgence presented additional difficulties--created a tremendous drain on his energies, mirrored in the dampening of the laboratory division's spirit as a creative force in public health. No new programs of any significance were initiated for the next several years and the small amount of research that was conducted was routine, uninspired, and pedestrian.⁸⁰ The entire experimental output from 1897

to 1899 barely equalled that of 1896; the contrast was even greater in regard to the character of the work than its quantity.⁸¹

The more consequential efforts of the laboratory up to 1897 were guided by a sense of exigency and practicality very much a reflection of the nature of its director. Biggs had lashed out against the hesitation of public health workers to exploit what the science of bacteriology had uncovered about the infectious disease process and perceived the municipal laboratory as the proper institutional framework to bridge the gap between fundamental discovery and application in the service of prevention and treatment.⁸² His contacts, direct and indirect, with some of the pioneers of bacteriology and his familiarity with developments in the discipline had imbued him with a strong sense of mission that lent fuel to his impatient temperament; consequently, the studies conducted under his aegis exuded an urgency and boldness that often precluded some of the typical elements of classical research methodology.

It is always true that the size of experimental and control groups is a key factor in determining the researcher's ability to draw meaningful conclusions and in providing a basis for others to consider the validity of an investigation and the deductions derived from it; in this respect the samplings used in a number of the laboratory's pursuits were inadequate.⁸³ The staff, made up primarily of young doctors, was genuinely curious and ambitious, but it was, after all, composed of part-time workers with private practices so that their opportunities to accumulate significant amounts of relevant data, even had they had a more patient employer, were restricted. Because of the modest pay scale

even Park, like Biggs, maintained a private practice and taught so that he too could not devote his total, undivided workday to the rigors of research.⁸⁴

The advantages of its association with the research laboratory notwithstanding, the diagnostic laboratory too siphoned off some of the vitality of the professional staff members who had, in any case--considering the state of medical curricula--only received a moderate amount of training in bacteriology and little actual preparation for experimental work.⁸⁵ The Health Department laboratory's parameters had been molded by Biggs so that it would not extend beyond its client-oriented role of utility to its urban constituency. Diagnostic testing provided such a service but diluted the already strained resources of the municipality's bacteriological division.

Lacking an abundance of expertise and the time for extensive, painstaking investigations--hallmarks of solid research--conclusions were, on occasion, predicated on scanty experimental samples and were dependent on the clinical data supplied by others, i.e., doctors who had supplied information when availing themselves of the department's service of free diagnostic examinations.⁸⁶

Not only did the research frequently lack a sound methodological approach but in some instances it showed disregard for human life. The city's inhabitants--especially the residents of its public institutions--were regarded as readily available subjects for experimentation.⁸⁷ In one such instance presumptiveness gave way to callousness. When attending physician Dr. Joseph Winters objected to the use of diphtheria antitoxin at the Health Department's Willard Parker Hospital, Park

arranged for only alternate diphtheria patients to receive the medication. After six weeks, long after it had become clear that those getting anti-toxin treatment were responding better, and only when Winters was brought to his knees and called for its end, the test was discontinued. Park ruminated on the incident later in his life--perhaps for purposes of catharsis--and explained that "although we had lost a few lives by it, we had gained a certainty as to the value of antitoxin which we would not otherwise have obtained, and thus enabled us to persuade the members of the medical profession much more rapidly than if we had not carried out the experiments."⁸⁸ Despite such a rationalization, although probably genuine, this was research with a vengeance.

Such blatant irresponsibility was atypical and explainable, even if not condonable, as an excess attributable to the exuberance of the aficionados of a young science whose self-imposed goals included promotion of the legitimacy of bacteriology as an instrument in the armamentarium of public health medicine. The "selling" of bacteriology within the context of experimental inquiries was a pervasive element in the laboratory's early published reports. Works of elaboration and verification--defending and providing additional support for the more fundamental discoveries of others (or, in the same genre, contradicting the opposition of detractors)--constituted one such type of study.⁸⁹ Others, with the same general goal, included discussions of the laboratory's gap-bridging technical or administrative innovations and were almost manual-like in their attempts to convince and instruct readers (presumably physicians and public health officials) of the workability of bacterial-oriented methods, as demonstrated by the New York model.⁹⁰

The success of the laboratory division in providing an institutional and operational paradigm can be evaluated on the basis of its acknowledged imitators.⁹¹ The public health laboratories that followed the leadership of New York's bacteriological department, however, also accompanied it in its fin de siècle decline.

Municipal and state health agencies, particularly in the eastern United States, had created facilities, or adapted existing ones, for the diagnosis of diphtheria--later appropriately adding tuberculosis and typhoid examinations--and true to the New York exemplar had begun the production and distribution of antitoxin (gratuitously to the poor, in most cases). Staffed by young physicians, working on a part-time basis, these bacteriological facilities were launched and modestly subsidized in response to the excitement engendered by the apparent success of the serum treatment of diphtheria. Lip service was paid to the importance of research, although investigations into means for the improvement of antitoxin manufacture were almost invariably encouraged and most seriously pursued.⁹² Even with such limited horizons, by century's end these laboratories had begun to suffer as undermanned staff, working in inadequate, overcrowded facilities, were deluged with urine, blood, and sputum samples sent for microscopic examinations by doctors, dentists, and often veterinarians. Such tests were conducted free of charge so that laboratories were dependent upon the generosity of legislatures and health boards that preferred to channel funds into more traditional public agencies.⁹³

By the late 1890s it had become clear from the example of the several municipalities and states that had tried, that the incorporation

of the laboratory into public health departments had not led to as full an exploitation of the contemporary bacteriological learning as had been anticipated. The economics of the marketplace and the vagaries of political power structures that controlled the lifeblood of the laboratories were obstacles of such enormous proportion as to give little credibility to the realization of Biggs' grand design. Publicly supported laboratories had also shown their susceptibility to the machinations of physicians and business interests.⁹⁴ Barring some unforeseen ground swell of popular demand as might follow a dramatic scientific breakthrough, or the news of an imminent health emergency, city and state governments were not apt to budge.

Other institutional formats had, however, already begun to embrace bacteriology and successfully incorporate it into their organizational structure. Clinical laboratories, most typically in teaching hospitals--already well established entities in Germany, France, and particularly England--were opened and conducted bacteriological examinations and medical research.⁹⁵ Students at a growing number of medical schools were being introduced to the basic bacteriological methods of disease diagnosis, although the incorporation of laboratory studies into the curriculum was still in its early, awkward stages.⁹⁶

Medical schools and the more progressive and affluent universities and colleges had found the creation of laboratories to be such a highly expensive endeavor that by 1899 William Welch observed that he could count on the fingers of one hand the number of educational institutions in America with facilities worthy of any note.⁹⁷ At that juncture, and during the preceding years, the public health laboratories,

with all their problems, were better supported than those of academia. The colleges, universities, and newer organizational forms were to provide the effective settings for investigations into the broader aspects of bacteriology, but the laboratories associated with municipal and state health departments had served, Welch noted, to introduce a more scientific spirit into public health medicine, and had stood as formidable means of defense between the community and epidemic disease.⁹⁸ The laboratory of the New York City Health Department was the prototype of this peculiarly American institutional structure and had, through its direct and indirect influence, maintained a pivotal position in the development of medical bacteriology and the expansion of public health services.⁹⁹

NOTES

¹New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for Its Prevention, p. 6.. In a year in which there were about 5,000 reported deaths due to phthisis, only 1,856 sputum samples were examined--about one-seventh as many as were tested for diphtheria, a far less prevalent disease. Ann. Rep., Bd. of Health, 1896, pp. 28, 214.

²Park and Biggs, "Report of Danger of Infection through Expectoration in Public Places," Ann. Rep., Bd. of Health, 1896, pp. 242-244; ibid., p. 29; "New York City Board of Health and Its Anti-Expectoration Ordinance," JAMA, XXVI (May 30, 1896), 1089.

³Ann. Rep., Bd. of Health, 1896, pp. 28-29.

⁴Charles Ingraham, "Control of Tuberculosis from a Stricter Medico-Legal Standpoint," JAMA, XXVII (September 26, 1896), 693-695; "Society Proceedings," ibid., XXVII (August 22, 1896), 431-434; "Tuberculosis and Bacteriophobia," Medical Record, L (October 24, 1896), 611-612.

⁵Guerard, "Report on the Distribution of Tuberculosis in New York City," Ann. Rep., Bd. of Health, 1896, pp. 244-256.

⁶Many of Guerard's figures were taken from a printed article by Dr. Roger Tracy, The Health Department's Register of Records, City Record, January 11, 1894. No attempt was made to hide the nature of Guerard's report. From the start it was pointed out that its object was to prove by statistical tables and maps that tuberculosis was an infectious disease (as shown from its groupings), that as a consequence of its distribution it was undoubtedly caused by a germ, and that there were good reasons to believe that sanitary measures could halt its diffusion. Guerard, Ann. Rep., Bd. of Health, 1896, p. 244.

⁷Ibid., pp. 244-252.

⁸Biggs, British Medical Journal, II (September 11, 1897), 631; New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for Its Prevention, p. 6. The fight against tuberculosis continued to be regarded as the special domain of philanthropic and religious organizations. Through the efforts of such groups England had cut its annual death rate from 2.97 per 1,000 members of the population (1848) to 1.54 per 1,000 by 1888--a greater reduction than in

any other country. Various forms of private hospitals, sanatoria, preventoria, and dispensaries multiplied and were imitated throughout France and Germany. The institutions and societies which began to spring up in America, in the 1870s, were dedicated to the diagnosis of tuberculosis, the dispensing of standard treatments, and education of the consumptive and his family, and were particularly concerned with the plight of the poor. Flick, pp. 11, 704-709; Lillian Brandt, The Charity Organization Society of the City of New York, 1882-1907 (New York, 1907), pp. 118-124.

⁹Biggs and Prudden, "The Status of Pulmonary Tuberculosis in New York City, and Its Control by the Board of Health," Medical News, LXX (January 23, 1897), 128.

¹⁰New York City Health Department, Regarding the Reporting of Tuberculosis, a one-page circular issued by the Health Department, 1897; New York City Health Department, Sanitary Code of the Board of Health, 1897, p. 5.

¹¹New York City Board of Health, The Action of the Health Department in Relation to Pulmonary Tuberculosis and the Scope and Purpose of the Measures Recently Adopted for Its Prevention, p. 7; New York City Health Department, Circular of Information to Physicians Regarding the Measures Adopted by the Board of Health for the Restriction and Prevention of Tuberculosis in the City of New York, 1897, p. 3.

¹²Biggs considered the reasons for such a policy to be obvious: The public health bears quite as close a relation to public morality as to general prosperity. Sickness brings in its trail, especially among the poor, uncleanliness, poverty, misery, wretchedness, destitution, and death. The physical and moral man are interdependent. That which degrades one, degrades the other; individual exceptions to the rule do not invalidate its force. Biggs, Medical News, LXII (January 8, 1898), 44.

¹³The attempt to gather statistical data on the existence of pulmonary tuberculosis in the city by the voluntary compliance of physicians and by the offering of free sputum examinations had clearly not produced satisfactory results. Ann. Rep., Bd. of Health, 1894, pp. 73-74; 1895, p. 38; 1896, pp. 28-29, 214.

¹⁴"Compulsory Reporting of Cases of Pulmonary Tuberculosis," Medical Record, LI (March 27, 1897), 459-460; "The Health Board and Pulmonary Consumption," ibid., LI (February 6, 1897), 197-198; "A Few Facts Relating to the Non-Contagiousness of Pulmonary Consumption," Medical News, LXX (February 6, 1897), 215; "The Health Board and Compulsory Reports," Medical Record, LI (January 23, 1897), 126; Times, January 22, 1897, p. 12.

¹⁵Ibid.; Philip Van Ingen, The New York Academy of Medicine: Its First Hundred Years (New York: Columbia University Press, 1949),

p. 263. Had it not been for the presence of Prudden on the committee, the wording of the statement might have been stronger. Winslow, The Contribution of Hermann Biggs to Public Health, pp. 13-15.

¹⁶Medical Record, LI (January 23, 1897), 126-127.

¹⁷Winslow, Life of Biggs, p. 147; Medical Record, LI (March 27, 1897), 459-460; "Tuberculosis and Health Department Regulations of New York," JAMA, XXVIII (March 27, 1897), 616.

¹⁸Ibid.; Medical Review, XXX (April 3, 1897), 269.

¹⁹Gay, University of California Chronicle, XVIII, no. 2 (1916), 708. The sense of distrust between physician and laboratory investigator went back to the seventeenth century but had largely disappeared at the beginning of the nineteenth century when pathologist and practitioner were often merged in one individual. Hostilities were reawakened with the appearance of full-time laboratory scientists. Shryock, American Medical Research Past and Present, p. 70.

²⁰Medical Record, LI (January 23, 1897), 126.

²¹Medical Record, LI (February 6, 1897), 197-198.

²²Medical News, LXX (February 6, 1897), 215.

²³Thomas C. Craig, "The Municipal Control of the Consumptive," Medical Record, LI (January 23, 1897), 116-118; "The Prevention of Tuberculosis," Medical News, LXX (January 9, 1897), 53-54; H. Arrowsmith, "The Modern Aspect of Tuberculosis," ibid., LXX (January 16, 1897), 68; "The Tuberculosis Question in New York," ibid., LXX (March 13, 1897), 341.

²⁴Ibid.; New York Herald, February 26, 1897, p. 2; Times, January 25, 1897, p. 6.

²⁵Winslow, Life of Biggs, p. 147; JAMA, XXVIII (March 27, 1897), 616; Medical Record, LI (March 27, 1897), 459-460; Times, March 4, 1897, p. 12; Medical Review, XXX (April 3, 1897), 269.

²⁶In the original report to the Health Board, published soon after the approval of the compulsory registration amendment, assurances were given that hopes of severely restricting the spread of tuberculosis were not some pie-in-the-sky fantasy of a few clustered laboratory investigators: "This is not the idle dream of sanitary enthusiasts or theorists, but is a conviction founded upon the most thorough and conclusive experimental investigations, which have been amply confirmed by practical experience." Medical News, LXX (January 23, 1897), 127.

²⁷New York City Health Department, Regarding the Reporting of Cases of Tuberculosis, p. 1; New York City Health Department, The

Importance of Bacteriological Examinations in the Early Diagnosis of Pulmonary Tuberculosis, a three-page circular, 1897, pp. 2-3; New York City Health Department, Circular of Information to Physicians Regarding the Measures Adopted by the Board of Health for the Restriction and Prevention of Tuberculosis in the City of New York, 1897, pp. 2-4.

²⁸Kaufman, pp. 143-159; Rosemary Stevens, American Medicine and the Public Interest (New Haven: Yale University Press, 1971), pp. 55-56.

²⁹Biggs, Medical News, LXII (January 8, 1898), 47. Biggs was apparently sincere in trying to establish some sort of reciprocity with the medical profession. He regretted that he could not offer monetary compensation for the reporting of diseases, as was done in some foreign countries, and then gently reminded the doctors that in America "it is the duty of the physician to make such reports, and that no payments should be received for the discharge of such a duty." After pointing out to them their professional obligations, he gave assurance that the Board of Health would extend the full services of its bacteriological laboratory to the medical community in return for their cooperation, with the hopes of "establishing more cordial and mutually confidential relations between the members of the medical profession of this city and the Health Department." Ibid. Biggs' approach is regarded by Daniel Fox as that of a clever strategist who, as a general course of action, attempted to alienate as few as possible while seeking to find the physicians' "price" for compliance with compulsory notification. Fox, Bulletin of the History of Medicine, XCIX (Summer 1975), 184.

³⁰Biggs' views are gleaned from the speech delivered on August 21, 1897, before the New York Academy of Medicine and entitled, "Sanitary Science, the Medical Profession, and the Public," found in Medical News, LXXII (January 8, 1898), 44-50, and the closing address delivered at the Sixty-fifth Annual Meeting of the British Medical Association in Montreal on September 3, 1897. The talk "Preventive Medicine in the City of New York," was published in the British Medical Journal, II (September 11, 1897), 629-638, and was received with considerable interest by other journals. Medical News, LXXX (September 11, 1897), 321-326; Montreal Medical Journal, XXVI (1897), 220-244; Sanitarian, XXXIX (November 1897), 385-412. An indication of Biggs' renown is that he was asked to address the Congress on Public Medicine after Lister declined a similar invitation. Winslow, Life of Biggs, p. 155.

³¹"Everything which is detrimental to health or dangerous to life, under the freest interpretation, is regarded as coming within the province of the Health Department." Efforts would be made to avoid interference with the private practitioner "unless such interferences becomes necessary for the protection of other persons from the possibility of infection." Biggs, British Medical Journal, II (September 11, 1897), 637.

³²Times, January 23, 1898, p. 5; January 24, 1898, p. 5.

³³Ibid., January 27, 1898, p. 5; January 29, 1898, p. 6.

³⁴Ibid., January 26, 1898, p. 12; February 3, 1898, p. 6. For an insight into nativistic perceptions of the recently arrived immigrants--particular the Jews and Italians of New York--during the "nationalist nineties," see John Higham, Strangers in the Land (New Brunswick: Rutgers University Press, 1955), pp. 87-105.

³⁵Times, February 2, 1898, p. 5.

³⁶Ibid., January 24, 1898, p. 5; January 26, 1898, p. 12.

³⁷Biggs, British Medical Journal, II (September 11, 1897), 630; Bd. of Ald., Proceedings, CCXV (July 2, 1894-September 18, 1894), p. 191; Ann. Rep., Bd. of Health, 1896, p. 24.

³⁸Times, January 23, 1898, p. 5.

³⁹Ibid.; January 26, 1898, p. 12; January 29, 1898, p. 6; February 16, 1898, p. 16.

⁴⁰Ibid., January 24, 1898, p. 5. The argument that the laboratory's sale of medications offered unfair competition to drug companies--in which some physicians had money invested--was contradicted by the protest at the fact that antoxin was sold to pharmacies at 90 cents per vial in New York but was available in other parts of the country at 50 center per vial and less. Ibid.; February 16, 1898, p. 16. If private companies could make a better and cheaper product, a Times editorial challenged, let them. Ibid., February 1, 1898, p. 6. Besides, the Health Department's ability to distribute diphtheria antitoxin free to doctors for use among the city's poor was only made possible by subsidization resulting from the laboratory's sale of the remedy. Ibid., January 26, 1898, p. 12.

⁴¹Ibid., January 24, 1898, p. 5; January 31, 1898, p. 6; February 16, 1898, p. 16.

⁴²Ibid., February 2, 1898, p. 5; February 5, 1898, p. 5; February 8, 1898, p. 11. The incident offers a rare opportunity to judge, to some extent, the difficult-to-research matter of the public's awareness and evaluation of the municipal laboratory. Whether Biggs' public relations ventures were successful, or whether the considerable press coverage of the battle surrounding the Brush Bill was the cause, one citizen outcry was recorded. At a local meeting of the Central Labor Committee, the bill was attacked as vicious and a resolution condemning it was passed by the delegates. The proposed law was seen as a direct blow aimed at halting the production and sale of an antitoxin which was cited as having prevented hundreds of deaths, particularly among the poor. Ibid., February 7, 1898, p. 5.

⁴³Ibid., February 5, 1898, p. 5.

⁴⁴The failure of the legislature to act on the bill probably owed much to its opposition by insurance companies. The 1897 addition to the health code making the registration of tuberculosis mandatory was of obvious advantage to this industry; any legislation which threatened the economic windfall gained by that ruling naturally attracted its attention. Large numbers of representatives from ten of the largest insurance companies in the country--Metropolitan, New York Life, Equitable, Mutual, etc.--descended upon the state capital. Ibid., February 8, 1898, p. 11. Exactly how they exerted their considerable influence can only be conjectured; it is likely, however--and an intriguing little possibility--that an industry often regarded as a paragon of private enterprise might have played a major role in prolonging the existence, or at least maintaining the vitality, of the municipal bacteriological laboratory.

⁴⁵Winslow, Life of Biggs, pp. 162-164.

⁴⁶Biographical sketch of Hermann Biggs, pp. 1-2; Biggs, Medical News, LXXII (January 8, 1898), 49. Biggs was originally appointed in 1892 at an annual salary of \$3,000 and was given no raise over the next ten years. In fact, when his yearly income was increased to \$5,000 when he took on the position of Health Department Medical Officer in 1902, his director's salary was listed as \$2,500. Times, September 14, 1892, p. 2; Bd. of Ald., Proceedings, CCXXVII (July 6, 1897-September 28, 1897), p. 411; ibid., n.s., I (January 6, 1902-March 25, 1902), p. 1090. By way of contrast, Koch was started as direction of the Institute for Infectious Diseases at a 20,000-mark salary. Dolman, Dictionary of Scientific Biography, VII, p. 426.

⁴⁷Biographical sketch of Hermann Biggs, p. 1; Winslow, Life of Biggs, p. 165.

⁴⁸Ibid., pp. 168-171.

⁴⁹Biggs, Medical News, LXXII (January 8, 1898), 44-50; Biggs, British Medical Journal, II (September 11, 1897), 629-638.

⁵⁰Biographical sketch of Hermann Biggs, pp. 2-3; Winslow, Life of Biggs, pp. 184-186.

⁵¹Ibid., p. 108; Duffy, A History of Public Health in New York City, 1866-1966, p. 239.

⁵²Prudden, Sketches and Letters, p. 290. The 1894 to 1898 interlude from the domination of Tammany Hall was remarkably free of intrigues, corruption, and the seedy sensationalism that followed the discovery of political transgressions. Although Wilson was attacked by physicians as the "stock-broker," laymen president of the Health Department, there was agreement with his claim that politics had never had a place in his organization. "The New York City Board of Health," JAMA, XXVIII (January 16, 1897), 135.

⁵³Prudden, Sketches and Letters, pp. 289-290. To thousands of New Yorkers "reform" meant that they couldn't buy drinks at the corner saloon on Sunday. Reformers simply did not have an appeal to the immigrant poor to match the personal politics at which Tammany was so adept. Alfred Connable and Edward Silberfarb, Tigers of Tammany (New York: Holt, Rinehart, and Winston, 1967), pp. 25, 185. The attempts of the Strong administration to deal with the immigrant problem by building new schools, parks, and playgrounds was regarded by many middle-class citizens as too socialistic, philanthropic, and an excessive outlay of money for "unfortunates and defectives." Simon Sterne, The Reconquest of New York by Tammany (New York: Forum Publishing Company, 1897), p. 558. As Tammany leader Richard Croker delightfully observed, "Well, Well, Well!, Reform has gone to Hell!" Connable and Silberfarb, p. 218.

⁵⁴Times, January 1, 1898, p. 6; January 2, 1898, p. 1; January 5, 1898, pp. 2, 6.

⁵⁵Ibid., p. 2; January 4, 1898, p. 7; January 6, 1898, p. 5.

⁵⁶Ibid., March 1, 1898, p. 4.

⁵⁷Ibid., March 4, 1898, p. 12; March 5, 1898, p. 12.

⁵⁸Ibid., January 21, 1898, p. 6; November 3, 1901, p. 6; Prudden, Sketches and Letters, p. 290.

⁵⁹Times, May 8, 1901, p. 8; July 5, 1901, p. 6; November 3, 1901, p. 6.

⁶⁰Ibid., July 5, 1901, p. 6; March 6, 1902, p. 7; December 8, 1902, p. 8.

⁶¹Ibid., April 4, 1902, p. 2; Ann. Rep., Bd. of Health, 1898, pp. 9-11; 1899, pp. 9-11; City Club of New York, The Health Department of the City of New York (New York, 1903), pp. 31, 33.

⁶²Rosenkrantz, Public Health and the State, Changing Views in Massachusetts, 1842-1936, p. 97.

⁶³Even the anti-Tammany City Club gave the Van Wyck administration credit for having had the wisdom not to tamper with the bacteriological division. In its 1903 published analysis of the Health Department the club, in fact, lauded the municipal laboratory for its having maintained itself as New York's bulwark against infectious disease during the Tammany years. City Club of New York, The Health Department of the City of New York, p. 33,

⁶⁴There is little that came from the municipal laboratory to refute seriously Duffy's observation that during the Tammany regime the Health Department "at best, marked time." Duffy, pp. 239-252; see Ann. Rep., Bd. of Health, 1898, pp. 42-43, 82-91, 106-108; 1899, pp. 71-72; 1900, pp. 35-36; 1901, pp. 34-35.

⁶⁵Ibid., 1898, pp. 31-32. In the lengthy discussions on the matter of the city's expansion held before the state's Sub-Committee of the Joint Council of the Affairs of Cities, the economic and political ramifications of expansion were acrimoniously debated while the problems of health supervision were scarcely touched upon. See Report of the "Committee on Greater New York" (New York: Wynkoop Hallenbeck Crawford Co., 1896), passim.

⁶⁶Ann. Rep., Bd. of Health, 1898, pp. 10-11, 32-33.

⁶⁷Ibid., pp. 11-13; 1896, p. 9. The other units of the bureau were the Division of Food Inspection and Offensive Trades, the Division of Medical Inspection of Schools, the Division of Sanitary Inspection, the Division of Contagious Diseases, and the Division of Marine Inspection. Ibid., 1898, pp. 33-34.

⁶⁸All samples were forwarded from culture stations, set up in the new jurisdictions, to the diagnostic laboratory at the Criminal Court Building in Manhattan; no branches of the Fourth Division were established in the outlying boroughs as was the case with other units of the bureau. The bulk of the new personnel were classified as "laboratory attendants"--the designation implying a function not requiring any particular preparation--and were perhaps low-level patronage appointments. Ibid., pp. 12-13, 33-34, 87.

⁶⁹Ibid., p. 12; 1899, pp. 11-12.

⁷⁰In 1897 the laboratory division was funded \$30,500 out of a total department budget of \$581,380, and received the same the following year. Bd. of Ald., Proceedings, CCXXVI (April 6, 1897-June 28, 1897), p. 380; ibid., CCXXVII (July 6, 1897-September 28, 1897), p. 268. By 1899 the Health Department's yearly allotment was \$1,110,538, of which its laboratory division received \$49,748. New York City Board of Estimate and Apportionment, Budget for 1899, pp. 57-58 (hereinafter cited as Bd. of Est.). Thus, from 1897 to 1899, as the number of people under the department's supervision increased 75 percent (from two to three and one-half million), its funds jumped 91 percent, while the laboratory saw only an increase of 63 percent during that period.

⁷¹The Health Board affirmed that, while it did not intend to halt production of antitoxin, it would take steps to limit it so that there would "exist no competition in this respect between the city and private manufacturers." It declared itself in opposition to any greater production than would serve the city's immediate needs on the basis that such "overproduction" and the consequent sale of surpluses was a "practice which has been visited with condemnation from many quarters, and which the Board is determined to discourage on the ground that the City should not be led into transacting a business of this character." Ann. Rep., Bd. of Health, 1898, pp. 42-43.

⁷²"The New York City Board of Health and Its Competition with Private Enterprise," Philadelphia Medical Journal, III (February 15, 1899), 406; Times, March 21, 1899, p. 8; March 22, 1899, p. 3. A vigorous fight for passage of the bill was conducted by a lawyer, J. J. Russell. He argued that tests carried out abroad, and in some New York hospitals, indicated that an alternative method, the Brucellin treatment (inhalation of chlorine gas), was safer and perhaps even more effective than diphtheria antitoxin. Russell's intentions were not entirely clear although there were indications of his association with a scheme to form a stock company to market the chlorine cure as a proprietary drug, a charge he denied. Ibid., March 22, 1899, p. 3; March 23, 1899, p. 9.

⁷³Ibid., March 22, 1899, p. 3.

⁷⁴Reynolds testified that his department never sought nor received bargain rates, that they tested all shipments and found every one to be of standard strength and purity as guaranteed, and that the New York product (used in over 4,000 cases) had reduced the mortality rate from 35 percent to 6.8 percent. Ibid., March 26, 1899, p. 1; March 28, 1899, p. 6; April 2, 1899, p. 13.

⁷⁵Biggs, "Letter," Philadelphia Medical Journal, III (February 15, 1899), 405-406; "What Ails the New York Board of Health," ibid., III (April 1, 1899), 684.

⁷⁶Biggs, ibid., III (February 15, 1899), 406; "The New York Board of Health, the Collier Bill, Etc.," ibid., III (April 15, 1899), 799.

⁷⁷The direct sale of biological products by the laboratory was not an innovative practice; the Pasteur Institute had begun to sell antirabic vaccine soon after its opening in 1888. Rosen, Bulletin of the History of Medicine, XXXIX (1965), 208.

⁷⁸Philadelphia Medical Journal, III (April 15, 1899), 800; "The New York Board of Health and the Sale of Antitoxin," ibid., III (April 22, 1899), 869. Diphtheria antitoxin was so necessary for the preservation of life and so difficult to prepare properly that it had become recognized as being in a category different from other medications. In Europe, antitoxin was produced under the supervision of health authorities or in semi-official laboratories, like the Pasteur Institute and the British Institute of Preventive Medicine. As far as New York was concerned, if the municipal laboratory did not maintain the right to sell its products, Biggs argued, it would lose thousands of dollars of revenues for the type of experimental investigations for which the city's government had not, under any administration, shown a willingness to appropriate funds. Furthermore, after giving out antitoxin, at no charge, to physicians for their poor patients, to hospitals and all public institutions in New York that requested it, and to Health Department inspectors--a total, in 1898, of \$40,000 worth of free medication--the sales of the excess amounted to only \$13,963. Biggs and Park, "The

New York Board of Health and Diphtheria Antitoxin--An Official Statement," Medical News, LXXIV (April 8, 1899), 438.

⁷⁹Philadelphia Medical Journal, III (April 22, 1899), 869; Reynold Wilcox, "The New York Board of Health and the Sale of Antitoxin," ibid., III (May 6, 1899), 970. Diphtheria antitoxin, however, and other products of the laboratory, continued to be sold for a number of years. By 1903 Health Commissioner E. J. Lederle decided that private companies were manufacturing a high standard antitoxin and so discontinued its sale by the Health Department. Ann. Rep., Bd. of Health, 1903, pp. 20-25. Years later, when retired from his public position, Lederle began the commercial production of biological products in his firm; this helped speed up the withdrawal of health departments from this type of work and contributed to the phenomenal expansion of the pharmaceutical industry. Baumgartner, Bull. of N.Y.A.M., XLVI (June, 1969), 561-562.

⁸⁰Ann. Rep., Bd. of Health, 1898, pp. 42-43, 82-87; 1899, passim; 1900, passim.

⁸¹Biggs, Ann. Rep., Bd. of Health, 1896, pp. 278-285; Biggs and Guerard, ibid., pp. 312-358; Biggs and Prudden, ibid., pp. 242-244; Billing, ibid., pp. 297-311; Guerard, ibid., pp. 244-273; Park and Williams, ibid., pp. 286-296; Biggs and Park, Am. Jnl. of Med. Sci., n.s., CXIII (March 1897), 274-298; Park and J. R. Atkinson, "Nasal Bacteria in Health," N.Y. Med. Jnl., LXVII (February 5, 1898), 178-182; Park and Atkinson, "The Relation of the Toxicity of Diphtheria Toxin to Its Neutralizing Value upon Antitoxin at Different Stages in the Growth of Culture," Journal of Experimental Medicine, III (1898), 513-532; R. J. Wilson, "Hydrophobia," N.Y. Med. Jnl., LXVIII (April 9, 1898), 437-438; Follen Cabot, "Rabies and Its Preventive Treatment," Medical News, LXXIV (March 18, 1899), 321-328; Cabot, "The Preventive Effect of the Cauterization of Wounds Infected with the Virus of Rabies after an Interval of 24 Hours," Medical News, LXXIV (March 18, 1899), 329-331. The work of 1897 to 1899 was generally technically narrow in scope and designed to offend no one; rabies, in particular, received considerable attention. Hydrophobia was a "safe" disease to investigate as it had very few victims, and, because of its peculiar pathological behavior, its diagnosis and treatment outside the normal practice of physicians--particularly by the so-called "Pasteur Institutes" which sprung up all over the world--was universally accepted. Times, March 10, 1898, p. 12; W. W. Keen, Medical Research and Human Welfare (Boston: Houghton Mifflin Company, 1917), p. 50; A. M. Stimson, A Brief History of Bacteriological Investigations of the United States Public Health Service (Washington, D.C.: United States Government Printing Office, 1938), p. 49; Bacteriological and Pathological Laboratory of the Delaware State Board of Health, Bulletin, no. 9 (October 1901), 7.

⁸²Ann. Rep., Bd. of Health, 1893, p. 25; 1896, pp. 28-29; Biggs, Medical News, LXXII (January 8, 1898), 44-50.

⁸³Beebe, "Report of Experimental Work to Determine the Value of Formalin as a Germicide," Ann. Rep., Bd. of Health, 1893, pp. 134-136; Biggs, ibid., 1896, pp. 279-280; Billings, ibid., pp. 279-280; Biggs and Park, Am. Jnl. of Med. Sci., n.s., CXIII (March 1897), 279-280.

⁸⁴Medical Society of the County of New York, Med. Dir., N.Y., 1896, p. lii; 1899, p. c; Medical Society of the County of New York, The Medical Register of New York, New Jersey, and Connecticut (New York: G. P. Putnam's Sons, 1894), pp. xciii, cxcii. In 1898 Park was appointed Adjunct Professor of Bacteriology and Hygiene at New York University; in 1899 he became an Associate Professor and in 1900 a full Professor, a post he held until 1933. From 1892 to 1932 he also served as Visiting Bacteriologist at the Willard Parker Hospital. Dalldorf, p. 14; "Deaths," JAMA (April 13, 1939), 1522.

⁸⁵Conn, Science, XI (March 16, 1888), 125-126; Ernst, Journal of the Boston Society of Medical Sciences, IV (January 10, 1900), 69-71; Bergey, Annals of Medical History, I (December 1917), 426-427.

⁸⁶Ann. Rep., Bd. of Health, 1896, p. 232; Biggs, ibid., pp. 278-280. Billings, for example, in one investigation tested 29 people (with only 6 controls) to determine the effect of antitoxin serum on blood cells. He found that 6 showed drops in their red blood cell count; 3 were shrugged off as being within the "normal range," while the remaining 3--a not insignificant 10.3 percent of a small test group--were unconvincingly rationalized away. The results were at best inconclusive and certainly presented no evidence to justify the concluding remark that "the antitoxin treatment of diphtheria has no deleterious effects upon the blood corpuscles." Billings, ibid., pp. 303-307, 311.

⁸⁷Ibid., p. 299; Biggs and Guerard, "The Use of Antitoxin Serum in the Treatment of Diphtheria under the Supervision of the New York City Health Department, with a Resumé of the Published Reports on this Subject," ibid., pp. 312-320; see also above, p. 115.

⁸⁸Park, American Journal of Diseases of Children, XLII (December 1931), 1441.

⁸⁹Biggs, Ann. Rep., Bd. of Health, 1894, pp. 99-103; Biggs and Guerard, ibid., 1896, pp. 312-358; Billings, ibid., pp. 297-311; Guerard, ibid., pp. 244-273.

⁹⁰Park and Beebe, Scientific Bulletin, No. 1, pp. 1-11; Biggs, Medical Record, XLVII (April 20, 1895), 481-484; Park, ibid., pp. 485-486; Biggs and Park, Am. Jnl. of Med. Sci., n.s., CXIII (March 1897), 274-298.

⁹¹Prudden, Sketches and Letters, p. 221; Annual Report of the Philadelphia Bureau of Health, 1895, p. 223; Park and Guerard, Bacteriology in Medicine and Surgery: A Practical Manual for Physicians, Health Officers and Students (New York: Lea Brothers and Co., 1899), p. iv;

Joseph McFarland, "The Beginnings of Bacteriology in Philadelphia," Bulletin of the Institute of the History of Medicine, V (1937), 186; Times, March 13, 1895, p. 13; September 4, 1895, p. 2; Winslow, The Contribution of Hermann Biggs to Public Health, p. 9.

⁹²Annual Report of the Philadelphia Bureau of Health, 1895, pp. 34, 235-238; Quarterly Bulletin of the Michigan State Board of Health, I (April 1898), 13; Annual Report of the Massachusetts State Board of Health, 1894, pp. cvi-cvii; 1895, p. xxiii; "Report upon the Production and Use of Antitoxin," ibid., pp. 687-708; Annual Report of the State Board of Health of Connecticut, 1895, p. 9; Bettman, Medical News LXVII (July 6, 1895), 5; Abbott, The Development of Public Health Work in Philadelphia, p. 25; Winslow, The Evolution and Significance of the Modern Public Health Campaign, p. 36; Welch, Public Health in Theory and Practice, p. 394; Stimson, p. 65.

⁹³Annual Report of the Massachusetts State Board of Health, 1899, pp. 669-677; Delaware Bacteriological and Pathological Laboratory, Special Bulletin A, pp. 1, 3, 4, 6; Annual Report of the Philadelphia Bureau of Health, 1898, pp. 24-25; Howard, p. 167. The entire staff of the Michigan state laboratory was comprised of Drs. V. C. Vaughan, F. G. Novy (both of whom also held university professorships), one assistant bacteriologist (also a physician), and one laboratory assistant. Annual Report of the Michigan State Board of Health, 1896, p. cxlvii. The Philadelphia municipal laboratory was begun in 1895 with a professional staff of three and one assistant (the House Drainage Division had fourteen employees, the Nuisance Division had twenty-seven); by 1898, and despite a tremendous workload, only one more bacteriologist and two helpers were added. Out of a Health Bureau budget of over \$265,000, a little over \$10,500 was apportioned for all expenses (salaries, apparatus, materials, etc.) of the laboratory division. Annual Report of the Philadelphia Bureau of Health, 1895, pp. 55-56, 221-238; 1898, pp. 60-61. It was not until 1901 that the annual appropriation for the Delaware laboratory topped \$1,300. Bacteriological and Pathological Laboratory of the Delaware State Board of Health, Bulletin, no. 3 (March 1900), p. 1; no. 4 (June 1900), p. 1; no. 7 (April 1901), p. 1.

⁹⁴See above, pp. 205-213.

⁹⁵Rosen, A History of Public Health, p. 334; Baumgartner, Bull. of the N.Y.A.M., XLVI (June 1969), 561; Dr. W. T. Councilman, Dr. F. B. Mallory, and Dr. R. M. Pearce, "A Study of the Bacteriology and Pathology of Two Hundred and Twenty Fatal Cases of Diphtheria," Journal of the Boston Society of Medical Sciences, V (1900-1901), 139-141. When the William Pepper Laboratory of Clinical Medicine, in Philadelphia, opened in 1894, there were already a small number of moderately well-equipped clinical laboratories; it, however, became the first of its kind in America to have its own building and was generously funded with the intentions that it would conduct diagnostic tests and would become a center for medical investigations and the training of advanced

students. Rosen, Bulletin of the History of Medicine, XXXIX (1965), 209; Welch, "The Evolution of Modern Scientific Laboratories," Johns Hopkins Hospital Bulletin, III (January 1896), 23.

⁹⁶Ernst, Journal of the Boston Society of Medical Sciences, IV (January 10, 1900), 69-71.

⁹⁷Welch Papers, I, pp. 617-618.

⁹⁸Ibid., p. 618.

⁹⁹Ibid., p. 326; Annual Report of the Philadelphia Bureau of Health, 1895, p. 223; Corner, p. 561; Chapin, "History of State and Municipal Control of Disease," A Half Century of Public Health, p. 143.

CHAPTER 5

GLORY AND DECLINE

The failure of the bacteriological laboratory to initiate any innovative public health measures for several years, beginning at the end of the nineteenth century, was more than an outgrowth of the local political peculiarities and personnel situations alluded to earlier. At the very time that the laboratory was feverishly involved in providing leadership in devising and implementing practical means for the application of bacteriology, the limitations of the science of unlocking the secrets of infectious disease were becoming increasingly obvious. The hope that the study of microbes could lead, in the foreseeable future, to elimination of the maladies they induced was generally abandoned as the complex nature and resiliency of bacterial parasites, and their perplexing relationship to man, became more and more appreciated.¹

The bacteriological model of disease provided by the pioneering efforts of Pasteur, Koch, and their associates and early successors, which had held up so well for almost three decades, had begun to falter. Certain ailments, among them some of the most highly contagious and thus, assumedly, parasitically induced--e.g., measles, smallpox, whooping cough, "grippe"--had stubbornly resisted all efforts to detect their etiological agents despite the application of techniques that had been successful in the search for the microbes of diphtheria, typhoid fever, tuberculosis, and cholera. The uncertainty went even further; the study

of diseases whose pathogens had been identified led to indications that contradicted the notions that they were transmitted by fomites or that bacteria floated about in the air, infecting whole rooms or houses.² The role of insect vectors in spreading sickness, first soundly demonstrated by Theobald Smith in 1893 while he was director of the pathology laboratory in the United States Bureau of Animal Industry, was pursued further by Army researchers when American troops were sent to tropical zones in the Spanish-American War and led to the recognition of a largely ignored element in the complex picture of disease diffusion.³

With the growth of germs outside the living body assuming less importance as a factor in causation, the role of the health carrier--itself a vaguely understood phenomenon--appeared to be of greater consequence than previously imagined.⁴ The very existence of the carrier state itself was an enigma and raised obvious questions on individual disease resistance and the causal influences of hereditary predisposition, personal hygiene, and societal factors.⁵

The bacteriological paradigm, weakened by the appearance of anomalies in its theoretical and methodological facets relating to etiology and transmission, was further strained by its inability to provide a dependable model for the creation of preventives and curatives. It had been hoped by bacteriologists that the introduction of antitoxin for the treatment of diphtheria in the early 1890s would establish a general principle by which curative sera for all infections could be developed.⁶ Such expectations were not realized; a decade later diphtheria was still the only disease against which serum had a great practical value--and even here the problem of "serum sickness" (a variety

of allergic reactions) had created substantial practical difficulties. Antitoxic serum did work effectively when used to immunize against tetanus, but its curative ability was limited and disputed. Then too, an auspicious start had been made by such notables as Pasteur, Koch, Behring, and Kitasato to develop active immunization by vaccine preparation from attenuated or dead microbes, but over twenty years after the first optimistic signs of the success of rabies prophylaxis, the practical results were slight. Even with those maladies whose causative agents had been discovered, little had been accomplished in the direction of large-scale prevention and cure. Afflictions like pneumonia, typhoid fever, tuberculosis, septicemia, and cerebrospinal meningitis ran rampant with physicians and public health officials unable to do much about it.⁷ Scientists had not forsaken the search for the means of disease control but had encountered case after case where nature simply refused to comply with the paradigm.⁸

The basic connection between microorganisms and infectious diseases had, however, become firmly entrenched as part of the general knowledge of science and was no longer seriously challenged. Thanks to bacteriology, the high rate of illness in filthy, overcrowded slums could be scientifically explained, and so fuel was added to the cause of those who advocated various forms of tenement reform. Consequently, there developed an acceleration of social services by public and private agencies in the early years of the twentieth century.⁹ The idea of *laissez faire* had never been fully accepted in dealing with the problems of community life, but by the 1890s there emerged a broad-based movement in support of conscious social action. Under the general banner of

reform, liberal progressives and socially concerned conservatives pushed for cooperative efforts to deal with a variety of problems such as poverty, illiteracy, prostitution, sweatshops, and tenement house reform.¹⁰

Poor health was among the most pervasive of the difficulties faced by the social crusaders. Public health nursing was introduced into the New York City Health Department by 1902, through the efforts of Lillian Wald of the Henry Street Settlement, to provide a force to go into the homes and eventually the schools to discover and provide assistance to the sick.¹¹ Increased attention to children was encouraged by the administration of Theodore Roosevelt, as settlement houses were established locally and a special Children's Bureau became part of the machinery of the national government.¹² The movement for community action led to the establishment of hospitals, dispensaries, sanatoria, preventoria, clinics, and a variety of other special facilities to educate and ameliorate sufferers of such diverse maladies as tuberculosis, trachoma, and gonorrhoea.¹³

Voluntary health agencies proliferated, typified by such as the American Society for the Control of Cancer and the Association for Prevention and Relief of Heart Disease, which joined the host of organizations already in existence dedicated to the eradication of tuberculosis. The idea behind many of these health agencies, often set up and maintained by great foundations created by private fortunes, was to develop, by experimental methods, procedures that could be used to prevent or treat the specific illness to which each was devoted.¹⁴

The emergence of new institutional forms and the widening of

socially oriented services by traditional bodies did not at all lead to an abandonment of bacteriological research or to a diminution in its vitality. The awareness of aberrations, of inconsistencies and unsuspected phenomena, pointed to the need for greater exploration so that anomalies might be understood. Some perhaps lost faith, but, on the whole--an indication of its strength--there were no serious attempts to renounce the bacteriological paradigm. The Germ Theory had served too well as a guide, the tools it provided had solved too many problems, for it to be summarily dismissed; what it needed was further modifications and articulations to resolve what appeared to be conflicts. A period of adjustment, of experimental retooling, was necessary to bring about a tighter theory-data fit so that the adjusted theory could function as a reliable model for the elaboration of discoveries that could be utilized to minimize the disturbing level of disease and death caused by microorganisms.

Discrepancies in the model that had stalled the anticipated progress in the health sciences were of such an esoteric nature as to demand for their resolution highly sophisticated equipment and techniques, greater specialization, and further conceptual refinements--in short, greater professionalization in bacteriological research. The need for such a development was obvious to many of those actively involved in the field; what was not clear was the source, if any, from which support for such a monumental venture would emerge.¹⁵

One avenue that appeared to be opening was private philanthropy. American businessmen had been too busy making money throughout most of the nineteenth century to indulge in the Renaissance tradition of

patronizing the sciences but, by the last decade, had shown some willingness to support their alma maters. The practice of giving, once established, could then be directed to the support of new institutional forms once the need for such philanthropy was recognized.¹⁶

The first spectacular instance of American largesse was the creation of the Carnegie Institute in Washington in 1902. The Institute did not intend to focus on any particular area, but was established, and generously provided for by its founder, for purposes of promoting a wide range of activities in research and scholarship through financial assistance to existing institutions and by the general encouragement of unusual talents.¹⁷ Generous grants were given to a number of ongoing projects, with particular emphasis on studies involving evolution, botany, marine biology, economics, nutrition, solar observation, and meridian astronomy.¹⁸ Carnegie was consulted and encouraged in the creation of his foundation by Theodore Roosevelt, Secretary of State John Hay (who served as its chairman), and Elihu Root. Their backing led to the government's informal blessing of the Institute and its incorporation by act of Congress in April 1904.¹⁹

While willing to foster science indirectly in such a manner, most of the legislators in Washington did not regard basic scientific research as a proper function of the national government.²⁰ Progressives had been somewhat successful in their drive to convince their more conservative colleagues that science and democracy were not incompatible--as witnessed by passage of the Pure Food and Drug Act and establishment of the National Bureau of Standards and the Bureau of Census in the early years of the century--but had gotten nowhere in attempts to

overcome the view that universities and private enterprises were the only appropriate centers for fundamental research.²¹

The only agencies involved to any extent in health experimentation that were also recipients of federal dollars were the Hygienic Laboratory of the Marine Hospital Service and the Army Medical School. The former received an appropriation of \$35,000 in 1901 to erect a building on Capital Hill to deal with matters relating to the general health.²² Although its founder Kinyoun (who had studied under Roux and at the Koch Institute) and his successor, Milton Rosenau, were bacteriologists, the facility dealt primarily with problems faced by the Service in fulfilling its responsibilities in foreign and interstate quarantine, medical inspection of immigrants, and in disseminating information to state and local agencies on the means for diagnosing and preventing communicable diseases.²³ The Army Medical School was established in 1893 by George Sternberg, soon after he became Surgeon-General, for the purposes of investigating diseases as they related to warfare and for providing advanced training in medicine and public health.²⁴ It, like the Hygienic Laboratory, received only lukewarm support as the general inertia regarding the government's responsibilities in disease research continued and was defended, against Progressive attempts at change, by such small but vocal groups as the National League for Medical Freedom, the Anti-Vivisection League, and the Christian Science Church.²⁵ Meanwhile, agricultural experimental stations, set up in every state of the Union, were granted huge sums for studies that were aimed at providing practical information for the American farmer.²⁶

With the government in Washington refusing to furnish any

substantial support for public health studies, the need for the assistance of private philanthropy took on even greater urgency. The Rockefeller fortunes were enlisted with the formal opening of the Institute for Medical Research in 1906.²⁷ Motivated by his religious principles and a desire for social recognition and perpetuation of his name, John D. Rockefeller's decision to undertake such a mission was, in part, an outgrowth of the contemporary limitations of bacteriology. His friend Frederick Gates, who aided in the creation of the University of Chicago, was apparently stirred by the shortcomings of medicine, garnered from his reading of Osler's Principles and Practices of Medicine in 1897, and called attention to the dire need of American medical research for a benefactor.²⁸ His plea was tragically confirmed by the death of Rockefeller's beloved grandson, his first, by scarlet fever in early 1901, following a short bout with the illness. When he learned from the doctors that virtually nothing was known about the malady, he decided to proceed with plans for a research center.²⁹

The general program of the Institute was to assemble a staff of proven investigators, to release them from the burdens of academia, and to provide them with the freedom and facilities to pursue their experiments. The personnel sought were of the "pathfinder type" who, by training and temperament, recognized the need for basic knowledge and were prepared to pursue it. Concern for the public welfare was not to be lost sight of, but the scientists were expected to move from one fundamental investigative project to another and to leave the practical applications of the fruits of their labors to others.³⁰

Beginning in 1901, before its laboratory facilities were

completed, the Institute's Board of Directors distributed grants-in-aid, to encourage health related studies, with money placed at its disposal.³¹ Among the first recipients was the bacteriological laboratory of the New York City Health Department, which received funds to conduct investigations and devise procedures to improve the safety of the city's milk supply.³²

Milk had long been recognized as a highly nutritious food--the cow was often referred to as "the foster mother of the world"--so that up until the middle of the nineteenth century few had reason to believe that it could help spread disease.³³ Even when the family cow was replaced by the local producer who delivered the beverage in loose cans and ladled it out to his customers, most Americans continued to consume milk that was only hours old and most likely seldom spoiled. With the development of industry and the growth of cities, however, the distance between producer and consumer widened. Urbanization led to an increased flow of milk from the country, and as the cities continued to expand it became necessary to import milk from greater and greater distances. In order to fulfill the demand of their burgeoning populations. As a result of the longer time needed to transport the product from the farm to the home of the consumer, the opportunities multiplied for contamination and subsequent spoilage. Shipment by railroad, beginning in the 1840s, was of little help since refrigeration was not possible; consequently, and along with the use of unclean containers and generally careless handling, the milk supplied to cities was often unsanitary, if not dangerous.³⁴

The hazards created by human sloppiness and natural processes

were compounded by the practices of unscrupulous dairymen who increased their profit margin by skimming cream (with unsterilized devices) which could then be used for separate sale, and by adding water to the already thinned milk. Public objections to the sale of this swill-milk led to the rapid development of effective municipal action against such tampering so that throughout the 1870s the problem no longer seemed a matter for concern.³⁵

With the spectacular rate of urban growth paralleled by an increased demand for milk, processors and distributors found that health agencies were unable to police effectively their activities and so returned, on a greater scale than ever, to the practices of dilution and adulteration. The fines imposed on those who were convicted were small compared to the profits gained by such chicanery. Furthermore, the chances of escaping detection were heightened by the liberal use of coloring agents and preservatives such as borax, boric acid, benzoic acid, and even formaldehyde, to delay and mask the more obvious signs of souring.³⁶

With the dawn of the bacteriological era there gradually developed among sanitarians and public health officials the suspicion, weakly supported by empirical observations, that adulterated milk not only robbed children of needed nutrition and contained irritating chemical agents but also harbored pathogenic microorganisms. Tuberculin testing of dairy cows by city and state authorities generally revealed a sizeable number of diseased animals so that even the untampered milk from the conscientious dairies was viewed as potentially dangerous to the general health.³⁷ Such fears were confirmed by the weight of the

authority of Robert Koch. During the course of his announcement on the discovery of the tubercle bacillus in 1882, he conjectured that a source of infection to humans was the meat and milk they consumed from tubercular animals.³⁸ He underscored this hypothesis eight years later in an address before the International Medical Congress in Berlin when he called for the application of bacteriological methods to the control of the public's milk supply.³⁹

While the public was kept informed of the dangers of impure milk, the press pushed for greater governmental involvement in the battle against the menace; the problem, however, was a complicated one. Biggs had suggested in his 1894 report to the Health Board that "meat and milk of tubercular cattle may be important sources of danger" and yet the division of bacteriology had no authority, nor specific responsibilities, in such matters.⁴⁰ As a consequence of the emphasis on chemical adulteration, the division of chemistry alone was accountable for the inspection of the milk sold in the city and yet did not have the power nor means to examine it for germs.⁴¹

Responsibility for the sanitary supervision of milk at its source rested with the New York State Board of Health, whose field workers were empowered to inspect dairy herds and order the slaughter of infected cows. Operating with a miniscule budget (only \$5,000 in 1892), the small number of state inspectors assigned to the work was a farce.⁴² Farmers had learned to hide their sick animals and, besides, nothing could be done to halt the large flow of filthy milk from Connecticut, New Jersey, and other areas beyond the state's jurisdiction.⁴³ Despite occasional reports of enforcement, the inspectors could do little to

affect the condition of the milk entering New York City, and with a state legislature dominated by representatives with rural constituencies, not much movement could be expected from the lawmakers.⁴⁴

The Times lost few opportunities to draw attention to the occasional findings of consumptive cattle and so helped inspire the legitimate concern of health authorities, physicians, and the public.⁴⁵ Following some local deaths attributed to the drinking of diseased milk, members of the Section of Public Health of the New York Academy of Medicine expressed the opinion that most of the 5,000 or so who died of tuberculosis in New York got the ailment from impure milk. Health Department Superintendents Edson and Roberts estimated that up to 5 percent of all milk in the city came from tubercular cows and so vowed, along with Health Commissioner Fowler, to protect the public no matter what the cost.⁴⁶

Following the lead of a few other American cities, the Health Board issued more stringent regulations against adulteration and, despite some setbacks, received the support of the courts in imposing higher fines on violators. All dealers and transporters within the city limits were required to purchase permits--which could be revoked if certain minimum standards of cleanliness and care were not maintained--upon presentation of information on the source of the milk they handled.⁴⁷

Although the Health Department increased its staff of milk inspectors and gave assurances that great strides had been made in the battle against scurrilous milk, the sheer magnitude of the problem precluded any dramatic improvements.⁴⁸ For example, all milch cows within the municipality's borders were administered tuberculin tests under the

Department's supervision; the 3,000 or so animals subjected to the examination constituted the source of approximately 10 percent of the milk consumed locally, so that the overwhelming majority of the supply came from untested cattle.⁴⁹ To the extent that New Yorkers were drinking better milk, it was as much due to private philanthropy and self-regulation within the industry as to Health Department machinations.⁵⁰

The attempts by well-meaning social reformers and health officials to mount a massive movement for purer milk were hampered by their failure to present any unassailable evidence to override the position of dairymen and medical authorities that no rigorously substantiated causal link between tuberculosis and milk had yet been established.⁵¹ Antagonistic theories on the inheritability of tuberculosis and on its origins as a disease of malnutrition had begun to lose their popularity but still had a sizeable number of advocates.⁵² Objections to the idea of disease transmission by milk, although self-serving when held by those in the dairy business, were founded on strong empirical grounds. Only a very small percentage of cows had tubercular udders, microscopic examinations of milk did not reveal the presence of the typical malady-causing bacillus, and no significant clinical data existed linking milk consumption with any form of tuberculosis.⁵³ Autopsies performed on 119 New York children who had died of tuberculosis revealed only a small number with lesions of the digestive tract. Dr. L. Emmett Holt, the prominent pediatrician who conducted the study, noted the power of the alimentary canal to destroy germs and so cast considerable doubt on the possibility of ingestion as an important mode of disease transmission.⁵⁴ The editors of the Medical News applauded Holt's position and expressed

the hope that his findings would channel the undue attention given to milk to the search for methods to keep the microbe from entering human respiratory tracts.⁵⁵

The evidence presented by Cornet, that the dry sputum of consumptives was the chief source of tubercular infection, eroded even further the position of the milk reformers.⁵⁶ Furthermore, although his mentor Koch had called for public attention to the matter of sanitary milk, he guarded his words and never flatly stated that bovine tuberculosis was transferrable to humans.⁵⁷ Biggs also equivocated in his public statements on the matter. The reluctance of either to make a firm commitment is understandable in light of the contemporary absence of experimental verification.⁵⁸

An attempt, in 1889, to determine whether tubercular cows posed any threat to humans was made by Harold Ernst at Harvard. A small experimental farm was set up and milk samples were tested by students at the Medical School laboratory. No tubercle bacilli, or other pathogenic organisms, were positively detected, so that Ernst appropriately labeled the study as inconclusive and emphasized the need for further investigations along these lines.⁵⁹

Over the course of the next few years the bacteriology of milk did, in fact, become an area of considerable attention at a number of agricultural experimental stations. The Connecticut (Storr's) Station at Wesleyan University under the direction of Herbert W. Conn, in particular, became well known for such investigations as did the station associated with the University of Wisconsin.⁶⁰ The bulk of the activities conducted under these circumstances involved research into

the role played by bacteria in butter and cheese production and their influence as the cause of tainted milk. Study after study easily confirmed the ubiquitousness of microbes throughout all phases of the voyage from cow to consumer and assumed correctly their association with spoilage and souring. The findings were rendered into simple terms--"changes in milk are caused by very small vegetable organisms called germs, microorganisms, or bacteria"--and promulgated to farmers under Department of Agriculture auspices. The major thrust of the publications was to emphasize the savings that could be realized if hygienic conditions were maintained by farmers and dairy workers. References to dirty milk as a conveyance of human illness were included in order to stress the importance of cleanliness, but were obviously speculative.⁶¹

Public and professional concern also prompted some of the newly created municipal and state laboratories to conduct bacteriological examinations of cows, barns, dairies, and retail stores, which inevitably turned up alarming evidence of contamination of the utensils and vessels used in milk preparation, storage, and transport. Health officers were divided on whether this constituted a danger to human life and so while laws to prevent the dilution, adulteration, and skimming of milk were enforced to various degrees, no legislation was enacted to protect the public against bacteria-infested milk.⁶²

One of the first decisive attempts to improve the quality of milk was made by a New York County Medical Society Commission, under Dr. Henry D. Chapin, beginning in 1900. Any company which agreed to adopt the fifty rules for cleanliness recommended by the United States

Department of Agriculture, and whose milk was consistently shown not to contain over 30,000 bacteria per cubic centimeter, was allowed to label its product as "certified" by the Commission.⁶³ A few companies did comply, but the majority did not, so that the greater quantity of milk reaching the city showed no improvement.⁶⁴ The municipal laboratory became a participant in the program when arrangements were made for it to do the bacteriological testing for the Milk Commission.⁶⁵

A matter of concern to Commission members, and to William Park, who now took an active interest in the matter, was the disturbingly high rate of infant mortality due, in large part, to what was vaguely classified as "summer diarrhea" ("cholera infantum").⁶⁶ The fact that the death rate was significantly higher in the summer, when food spoilage was most common, led to the suspicion that the germ content of milk was largely responsible for the termination of young lives.⁶⁷ The belief was not a novel one, but had never been systematically substantiated in a large-scale investigation which took into consideration the sundry clinical, microbiological, commercial, and social factors involved.⁶⁸ With such a monumental plan in mind, Biggs was able to obtain a grant-in-aid from the Rockefeller Institute, which stood to gain from the good public relations such a venture was certain to create.⁶⁹

The initial phases of the work began in late 1900 under the direction of Park and culminated in a report published in the Journal of Hygiene the following July.⁷⁰ Examinations by other public health laboratories had already pointed up the high incidence of germ life in city milk, while farm studies, particularly by the agricultural station, had demonstrated the unsanitary environment to which milk was exposed after

it left the cow.⁷¹ Park's objective was to determine how much contamination took place during milking and how much growth occurred afterwards in transit from the farm to the dairy and from there to the city. With Rockefeller money, Drs. Sara Belcher and Rose A. Bebb were retained by the municipal laboratory; the former was dispatched to the countryside to study farm conditions, the latter assisted Park with the microscopic work conducted at the Carnegie and Health Department laboratories. The study, the most ambitious of its kind to that date, gathered together a wealth of data on the amount of germ life present immediately after milking, and at the end of each of three successive twenty-four hour periods (milk often had to travel up to 350 miles and was three days old when it reached the consumer). Not surprisingly, the results showed a tremendous increase in the bacterial count from farm to city which was blamed on the generally filthy conditions that were rampant from barn to retailer. These findings were compared with those of a control--where special care was taken to secure hygienic handling--which demonstrated a significantly lower degree of contamination. Park's conclusion, firmly supported by the data, was that the normally high bacterial presence in New York City's milk was directly related to exposure to filth, the time interval from cow to consumer, and the temperature at which the milk was kept--three factors which could, he insisted, be controlled.⁷²

Park's hope was that his research would help convince public officials of their responsibility to "force the farmers and the middlemen to use cleanliness, cold, and dispatch."⁷³ The discovery of bacteria swarming in milk was not likely to lead to official action, however, as

no substantive evidence to confirm the existence of a connection between contamination and illness had been demonstrated by the investigation.⁷⁴ With exactly such a goal in mind, and with a further grant from the Rockefeller Institute for Medical Research, a study was initiated in the summer of 1901 "to determine whether any relationship existed between the number and character of the micro-organisms in milk, and the amount of diarrheal disease in the children to whom it was fed."

The general direction of the investigation was guided by Park and L. Emmett Holt, a member of the Institute's board of directors. Clinical observations were made by municipal laboratory staff members (all physicians and all, but one, females) and three volunteers. The bacteriological investigations were carried out in the Health Department's Research Laboratory and, as with the earlier study, at the Carnegie laboratory of New York University; four employees of the municipal laboratory were assigned exclusively to this aspect of the research. Observations were made during the summer of 1901, the winter of 1901-1902, and the summer of 1902. During each season the health of different groups of infants was carefully monitored by the physicians, each of whom had less than 50 subjects under his (or her) personal scrutiny. Excluding all instances of imperfect records and cases studied for too short a time to draw accurate deductions, there remained 632 children who constituted the experimental group.⁷⁵

The youngsters, all of whom lived in the poor, densely populated Lower East Side of New York, were classified according to whether they were fed condensed milk, store (milk purchased loose from large cans at four cents a quart, the poorest grade sold), bottled milk (about

eight cents a quart, generally in good condition, and used by those "not so poor as those who used store milk"), and milk from the Straus Depots (from "certified" farms and of generally excellent quality).⁷⁶ Bacterial counts of the actual milk consumed in all homes were taken once or twice a week. The bacteria were isolated from the samples, cultured, and tested for pathogenic properties by intraperitoneal and subcutaneous inoculation of guinea pigs and by direct feeding to kittens. Many guinea pigs died, but since milk is swallowed by humans and not injected under the skin, little importance was given these results, a conclusion confirmed by the death of only one of the many young kittens.⁷⁷ Almost all the strains of bacteria, isolated and carefully classified according to the guidelines in The Manual of Determinative Bacteriology, were found to be identical with those obtained from numerous specimens of hay, grass, commercial feed, manure, and water.⁷⁸ The data strongly suggested that the "milk bacteria"--the term suggested that the majority of microbes in milk came predominantly from the cow--described a phenomenon which did not exist and that the contamination was therefore an *outgrowth of commercial practices*.

Although two years of effort failed to uncover any relationship between specific bacterial varieties and childhood illnesses, the investigation yielded compelling evidence of a causal link between the extent of bacterial contamination and the incidence of infant diarrheal morbidity and mortality. On the basis of thorough and frequent clinical examinations, the cases were divided according to whether the child "did well" (regular weight gain and "no diarrhea worth mentioning"), "did fairly well" (weight stationary or slight gain and some diarrheal

disturbance), "did badly" (loss of weight with considerable digestive disturbance), or died. During the winter, when milk bacterial counts were lower (averaging about 400,000 per cubic centimeter in the poorest store milk), 93 percent of the 211 children were in good health, i.e., did well or fairly well; during the summer months, however, when milk contamination was at its highest (an average of about 20,000,000 and up to 200,000,000 per cubic centimeter), health infants comprised 292 of the 421 observed (69 percent), while 88 did badly and 41 died (almost all of diarrheal diseases). Furthermore, a breakdown according to the type of milk consumed showed that the instances of poor health were proportionately higher among those children who drank the milk with the highest bacterial infestation, i.e., store milk and condensed milk.⁷⁹

The study was precisely the type for which the municipal laboratory was uniquely fit. A growing public awareness of the role of bacteria in disease, the basic respect of most people for the researcher, and increasing community confidence in the Health Department were all of benefit to the investigators so that accessibility to human subjects, and obtaining their cooperation, were seldom problems.⁸⁰ Then too, a corps of milk inspectors already existed so that the taking of samples from wholesalers and transporters was expedited and--important in situations where there might otherwise have been refusal--a legal prerogative.⁸¹

Novel also were the manner and rapidity with which the implications of the milk studies were translated into policy. Little, it was felt, could be accomplished by printed instructions to tenement mothers who generally threw away such materials and who were, according to the

physicians, "anxious and willing, but ignorant and stupid."⁸² In a preliminary report to the Health Board, Park, a practical man, urged that the "cordial co-operation" of farmers and carriers be sought in an effort to improve the quality of milk, but that health authorities were obligated, on the basis of the evidence gathered under his direction, to prevent the sale of milk made unfit by an excessively high number of bacteria. Some maximum figure for bacterial contamination would have to be adopted, beyond which the milk would not be allowed to be sold.⁸³

Acting on Park's recommendation, the Health Department, beginning in May, 1901, issued circulars to those farmers and dairymen supplying the metropolitan area, that informed them of the dangers of germs-- "they incite change . . . which we know as disease"--and advised them of how they could reduce contamination. Simple instructions were provided on how to insure cleanliness, maintain low temperatures, and effect quick transport of their milk. Parenthetical threats were included that milk could be condemned, or that action might be taken if any contagious diseases were traced to infected supplies, although it is not at all clear that the Health Department had, in fact, any such authority at the time.⁸⁴ The willingness of the Department to take action was lauded in the press and supported in the courts in response to public concern and the influence of changing concepts regarding the government's responsibilities for safeguarding its citizens.⁸⁵

The investigations that prompted the stepped-up surveillance of the city's milk were among the most influential in the history of the bacteriological laboratory in that they accelerated a general awakening in regard to the importance of milk in the overall health picture of

the community. Municipal and state laboratories and agricultural stations, and even some conscientious dairies, initiated or intensified experimental efforts in this direction, often focusing their attention on a particular aspect of the New York studies which thus came to serve as research models.⁸⁶

In addition, the evidence of the damaging effects of impure milk led to increased agitation for governmental and philanthropic involvement in distribution of the product.⁸⁷ The data presented by Park and Holt showed that the children who received milk from the Straus depots had the lowest level of illness and death.⁸⁸ Consequently Straus, and other charitable groups, set up milk stations for the sale, or donation, of safe milk in locations throughout the poorer districts.⁸⁹ Pressure by such organizations as the Pure Milk League, and the Milk Commission of the New York Association for Improving the Conditions of the Poor, led to a few municipally operated stations.⁹⁰ The most effective long-range measure, however, was the Health Department's adoption of a grading system and its requirement that, beginning January 1, 1912, all milk entering New York had to be pasteurized.⁹¹

A few cities were already considering compulsory pasteurization and more would follow. The insistence on sterilization, and the general community and governmental concern for the quality of milk, were instrumental in reducing the appalling levels of infant mortality.⁹² Although New York's municipal laboratory did not receive the recognition it did for its diphtheria work, where its role was more direct and obvious, its milk investigations of 1900 to 1902 rank among its more substantial contributions to public health.

The laboratory also became an important participant in the effort to settle the perplexing question of whether tuberculosis was transferrable from cow to human via the milk supply. The matter became a major subject of discussion in the literature following Koch's surprising statement, delivered at the International Congress of Tuberculosis in London in 1901, that the bovine and human forms of the disease were distinct and could not be transmitted from one to the other.⁹³ The scientific world became divided on the issue, with Behring and Lister aligning themselves with Koch's opponents who considered his statement to be not only inaccurate but also a hindrance to all those who were actively involved in promoting stricter public health measures.⁹⁴

When the Congress ended, the British government appointed a Royal Commission of Tuberculosis to study the subject. Its final report, issued in 1907, found it convenient to distinguish between three types of bacilli--human, bovine, and avian--and indicated that the bovine type was sometimes found in the human body.⁹⁵ A German commission, already studying the matter before Koch's electrifying proclamation, reported similar findings and implied that the different types of tubercle bacilli were capable of changing from one form to another.⁹⁶ In 1908, at the International Congress on Tuberculosis held in Washington, D.C., numerous papers were presented on the issue, but no clear consensus emerged.⁹⁷

Resolution of the question of whether bovine tuberculosis could be passed to humans was of more than academic interest. As long as physicians and public health authorities were undecided on whether they ought to concentrate their energies in the battle against the spread of tuberculosis on the diseased individual or on a possible source of infection,

the entire area of prevention suffered from the indecision. An extensive study of New York City milk, by Assistant Bacteriologist Alfred Hess, disclosed--through animal inoculation and clinical observations of children who consistently drank the poorest quality raw milk--that 16 percent of the milk sold contained tubercle bacilli which, in a fraction of cases, did induce disease in young children. He found that the particular form of the illness brought on by infected milk was tuberculosis of the cervical glands.⁹⁸

Cervical adenitis, as it was called, was precisely the condition studied by the English and German commissions, since it had been suspected that this particular type of tuberculosis was incited by impure milk.⁹⁹ What still remained unclear was whether tuberculosis of the cervical glands in children was an exception, or instead, the first proven example of a general phenomenon. If milk was the carrier of the more prevalent forms of tuberculosis (consumption, in particular), then massive public health measures, with enormous commercial implications, would become imperative.

Beginning in 1909, specimens from lesions of non-selected cases--i.e., from a variety of types of tuberculosis and from different age groups--were obtained from city hospitals and sent to the municipal laboratory. After almost two years of work, which involved nearly every one of the bacteriologists of the Research Laboratory in isolating bacteria and in conducting virulence tests, data were published showing that in only 1 out of 297 cases of adult tuberculosis was the bovine type of bacillus found. None of the 278 of this group with the pulmonary form showed the bovine germ nor did any of the 13 consumptive youngsters.

Only in the cases of cervical adenitis in children was the bovine bacillus found in a significant number of instances (20 of 45).¹⁰⁰ The investigation demonstrated that milk was, at most, a minor causal factor in the overall tuberculosis picture and so discouraged the disproportionate attention previously given the matter.¹⁰¹

The 1909-1910 study on bovine and human tubercle bacilli involved the efforts of nine members of the bacteriological division. No clinical work was necessary as all samples tested were accompanied by clinical information from the contributing hospital, so that the entire inquiry took place at the laboratory. Although the work of isolation, cultivation, and virulence testing is tedious and time consuming when done conscientiously, the fact that the study represented the entire research output for the period is indicative of the division's limited manpower.¹⁰²

In its second decade, as in its first, the professional staff of researchers was comprised almost exclusively of recent graduates of medical schools (a high proportion being women), few of whom remained with the division for more than a few years. The funds appropriated for the salaries of the researchers--who were classified as Assistant Bacteriologists and compensated on the basis of their years of service--were not sufficient to command a total work commitment. Consequently and with the singular exception of Anna Williams, the professional personnel divided their time between the municipal laboratory, private practices, hospital responsibilities and, in some cases, teaching duties.¹⁰³

The struggle to acquire adequate funding for the municipal

laboratory's diagnostic, research, and antitoxin production activities was to be an annual battle throughout its history.¹⁰⁴ The problem was not a political one from 1903 to 1918, as Tammany political boss Charles F. Murphy gave his powerful support to Health Department efforts during this entire period.¹⁰⁵ Rather, as the population continued to explode as droves of poor immigrants flowed into the city, an increasingly larger fraction of the municipality's budget was channeled into what were regarded as more essential services. The Street Cleaning and Fire Departments generally received about five times the allotment of the Health Department, and the Police Department obtained about ten times as much. Assistance to the indigent devoured a large part of the public moneys so that the Department of Charities alone was granted a greater allotment than the Health Department. Of those funds the Department was allocated by the Board of Estimate, the majority went for the work of inspection, and the upkeep of hospitals, clinics, and other treatment facilities. The sums earmarked for the bacteriological laboratory ranged between 4.7 and 5.4 percent of the total Department budget during the years from 1901 to 1910; the actual amounts received for all expenses (salaries, equipment, materials, rental of stables, etc.) averaged about \$50,000 annually during the period, with the profits from the sale of antitoxins accounting for as much as one-third of the figure in certain years.¹⁰⁶

With no money available for the purpose, the staff of the diagnosis laboratory took it upon itself to renovate the quarters in 1906, so that "a poorly equipped and ill-lighted assortment of rooms" took on the appearance of a "first-class laboratory." Although this was an

admirable display of esprit de corps, it points up the demeaning circumstances under which the division functioned.¹⁰⁷

More detrimental than the dreary and insufficiently supported physical facilities were the effects of austerity on the division's ability to attract and retain superior personnel. A salary request by the laboratory for the purposes of maintaining a particular bacteriologist led to a letter from the Supervising Statistician of the Bureau of Municipal Investigations and Statistics to Comptroller Herman Metz, containing the observation that

. . . he is engaged in antitoxin work, which requires skill and experience. The rate of \$1,350 a year does not appear unreasonable for competent men for this work. It seems that the Department of Health is handicapped by the inducements offered to competent men by private parties . . . and it is claimed that certain men remain in the employ of the Department at a pecuniary sacrifice.¹⁰⁸

Thus, when the science of bacteriology was passing through a period of readjustment necessitated by the regular appearance of ambiguities and discrepancies which weakened the paradigmatic value of the Germ Theory and the techniques that had evolved from it, the municipal laboratory was ill-prepared to assume a major role in the response. The highly technical research needed to explain and resolve the apparent conflicts that had arisen demanded a variety of specialists working on a full-time basis in facilities equipped with sophisticated, highly expensive equipment.¹⁰⁹ Private philanthropy had begun to meet the challenge through the donation of large sums for the construction of independent, or hospital- or university-associated, centers for the advancement of basic research. The Rockefeller Institute, the McCormick Memorial Institute for Medical Research (1903), the Sprague Memorial

Institute (1911), and the Hooper Institute for Medical Research (1914), to name a few, began their operations with annual budgets measured in the hundreds of thousands of dollars while the New York City Health Department's bacteriological division--typical of public health laboratories in this regard--had to struggle along with allocations barely adequate to support its routine duties.¹¹⁰

The municipal laboratory did not reduce its research activities because of the emergence of the giant research facilities. Its recognized expertise in the municipal control of disease, particularly diphtheria, and its accessibility to the public, resulted in its being the recipient of a number of Rockefeller grants and a desirable participant in multi-institutional investigations.¹¹¹

Symptomatic, in fact, of the bewilderments and uncertainties that had plagued bacteriological studies was the increasing reliance on cooperative projects, especially when urgent health problems arose. The rising incidence of pneumonia, and the experimental confusion caused by the varied morphological forms and seemingly inconsistent virulence of the pneumococcus, led to the formation of a Commission on Acute Respiratory Diseases, at the request of the Health Department, in 1904. Besides Park and his associates from the bacteriological laboratory, members included Welch and Osler from Johns Hopkins Medical School, Janeway of the Bellevue Medical College, Prudden and Holt of Columbia's College of Physicians and Surgeons, and representatives from Mt. Sinai Hospital, the University of Pennsylvania, and the City Hospital of Boston. Each facility was to concentrate its attention on the bacteriological and clinical aspects of lobar pneumonia, with the hope that the combined data would

lead to some progress on the matter. The municipal laboratory took samples from the occupants of city hospitals and foundling homes, from Bellevue medical students, and from Department personnel, and found numerous strains of the microbe in healthy and sick individuals, but could make little sense of the findings. The overall design of the investigation was vague and obviously hastily conceived; nothing of value came from the entire project, although it set the tone for future cooperative efforts with private, public, and university laboratories which would yield some significant data.¹¹²

One area in which the laboratory would continue to make important research and practical contributions without the direct assistance of others was in the battle against diphtheria. The division's early acclaim had come from its anti-diphtheria efforts and with Park at the helm the disease remained in the forefront of its activities. Its free diagnostic service was highly reliable and efficient and had become extremely popular with the city's physicians.¹¹³ The amount of antitoxin manufactured each year continued to rise as drugstores continually increased their orders for the medication, which they received on consignment and sold to doctors; in addition, the municipal laboratory supplied the city of Chicago and other towns and individuals outside the New York City limits.¹¹⁴ Health Department medical inspectors administered antitoxin free to impoverished tenement victims and private physicians were encouraged to use the curative on all their patients, no matter how poor.¹¹⁵

The successful results of the employment of diphtheria antitoxin in New York City were mirrored by hospitals, physicians, and health

departments throughout the world.¹¹⁶ Certain physicians, however, were reluctant to use the medication, and some patients refused the treatment because of reports of deleterious reactions ("serum sickness") leading to rashes, paralysis, and death.¹¹⁷ The problem was statistically a minor one--after over 50,000 antitoxin injections were given in New York, only two confirmed "serum deaths" occurred--but a major one from the public health standpoint as it reduced the utilization of antitoxin.¹¹⁸

As early as 1896 a chemist, James Atkinson, was added to the research staff with the sole assignment of attacking the problem. Although unsuccessful, his hiring indicates a recognition by Biggs that certain problems in bacteriology required for their solution the expertise of other than bacteriologists.¹¹⁹

This hiring policy was continued under Park's leadership when chemists Banzhaf and Gibson--as true with their predecessor, the only non-physicians on the professional staff--were taken on as members of the division. Like Atkinson, they tried various physical and chemical means to separate the protective substances from serum from the toxic and tested their preparations on the unsuspecting inhabitants of the city's asylums, public hospitals, and tenements.¹²⁰ The two succeeded in concentrating antitoxin, by 1906, so as to eliminate much of its allergic action, and "Gibson's globulin-solution" became the first refined serum to be used therapeutically.¹²¹

The problem of "serum sickness" had been mitigated by the technical skills of chemists focusing their efforts on one narrow investigation. Such specialization was essential to effectively meet the challenge posed by the numerous discrepancies and hindrances that faced

bacteriology now that the discipline had supplied answers to many of the broader questions concerning infectious disease. The municipal laboratory division was not, however, allocated sufficient funds to permit the regular employment of personnel with advanced educational backgrounds in useful research areas, so that these early chemists represent notable exceptions.¹²²

Forced by circumstances to leave the esoteric problems to the investigators working in the better endowed research centers, the city laboratory was still able to contribute to efforts to reduce the incidence of diphtheria. The one resource of the laboratory that few research facilities could rival was its readily available supply of human experimental subjects, a commodity it did not hesitate to use to test the efficacy of immunization.¹²³

A number of French and German researchers had begun to use "protecting vaccinations" of antitoxin on children in institutions, and in situations where surveillance was difficult, around the turn of the century, and generally reported good results.¹²⁴ The single largest, continuously running immunization effort was that conducted under the direction of the bacteriological laboratory. The unpublicized program begun by Biggs in 1895, that encouraged Health Department inspectors to immunize as many members of the family of diphtheritics, and occupants of public institutions, as possible, continued unabated. By 1904 over 52,000 exposed children living in such circumstances were vaccinated with only 120 coming down with the disease within thirty days of immunization.¹²⁵ In the process, the death rate of diphtheria in New York City fell from a rate of 15.9 per 10,000 in 1894 to 2.2 per 10,000 by 1912.¹²⁶

When the means were devised for permanent, active immunization, it was the New York City laboratory that took the lead and conducted a full-scale attack on diphtheria in the early 1920s that soon resulted in the virtual elimination of the ailment as a cause of death.¹²⁷

NOTES

¹Wilson G. Smillie and Edwin D. Kilbourne, Preventive Medicine and Public Health, 3rd ed. (New York: The Macmillan Company, 1963), p. 9; James I. Fellows, Zymosis and Pathogenesis: A Bacteriological Sketch (New York: By the author, 1891), pp. vii, 34-35; Annual Report of the Illinois State Board of Health, 1899, pp. xlvii-xlix; "After Thoughts on Diphtheria," Medical News, LXXVIII (February 2, 1901), 195-196.

²As evidence of the insignificance of non-living transporters of disease, Chapin showed that 70 to 90 percent of the diphtheria bacilli exposed to normal room conditions die in one week. The matter of conveyance was further muddled for, despite the frailty of germs, disinfection accomplished little and was, in fact, counterproductive in that the method gave false encouragement that treated areas were disease free. Chapin, Municipal Control of Diphtheria (Providence, n.d.), pp. 3-5; Chapin, JAMA, XLVII (August 25, 1906), 574-580.

³Clark, pp. 120-126; "Insects and Human Vectors," Am. Jnl. of Med. Sci., CXXIV (October, 1902), 748; "Address of the President of the United States," Transactions of the Fifteenth International Congress on Hygiene and Demography, I (1913), 53; Chapin, "The Evolution of Preventive Medicine," JAMA, LXXVI (January 22, 1921), 217; Winslow, The Evolution and Significance of the Modern Public Health Campaign, pp. 36-44.

⁴Chapin, The Sources and Modes of Infection (New York: John Wiley and Sons, 1910), pp. iii-v, 29-90. This work was a landmark compilation of experimental and empirical evidence challenging and flatly contradicting many of the traditional views of Germ Theory adherents. The importance of the transfer of infection via the air and fomites was devastatingly refuted while data attesting to the route of infection via direct contact was presented in considerable, and convincing, detail. Ibid., pp. 1-28, 122-265.

⁵By 1909, Yale Professor of Political Economy, Irving Fishberg, had drawn up a statement calling attention to the apparent roles played by such variables as diet, alcohol, tobacco, fatigue, exercise, psychological state, living conditions, etc., in explaining the great variations in human susceptibility. Fishberg, chairman of the Committee of One Hundred on National Health, observed how little was known about these matters and called for their further investigation. Irving Fishberg, "Report on National Vitality: Its Wastes and Conservation," Bulletin 30 of the Committee of One Hundred on National Health (Washington, D.C.: Government Printing Office, 1909), pp. 2-13, 50-53. See H. Illoway, "The Importance of Proper Dietary Regimen in the Treatment of Chronic Heart Affections, and an Attempt to Formulate Some Rules Therefor," Am.

Jnl. of Med. Sci., CXXIII (March 1902), 457-471, and "Metabolism and Diet," Medical News, LXXXI (October 4, 1902), 648-649.

⁶Sternberg, Practical Results of Bacteriological Researches, pp. 1-17; Park, Pediatrics, IV (1897), 385-398.

⁷Winslow, The Evolution and Significance of the Modern Public Health Campaign, p. 47; Park, "A Critical Study in the Results of Serum Therapy in the Diseases of Man," The Harvey Lectures, I (1905-1906), 101-103; Welch, "The Benefits of the Endowment of Medical Research," Johns Hopkins Hospital Bulletin, XVII (August 1906), 250. The public health picture was complicated by a growing awareness of the incidence of diabetes, cancer, and circulatory, renal, and nervous disorders--some of which were suspected of being parasitic in origin. Ibid.; "On the Relation of Chronic Interstitial Pancreatitis to the Islands of Langerhans and to Diabetes Mellitus," Am. Jnl. of Med. Sci., CXXII (July 1901), 96-98; Alfred Croftan, "An Experimental Investigation into the Causes and the Treatment of Diabetes Mellitus," ibid., CXXIII (April 1902), 662-675; "The Protozoon of Cancer," ibid. (May 1909), 503-539; "Experimental Diabetes," Medical News, LXXX (February 8, 1902), 281; "The Cancer Problem," ibid., LXXVIII (May 11, 1901), 754; "Cause of Cancer," ibid., LXXVIII (June 29, 1901), 1025-1026; "The Protozoon of Cancer," ibid., LXXVIII (May 4, 1901), 707-709.

⁸Winslow, The Evolution and Significance of the Modern Public Health Campaign, p. 47; Park, The Harvey Lectures, I (1905-1906), pp. 101-103. The experimental roadblocks hampering the discovery of medications were patiently explained by Park to an assemblage of physicians, under the auspices of the Harvey Society. The Society's purpose was to familiarize physicians, through annual lectures, with recent research developments and, as such, represented the growing spirit of accommodation between the practitioner and the scientist, and their mutual dependence. Park pointed out that the phenomenon of artificial immunity was dependent on certain body responses--white blood cell activity and antibody formation--that were scarcely comprehended and, like the search for curatives, was complicated by indications that bacteria could physiologically change themselves to resist the scientist's frustrating attempts at their destruction. Ibid., pp. 103-107.

⁹Lubove, The Progressives and the Slums: Tenement House Reform in New York City, 1890-1917, pp. 83-85; Wiebe, pp. 168-172.

¹⁰Rosen, A History of Public Health, pp. 348-349; L. L. Dock, "Extracts from the Report of the Tenement House Commission, New York, 1901," American Journal of Nursing, I (May 1901), 538-541.

¹¹Duffy, A History of Public Health in New York City, 1866-1966, p. 254; Smillie, Public Health: Its Promise for the Future, pp. 411-412; Winslow, The Evolution and Significance of the Modern Public Health Campaign, p. 58.

¹²Ibid., p. 54. New York helped lead the way in this area. The Health Department added a well-staffed Division of Child Hygiene in 1908 and headed it with Dr. Josephine Baker, the driving force behind its creation. Ann. Rep., Bd. of Health, 1908, pp. 312-360; Baumgartner, Bull. of N.Y.A.M., XLVI (June 1969), 562-563; Duffy, A History of Public Health in New York City, 1866-1966, p. 260. After years of public agitation and discussion, the federal government instituted the Children's Bureau in 1912, dedicated to the overall welfare of minors. Lenor S. Goerke and Ernest L. Stebbins, Mustards Introduction to Public Health, 5th ed. (New York, The Macmillan Company, 1968), p. 35.

¹³Welch, Public Health in Theory and Practice, pp. 43-44; Smillie and Kilbourne, p. 10; Chapin, JAMA, LXXVI (January 22, 1921), 221.

¹⁴It was the plan of these voluntary organizations to devise new health methods, demonstrate their effectiveness, and turn them over to public agencies who would bring their benefits to the community. Problems with this particular form of philanthropy led to unbalanced programs, the growth of vested interests, a certain unwillingness to share successful discoveries, and lackluster leadership. Such structures, which reached their greatest productivity around 1925 and which helped contribute to the battle against human deprivation, gradually faded due to the imposition of higher income and inheritance taxes. Smillie and Kilbourne, pp. 10-11; Welch, Public Health in Theory and Practice, pp. 45-47.

¹⁵The following overview of the "paradigm crisis" in bacteriology that faced the scientific community at the beginning of this century is based on the perceptions on the backgrounds and consequences of intellectual revolutions of Thomas S. Kuhn in The Structure of Scientific Revolutions (Chicago: The University of Chicago Press, 1962). Kuhn illustrates his thesis almost exclusively with references to the physical sciences so that specific references to his text--as his insights are applied to the discipline under consideration here--would be misleading and inappropriate. His general analysis holds up well in respect to the readjustments made in research in bacteriology during the period this dissertation touches on. The agreement of Kuhn's views with early twentieth century developments in bacteriology adds further historical confirmation of the soundness of his observations; these observations helped put the era in perspective and provided a general direction for this chapter, for which the author is indebted.

¹⁶Richard Hofstadter and Walter P. Metzger, The Development of Academic Freedom in the United States (New York: Columbia University Press, 1955), pp. 413-414; Shryock, American Medical Research Past and Present, p. 42.

¹⁷Caryl P. Haskins, "The Report of the President on the Sixtieth Anniversary of the Carnegie Institute for 1961-1962," Science and Society, ed. Norman Kaplan (Chicago: Rand McNally and Comp., 1965),

pp. 156-157. Daniel Coit Gilman, after leaving the presidency of Johns Hopkins, was instrumental in assisting Carnegie in shaping the form of the foundation created by his endowment. The Institute was originally given \$10,000,000 in 5 percent bonds, to which \$2,000,000 was added in 1907, and another \$10,000,000 in 1911. Its purpose, in Carnegie's words, was to "encourage in the broadest and most liberal manner investigations, research, and discovery on the application of knowledge to the improvement of mankind." This end was to be accomplished through cooperation with universities, colleges, technical schools, learned societies, and individuals. Fabian Franklin, The Life of Daniel Coit Gilman (New York: Dodd, Mead, and Com., 1910), pp. 389-398; Carnegie, Autobiography (New York: Doubleday, Doran and Comp., Inc., 1933), p. 249; Leonard P. Ayres, Seven Great Foundations (New York: Russell Sage Foundation, 1911), pp. 31-32.

¹⁸Ibid., p. 32; Carnegie, Autobiography, pp. 250-252.

¹⁹Ibid., p. 239; Ayres, Seven Great Foundations, p. 31.

^{20A}. Hunter Dupree, Science in the Federal Government: A History of Policies and Activities to 1940 (Cambridge: The Belknap Press, 1957), pp. 291-301.

²¹Ibid.; James Harvey Young, The Medical Messiahs (Princeton: Princeton University Press, 1957), p. 7.

²²Medical Research: A Midcentury Survey, I, p. 641; Rosen, Bulletin of the History of Medicine, XXXIX (1965), 217.

²³Ibid.; Stimson, A Brief History of Bacteriological Investigations of the United States Public Health Service, pp. 2, 5, 16. Under Roosevelt's administration the division developed some laboratories for bacteriology, as well as for chemistry and pathology--but most of its work was related to routine administration and to its role as a liaison with state health authorities. Dupree, p. 267; Shryock, American Medical Research Past and Present, p. 46.

²⁴The Spanish-American War had helped somewhat to bring some attention to the need for a better understanding of health problems. In the short war, 541 died of battlefield-inflicted wounds, while 3,500 fell to disease. Consequently, Sternberg was able to emphasize the study of bacteriology and appointed Walter Reed to head a commission to collect data on typhoid fever, the major concern of the Army School. By World War I, and with the cooperation of European researchers, typhoid was no longer a serious military hazard. Ibid., p. 49; Dupree, pp. 264-265.

²⁵Ibid., p. 270; R. D. Leigh, Federal Health Administration in the United States (New York, 1927), pp. 289-290.

²⁶The Hatch Act of 1887 provided federal funds for agricultural stations, which were often associated with universities and were

typically staffed by college professors. By 1906 their work was considered so important as to lead to passage of the Adam's Act, which raised the appropriations for each station from \$15,000 to \$20,000, at a time when the government was recovering from the large expenses of the Panama Canal and the Spanish-American War. Bacteriology was studied in these facilities, particularly as it related to soil fertility. Alfred C. True, A History of Agricultural Experimentation in the United States, 1607-1925, United States Department of Agriculture Miscellaneous Publication, No. 251 (1937), pp. 67-165; True, A History of Agricultural Extension Work in the United States, 1785-1932, United States Department of Agriculture Miscellaneous Publication, No. 15 (1928), pp. 14-57; J. D. B. DeBow, "An Early Demand for Agricultural Research," Science and the Emergence of Modern America, ed. A. Hunter Dupree (Chicago: Rand McNally and Co., 1963), pp. 30-33; Alabama Agricultural Experimental Station of the Alabama Polytechnic Institution, Cooperative Fertilized Experiments with Cotton (1915), *passim*; Iowa State College of Agriculture and Mechanical Arts Experimental Station, The Maintenance of Fertility (1908), p. 4. The agricultural experimental stations played an important role in the development of American science in that they helped establish a solid research tradition in a large number of universities and colleges throughout the country. True, A History of Agricultural Experimentation and Research in the United States, 1607-1925, pp. 119-121, 144. Agricultural research centers served as training grounds for some of the country's fledgling bacteriologists; Theobald Smith, one of the most prominent, was director of the pathology laboratory in the United States Bureau of Animal Industry in Washington, from 1884 to 1895. Clark, p. 120.

²⁷Corner, p. 64.

²⁸Raymond B. Fosdick, The Story of the Rockefeller Foundation (New York: Harper and Brothers, 1952), pp. 6-8.

²⁹Corner, p. 31. Rockefeller had also been influenced by Carnegie's philanthropic activities and his essay, the "Gospel of Wealth," with its message that to die rich was to die disgraced. The piece appeared in 1889 in the North American Review. Fosdick, p. 5. Knowing that the millionaire was an avid reader of this publication, Carl Snyder placed an article in journal in 1902 appealing to Rockefeller's nationalistic pride. Pointing out the achievements of Pasteur, Lister, Behring, Koch, and Kitasato, he noted that not one was American; this, Snyder emphasized, was not a reflection of the talent in America but a sign of its lack of institutions to rival those of Germany and France. He observed that "we have no institutions in America comparable to the Pasteur Institute, no great laboratories where the investigator may go with his hopes and his plans, and work upon them advantageously and in peace," and ventured that "the one cause of our inferiority in a scientific way lies in this want." Snyder, "America's Inferior Position in the Scientific World," North American Review, CLXXIV (January 1902), 59-77. Influences may have traveled back across the Atlantic. Rockefeller Foundation Director of Medical Sciences, Alan Gregg, suggests that the examples of Carnegie and Rockefeller beneficence to the cause

of scientific investigation stimulated the initiation of the Kaiser Wilhelm Gesellschaft in Germany and the British Medical Research Council in 1913. Gregg, The Furtherance of Medical Research (New Haven: Yale University Press, 1941), p. 15. Rockefeller's intentions might not have been as purely altruistic as his biographers would have us believe. It has been suggested that the program he later financed to eradicate hookworm in the South was established primarily for the purpose of combatting an endemic condition that cut down on the productivity of agricultural and industrial workers, much to the detriment of Northern investors. The efforts of his International Health Board overseas can be considered an attempt to create an impression of humanistic concern as a means to lower cultural resistance to American imperialism and economic exploitation. E. Richard Brown, "Public Health in Imperialism: Early Rockefeller Programs at Home and Abroad," American Journal of Public Health, LXVI (1976), 897-903; see also James H. Cassedy, "The 'Germ of Laziness' in the South, 1900-1915: Charles Wardell Stiles and the Progressive Paradox," Bulletin of the History of Medicine, XLV (March-April 1971), 1965-1967. For an explanation of how and why alien medical assistance aroused the suspicion of natives see Frantz Fanon, A Dying Colonialism, trans. Haakon Chevalier (New York: Grove Press, 1965), pp. 121-136.

³⁰Welch, Johns Hopkins Hospital Bulletin, XVII (August 1906), 247-251. As the years proceeded, certain arms of the Institute became directly involved in the worldwide battle to control specific diseases; its initial total commitment to basic research, however, suggests a conscious role assumption and a tacit willingness to "niche-split" with existing organizations with proven records of practical application, notably the New York City Health Department's laboratory. That such an understanding was made looms likely in light of the fact that among the five called in for consultation by Rockefeller were Biggs, Prudden, and Welch. Fosdick, pp. 45-47; Corner, pp. 32-33, 90. Rockefeller had even considered the possibility of making arrangements for use of the municipal laboratory before he had made his decision to build an entirely new facility. Ibid., p. 39.

³¹Ibid., pp. 43-46. Grants-in-aid were generally unknown in this country, but had been provided for years by the British Medical Association and, occasionally, on a small scale, by the American Medical Association. Richard J. Storr, The Beginnings of Graduate Education in America (Chicago: The University of Chicago Press, 1953), p. 31. Among the members of the Board who voted on such awards were Theobald Smith and Simon Flexner. Flexner gave up a professorship at the University of Pennsylvania and served as the first director of the Rockefeller Institute. He personally headed its Division of Pathology and Bacteriology and made it the largest of the laboratory groups. Ibid., pp. 53, 64, 186; Harvey Cushing, The Life of Sir William Osler (Oxford: Clarendon Press, 1925), II. p. 551.

³²Park, "The Great Bacterial Contamination of the Milk of Cities. Can It Be Lessened by the Action of Health Authorities?" Journal of Hygiene, I (July 1901), 391.

³³There were occasional reports of "milk sickness" ("trembles") in the late eighteenth and early nineteenth centuries in America due, it was rightly suspected, to the drinking of milk from animals that had grazed on poisoned plants. Abraham Lincoln's mother, Nancy Hanks, is said to have died of "trembles." Wain, pp. 250-251.

³⁴Ibid., p. 251; Chapin, A Half Century of Public Health, p. 148.

³⁵Ibid.; Duffy, A History of Public Health in New York City 1866-1966, p. 133. In 1843, Robert Hartley, founder of the New York Association for Improving the Conditions of the Poor, published The Cow and the Dairy, which became well known in the campaign against watered milk and helped bring about a law in 1864 aimed at halting such deception. John Spargo, The Common Sense of the Milk Question (New York: The Macmillan Company, 1908), pp. 120-121.

³⁶Duffy, A History of Public Health in New York City 1866-1966, pp. 133-135; Wain, p. 152. See John Morris, Milk: Its Adulteration, Analysis, Etc., paper read before the Maryland Academy of Sciences, 1882, pp. 3-5. Random inspections and microscopic examinations conducted by the Massachusetts State Board of Health revealed the common utilization by dairymen of certain coloring additives "swarming with germs." Not one dairy in the state was found to provide its customers with unadulterated milk. Annual Report of the Massachusetts State Board of Health, 1888, pp. 167-186.

³⁷H. A. Harding, "The Development of City Milk Supply Problems," University of Wisconsin Studies in Science, no. 2 (1921), 29-30; Annual Report of the Philadelphia Bureau of Health, 1894, pp. 207-225; Prudden, Sketches and Letters, p. 87; Times, July 3, 1892, p. 4; November 12, 1892, p. 4; November 20, 1892, p. 4; December 24, 1892, p. 4.

³⁸Koch, American Review of Tuberculosis, XXV (March 1932), 322-323.

³⁹Koch, "An Address on Bacteriological Research," British Medical Journal, II (August 16, 1892), 383.

⁴⁰Ann. Rep., Bd. of Health, 1894, p. 101; Times, November 20, 1892, p. 4.

⁴¹When meat inspectors of the division discovered a tuberculous carcass within city limits, they were under orders to trace its origin to find if it had come from any dairy herd that sent milk to New York City. A veterinarian from the division was sent to the farm and, if tuberculosis was discovered, the State Board of Health was notified and sales of milk from the herd prevented until proof was supplied that all diseased animals were destroyed. The procedure was time consuming and assailed as a health measure akin to "locking the stable door after the horse is stolen." Ann. Rep., Bd. of Health, 1894, pp. 62-63.

⁴²Times, December 24, 1892, p. 4.

⁴³Ibid., July 13, 1892, p. 4; November 12, 1892, p. 4.

⁴⁴Ibid., January 5, 1894, p. 9; January 18, 1894, p. 10; June 7, 1894, p. 4; April 2, 1894, p. 4.

⁴⁵Ibid., February 21, 1895, p. 4; July 24, 1895, p. 12; September 19, 1895, p. 15.

⁴⁶Ibid., March 30, 1894, p. 9; November 9, 1895, p. 8.

⁴⁷Ibid., October 7, 1895, p. 9; October 17, 1895, p. 9; January 5, 1896, p. 4; February 14, 1896, p. 10; September 10, 1897, p. 4; Biggs, British Medical Journal II (1897), 634.

⁴⁸Ann. Rep., Bd. of Health, 1895, p. 31.

⁴⁹Biggs, British Medical Journal, II (1897), 634; Duffy, A History of Public Health in New York City 1866-1966, p. 136.

⁵⁰In 1895, a number of wholesalers and dealers joined together to form an association dedicated to the distribution and sale of healthy, unadulterated milk. Membership in the organization was a guarantee of good standing and presumably carried with it the opportunity for greater sales through increased public trust. Times, September 21, 1895, p. 9; September 27, 1895, p. 7. Millionaire reformer Nathan Straus, stepping up a charitable activity he began in 1893, established a number of milk depots in tenement areas throughout the city. The philanthropist had been influenced by the well-known New York pediatrician, Abraham Jacobi, who estimated that 90 percent of the fatal illnesses of children under one year of age were due to intestinal disorders, most of which resulted from the lack of proper food, especially milk. To reduce the death rate among these youngsters, Straus opened stations for the poor which offered inexpensive, or free, milk that had come exclusively from tuberculin-tested cows and was of a superior quality. Ibid., May 13, 1894, p. 13; May 16, 1894, p. 2; June 9, 1894, p. 2; June 24, 1894, p. 8.

⁵¹The enthusiastic interest of reformers in this matter was a reflection of the humanitarian progressives' concern for the child. Milk was the food of the young, and the young, if protected, nurtured, and guided, would bring society closer to the utopia that the reformers envisioned. Such progress, however, required untiring vigilance and inspection, the introduction of scientifically based procedures, and bureaucratic administration. Wiebe, pp. 145-155, 169. The ultimate development of urban solutions to the milk problem owed much to the impetus of these new reformers.

⁵²"Tuberculosis and Bacteriophobia," Medical Record, L (October 24, 1896), 611-612; "The Alleged Heredity of Consumption," ibid., LII (November 27, 1890), 799.

⁵³J. A. Jeffries, "How is Tuberculosis Acquired?" Sanitarian, CCLXX (May 1892), 411-415.

⁵⁴L. Emmett Holt, "Tuberculosis in Infancy and Early Childhood, With Special Reference to the Mode of Infection," Medical News, LXIX (December 12, 1896), 657-658.

⁵⁵"The Prevention of Tuberculosis," Medical News, LXX (January 9, 1897), 53.

⁵⁶Ann. Rep., Bd. of Health, 1896, p. 271.

⁵⁷Koch, American Review of Tuberculosis, XXV (March 1932), 322-323; Koch, British Medical Journal, II (August 16, 1892), 383.

⁵⁸Ann. Rep., Bd. of Health, 1894, p. 101. Attempts by reformers and health officials to attribute specific tuberculosis deaths to "diseased milk" were more emotional than objective and were based on sketchy and tenuous "evidence." Times, March 30, 1894, p. 9; April 2, 1894, p. 4; November 9, 1895, p. 8; November 11, 1895, p. 4; D. H. Bergey, "Bovine Tuberculosis as a Factor in the Production of Human Tuberculosis, Through the Use of Meat and Milk," Medical News, LXX (January 23, 1897), 102-105.

⁵⁹Harold C. Ernst, Infectiousness of Milk (Boston, Massachusetts, Society for Promoting Agriculture, 1889), pp. 3-37.

⁶⁰U. S. Department of Agriculture, Office of Experiment Stations, Bulletin #25, Dairy Bacteriology (Washington, 1895), pp. 7-9; Gorham, A Half Century of Public Health, p. 83; True, A History of Agricultural Experimentation and Research in the United States, 1607-1925, pp. 158-159. Dr. H. L. Russell served simultaneously as head of the Department of Bacteriology at the University of Wisconsin and as Chief Bacteriologist of its agriculture station. The study of dairy bacteriology here, and elsewhere, provided an important early training ground for American researchers, a matter that has received little attention in the literature. Conn, for example, became a major figure in the public health movement in Connecticut and one of the founders of the Society of American Bacteriologists (1899). Both he and Russell served as President of the organization in later years. H. W. Conn, W. M. Esten, and W. A. Stocking, Classification of Dairy Bacteria (1906), p. 1; H. A. Harding, "The Development of City Milk Supply Problems," University of Wisconsin Studies in Science, no. 2 (1921), 29-30; Clark, pp. 145-148, 185, 314.

⁶¹U. S. Department of Agriculture, Office of Experiment Stations, Bulletin #25, Dairy Bacteriology, pp. 9-19; R. A. Pearson, Farmer's Bulletin #63, Care of Milk on the Farm (Washington, 1897), 21-38; Conn, Farmer's Bulletin #29, Souring of Milk and Other Changes in Milk Products (Washington, 1895), pp. 2-15. Conn warned farmers that they had better take precautions to keep their cows and equipment clean and not fight

State attempts at inspection since "the public is rapidly becoming suspicious of the healthful qualities of our milk supply . . .", ibid., p. 17.

⁶²Philadelphia Bureau of Health, Annual Report, 1897, pp. 113-128; State Board of Health of Connecticut, Annual Report, 1895. p. 11; 1898, p. xx; Gorham, A Half Century of Public Health, p. 83.

⁶³Such involvement by the medical community in matters related to the general health represented an ambitious new approach by physicians in their quest for professionalization and, with it, status and power. Rather than place themselves in the position of opposing public health procedures based ostensibly on the Germ Theory of disease, as they had done in some of the conflicts of the 1890s--during an era when laymen placed great faith in science and scientists--some physicians' organizations seized on the idea of embracing scientific medicine as their own special domain. Kunitz, pp. 16-18; John C. Burnham, "Medical Specialists and Movements toward Social Control in the Progressive Era: Three Examples," Building the Organizational Society, ed. Jerry Israel (New York: The Free Press, 1972), p. 19. The New York County Medical Society--which represented the "regulars"--through its Milk Commission proclaimed itself, by implication, as possessing expertise in bacteriology, declared its humanistic concern for the welfare of society (especially its children), and in a "trust-busting" age became a voluntary watchdog over the milk industry. Underlying the entire effort was the assumption that physicians had an explicit social role in American life--if not individually, at least through their organizations.

⁶⁴Times, February 26, 1900, p. 5; July 22, 1900, p. 21; U.S. Department of Agriculture, Bureau of Animal Husbandry, Market Milk: A Plan for Its Improvement (Washington, 1900), pp. 190-191. In Europe too there was growing concern with the milk supply. Obligatory tuberculin tests on cattle in Belgium, France, and Holland led to the slaughtering of sick animals, although here too there was seemingly little control over contaminated milk once it left the farm. Olaf E. Steinstrom, Tuberculosis in Livestock and the Combating of Disease (1900), pp. 14-28.

⁶⁵Times, June 22, 1901, p. 8; Oliver, p. 191. Biggs' report from the laboratory in 1892 contains one of the earliest accounts purporting to demonstrate the presence of tubercle bacilli in milk. Milk specimens had been sent from a herd in Scarsdale in which bovine tuberculosis had been found. Guinea pigs injected with these samples developed, according to Biggs, generalized military tuberculosis. Ann. Rep., Bed. of Health, 1892, pp. 202-203.

⁶⁶Of the total of 70,872 deaths in New York City in 1900, 36.46 percent (25,836) were children, the second lowest in ten years (in 1899 the figure was 36.42 percent). Looked at another way, the infant mortality rate that year was 189.4 per 1,000 children (five years old and under). The figure for Washington, D.C., was 274.5 per 1,000, and for Charleston, a difficult to believe 419 deaths for each 1,000 youngsters.

Jesse Burks, "Clean Milk and Public Health," Annals of the American Academy of Political and Social Science (March 1911), 442-443; Charles Harrington, "Infantile Mortality and Its Principal Cause--Dirty Milk," Am. Jnl. of Med. Sci., CXXXII (December 1906), 812-813; Ann. Rep., Bd. of Health, 1901, pp. 10-11.

⁶⁷Harding, University of Wisconsin Studies in Science, no. 2 (1921), p. 35. In 1900 over 6,000 children died from diarrheal disorders. Times, June 22, 1901, p. 8.

⁶⁸From 1889 to 1896 the local health department in Rochester took over the production of milk in the summer months. The general health of the children seemed better than in previous years. George Goler, But a Thousand a Year (New York: The Charity Organization Society, 1905), pp. 1-4.

⁶⁹The study which followed, conducted at a time when the exact format of the Institute was not settled upon, demonstrated to John D. Rockefeller that his financial gifts to research could bring about tangible public benefits. Corner, p. 47.

⁷⁰Park, "The Great Bacterial Contamination of the Milk of Cities. Can It be Lessened by the Action of Health Authorities?" Journal of Hygiene, I (July 1901), 391-406.

⁷¹Conn, Esten, and Stocking, Classification of Dairy Bacteria, pp. 1-14; Russell, Bacterial Life of Milk, Address delivered before the Ohio State Dairy Association, February 6, 1901, p. 13; n. 60.

⁷²Health Department Inspectors assisted in the study and took samples of milk right after it arrived within the city's limits. Microscopic examinations of milk on its way to the tenement districts, during the summer months, revealed an average of 1,977,692 bacteria per cubic centimeter, with some samples reaching between 5,000,000 and 6,000,000. During the summer, milk destined to the shops where the poor purchased their food averaged 5,163,000 bacteria per cubic centimeter. Milk from the better dairies that was sent to the more affluent neighborhoods showed only about 10 to 20 percent as much contamination. Park, Journal of Hygiene, I (July 1901), 391-401.

⁷³Ibid., p. 402.

⁷⁴Authorities were having a difficult enough time enforcing existent regulations against the blatantly repulsive practice of adulteration. Dealers arraigned for selling treated milk were almost always bailed out by the wholesalers who supplied them with the product, and so continued on in operation. Times, February 3, 1901, p. 24. Milk reform was further set back when the State Appellate Division declared as unconstitutional laws prohibiting the addition of preservatives to milk. Ibid., April 4, 1901, p. 26.

⁷⁵Park and Holt, "Report upon the Results with Different Kinds of Pure and Impure Milk in Infant Feeding in Tenement Houses and Institutions in New York City," Ann. Rep., Bd. of Health, 1902, pp. 275-276.

⁷⁶At first the intention was to make no change in the food the children received. When, however, it was decided to compare the effects of heated and unheated milk in the summer, it was found that--perhaps due to agitation in the press and Health Department efforts--most of the infants received milk that had been warmed. In order to have a statistically significant number for comparison, and rather than simply search out additional subjects, the investigators "place[d] a number of infants upon a modified [unheated] raw milk provided for them." Ibid., p. 280. As they had done in the past, the Health Department investigators dealt casually and irresponsibly with the lives of the poor.

⁷⁷Ibid., pp. 276-277.

⁷⁸Ibid., p. 277; Letchworth Smith, "The More Common Varieties of Bacteria Met with in the Milk Supplies to New York City Determined from those Occurring in 71 Samples of Milk Selected from Various Places and at Different Times," Ann. Rep., Bd. of Health, 1902, pp. 299-317; Frederick Chester, A Manual of Determinative Bacteriology (New York: Macmillan Co., 1901).

⁷⁹Park and Holt, Ann. Rep., Bd. of Health, 1902, pp. 282-286.

⁸⁰Duffy, A History of Public Health in New York City 1866-1966, p. 250; Times, March 11, 1902, p. 8; Conn, The Story of Germ Life (New York: D Appleton and Co., 1897), pp. 9, 128; John M. Coulter, "Public Interest in Medicine," Popular Science Monthly, LXII (August 1905), 306-308. According to a University of Chicago professor, "men engaged in research are looked upon in general as inoffensive but curious . . ." Ibid., p. 306.

⁸¹Ann. Rep., Bd. of Health, 1898, p. 10.

⁸²Park and Holt, Ann. Rep., Bd. of Health, 1902, p. 296.

⁸³Park, "The Amount of Bacterial Contamination of City Milk-- Is It Practicable to Lessen It?" ibid., pp. 317-329.

⁸⁴New York City Department of Health, Circular of Information Concerning the Growth of Bacteria in Milk, 1901, pp. 1-2; New York City Department of Health, Circular of Information for Farmers Relating to the Collection and Care of Milk, 1901, pp. 1-2.

⁸⁵Times, April 1, 1902, p. 7; May 10, 1902, p. 3; June 3, 1902, p. 3; March 21, 1903, p. 16; September 24, 1901, p. 1. In one instance a \$500.00 fine was slapped on a dairyman based on Health Department findings of adulteration by a judge who declared that "babies of the big city must not die that the up-State farmer may profit . . ." ibid., April 8,

1902, p. 16. In order to keep tighter control over all facets of the milk traffic, a section was added to the Sanitary Code providing that no milk shall be received, held, kept, offered for sale, or delivered in New York City without a permit from the Board of Health, which would only be issued if certain hygienic standards were maintained. Although the regulation extended the Department's authority beyond the city's borders, it was upheld in court on the grounds that it protected children who were too helpless to protect themselves. Ibid., March 21, 1903, p. 16. In 1905 the matter reached the United States Supreme Court, which decided unanimously that the position of the Health Department was reasonable, valid, and not unconstitutional. Ernest Lederle, The Sanitary Control of Local Milk Supplies through Local Official Agencies, Reprint Series, no. 11; New York: New York City Health Department, 1912), p. 8.

⁸⁶Storrs Agricultural Experimental Station, Comparative Studies with Covered Milk Pails (1907), pp. 77-103; State of New York, Department of Agriculture, Bacteria in Milk (Albany: J. B. Lyon, 1902), pp. 9-11; Michigan State Agricultural College Experimental Station, Bacterial Associations in the Souring of Milk (1908), pp. 3-62; Bacteriological and Pathological Laboratory of the Delaware State Board of Health, Bulletin, no. 17 (October 1903), p. 10; "Bacteria in Grocery Milk," Medical Record, LXVI (December 24, 1906), 1020.

⁸⁷The volatile muckraker John Spargo considered clean milk a key factor in preventing a decline of the white race least "the experience of those great civilizations of antiquity be ours." Spargo, pp. 3-4.

⁸⁸Park and Holt, Ann. Rep., Bd. of Health, 1902, p. 283.

⁸⁹Times, June 17, 1907, p. 3; September 22, 1908, p. 6; November 28, 1908, p. 6. Straus traveled to Europe and succeeded in convincing German, English, and Irish authorities to establish milk stations like those in New York. Ibid., May 4, 1908, pt. 3, p. 1; February 2, 1908, pt. 3, p. 1; January 28, 1908, p. 4.

⁹⁰Ibid., April 4, 1909, p. 10; April 12, 1909, p. 4; January 19, 1909, p. 5; January 20, 1909, p. 6; April 27, 1907, p. 6; January 24, 1909, p. 16; December 21, 1908, p. 8.

⁹¹New York City Department of Health, Advice to the Public on the Use of Milk, 1912, p. 1; "Conference of the Delegates Appointed by the Governors of the Eastern and Middle States by the New York Medical Committee to Consider Improvement of State Laws for the Control of Milk Products and for the Suppression of Bovine Tuberculosis," February 5 and 5, 1914, MS, New York Academy of Medicine Public Health Archives; Bd. of Ald., Proceedings, n.s. IV, October 3, 1911-December 29, 1911, p. 144.

⁹²Civil League, Proposed Ordinance for the Regulation of the Milk Supply of Saint Louis, 1912, pp. 2, 10-11; United States Department of Agriculture, A Study of the Bacteria which Survive Pasteurization (1913), pp. 10-66; New York Milk Committee, "Summary of Work Done by the New York Milk Committee during 1914," MS, p. 1, New York Academy of Medicine Public Health Archives.

⁹³Koch's stance, a reversal of his earlier leanings, was based on his own observations and a long series of studies conducted by Theobald Smith from 1896 to 1898 at the laboratory of comparative pathology at Harvard Medical School. Flick, pp. 732, 744-749; Smith, "A Comparative Study of Bovine Tubercle Bacilli and Human Bacilli from Sputum," Journal of Experimental Medicine, III (1898), 451-511.

⁹⁴Flick, p. 737; "The Intercommunicability of Human and Bovine Tuberculosis," Am. Jnl. of Med. Sci., CXXIV (October 1902), 747-749; "Koch's Alleged Discovery," Medical Record, LX (July 27, 1901), 137; "Human and Bovine Tuberculosis," ibid., LX (August 10, 1901), 230-239; "Von Behring's Immunization against Tuberculosis," Medical News, LXXX (June 21, 1902), 189-190; "The Relationship of Human and Bovine Tuberculosis," Am. Jnl. of Med. Sci., CXXVII (February 1904), 373-374.

⁹⁵"Human and Bovine Tuberculosis," Medical Record, LXVI (July 23, 1904, 139; Flick, p. 739.

⁹⁶Ibid., pp. 744-749.

⁹⁷Transactions of the Sixth International Congress on Tuberculosis, II (1908), passim. Park, in a short paper, expressed the view that sputum was the major source of infection, that milk was perhaps also a source, but that the entire matter of how tubercle bacilli gained entrance was still uncertain. Park, "Sources of Tubercle Bacilli Producing Human Tuberculosis," ibid., II (1908), 157-161.

⁹⁸Alfred Hess, "The Incidence of Tubercle Bacilli in New York City Milk," Collected Studies from the Research Laboratory, VI (1908-1909), 64-80 (hereinafter cited as CSRL). From 1905 to 1926 articles by members of the laboratory division, which were published in various medical and scientific journals, also appeared in Collected Studies from the Research Laboratory. The publication contained most of the technical papers written by staff members, reprinted with some revisions, as well as reports and protocols which were unsuited for regular technical journals. Collected Studies joined the growing number of American journals that began to arise around the turn of the century in response to a definite need. In the past, American researchers had to publish their papers in shortened form in periodicals devoted mainly to practical medicine or send them to European journals. Journal of Experimental Medicine, I (1902), p. 1. Consequently three native journals devoted to experimentation in the medical sciences were created; the Journal of Medical Research, started as the Journal of the Boston Society of the Medical Sciences in 1896, edited by Ernst, became the official organ of

the American Association of Pathologists and Bacteriologists; the Journal of Experimental Medicine, founded in 1896 by Welch and published under the auspices of the Rockefeller Institute by 1905; and the American Journal of Physiology, started in 1898. Gorham, A Half Century of Public Health, p. 92; Corner, pp. 62-63. As the amount of experimentation in bacteriology, and other research fields, increased and became more highly technical, the number of journals multiplied. There was, in fact, such a proliferation of periodicals as to lead to the complaint by some scientists that such a tremendous quantity of inferior research had found its way into the literature as to submerge the sound studies and so hinder scientific progress. Thomas Lewis, "Research in Medicine: Its Position and Its Needs," British Medical Journal, I (March 15, 1930), 482; Wilbur C. Davison, "Reflections on the Medical Book and Journal Situation," Bulletin of the History of Medicine, XI (February 1942), 186-188.

⁹⁹"Human and Bovine Tuberculosis," Medical Record, LXVI (July 23, 1904), 139; Flick, pp. 744-749.

¹⁰⁰The findings were issued in a preliminary report in 1909 and in final form in 1910. Park et al., "The Percentage of Cases of Tuberculosis Due to the Human and Bovine Types of Bacilli," CSRL, IV (1908-1909), 7-63; Park et al., "The Relative Importance of the Bovine and Human Types of Tubercle Bacilli in the Different Forms of Human Tuberculosis," CSRL, V (1910), 1-63.

¹⁰¹J. George Adami, an influential authority on tuberculosis, sent a personal note to Park commending him on the study, which he read in a reprint published in the Journal of Medical Research. Oliver, p. 289. Some were not willing to accept such findings and continued to crusade for stringent control of milk at its source. Tuberculin testing and other regulations designed to cut down on bovine tuberculosis were continued, but the emphasis in fighting tuberculosis was placed on education, and the identification and isolation of the sick. Burton Rogers, New Evidence on the Causes of Human Tuberculosis, Speech delivered at the annual meeting of the National Tuberculosis Association, June 8, 1918; Department of Health of the City of New York, Handbook of Information Regarding the Routine Procedures of the Division of Communicable Diseases (New York: J. W. Pratt Co., 1910), pp. 27-28; Keen, Medical Research and Human Welfare, pp. 84-87; S. Adolph Knopf, A History of the National Tuberculosis Association (New York: National Tuberculosis Association, 1922), p. 326; C. E. Ford, "The Municipal Health Department and the Tuberculosis Problem," Transactions of the National Association for the Study and Prevention of Tuberculosis (1914), 365-368.

¹⁰²Park et al., CSRL, V (1910), 1. The only indication that any other research was conducted during this time was a short piece by Park summarizing some work that had been going on for a few years. Park, "Antidiphtheritic Serum and Antidiphtheritic Globulin Solutions," JAMA, LII (January 1910), 251-253.

¹⁰³Medical Society of the County of New York, Medical Directory of the City of New York, 1903, pp. 15, 112; 1904, p. 61; 1905, pp. 51, 209, 259, 291; 1906, pp. 65, 587; 1907, pp. 107, 161; 1909, pp. 141, 162, 208, 300; 1911, p. 191; 1912, pp. 169, 178, 251.

¹⁰⁴Ann. Rep., Bd. of Health, 1906, I, p. 452; New York City Department of Health, Department Estimate for 1910 (New York, 1910), p. 34; n. 103.

¹⁰⁵Murphy had been treated for typhoid fever by Biggs whom he grew to respect and so, by association, became a friend of the Department. Duffy, A History of Public Health in New York City 1866-1966, pp. 257, 284.

¹⁰⁶Times, May 3, 1902, p. 8; June 26, 1902, p. 8; Board of Estimate and Apportionment, Budget for 1901, pp. 61-64; 1902, pp. 25-26; 1903, pp. 74-76; 1904, pp. 89-90; 1905, pp. 98-99; 1906, pp. 80-81; 1907, pp. 86-87; 1908, p. 45; 1909, pp. 35-38; 1910, pp. 10-14.

¹⁰⁷Ann. Rep., Bd. of Health, 1906, I, p. 452.

¹⁰⁸Bd. of Ald., Proceedings (June 6, 1909-June 29, 1909), p. 900. See also New York City Department of Health, Department Estimate for 1910, p. 34, for data on the payroll expenses of the bacteriological laboratory and its note on the "insufficiency of salary appropriations for this Division."

¹⁰⁹For a comprehensive view of the types of apparatus available for bacteriological studies during the period, much of which was imported from Germany, see Bausch and Lomb Optical Company, Bacteriological Apparatus (Rochester, 1900), pp. 5-150; Eimer and Amend, Revised and Enlarged Catalogue of Bacteriological Apparatus (New York, 1907), pp. 6-211.

¹¹⁰Henry P. Walcott, "Address of the President of the Congress," Transactions of the Fifteenth International Congress on Hygiene, I (1913), 70-71; Young, p. 39; Rosen, Bulletin of the History of Medicine, XXXIX (1965), 201; Cushing, p. 551; Corner, pp. 94, 150. Professional staff members of public health laboratories throughout the country had become so deluged with routine responsibilities that a drive began to seek methods for the systematization of such duties and for inexpensive labor-saving devices so that some "attention may be given . . . to keep the laboratories in touch with modern progress." Stephen Gage, "Apparatus and Expedients in the Bacteriological Laboratory," Technology Quarterly, XXI (December 1908), 508.

¹¹¹Cyrus Fields and Oscar Teague, "The Electrical Charge of Toxin and Antitoxin," CSRL, II (1906), 5-55; A. Sophian, P. L. Du Bois, and J. B. Neal, "Studies on Meningitis during 1911," ibid., VI (1911), 15-22; Olga Povitsky, "Tests on Hemoglobinophilic Bacilli from Conjunctivitis in Regard to Their Virulence and Their Agglutinating Properties," ibid., VII (1912-1913), 93-100; E. Steinhardt, "A Preliminary

Note on Spirocheta Pallida and Living Tissue Cells in Vitro," ibid., VII (1912-1913), 104; Harriet Wilcox and Marian Taylor, "The Presence of Diphtheria and Diphtheria-like Organisms in Scarlet Fever," ibid., VII (1912-1913), 105-108.

¹¹²"Introductory Notes to Studies on the Pneumococcus under the Auspices of the Medical Commission for the Investigation of Acute Respiratory Diseases of the Department of Health of the City of New York," Journal of Experimental Medicine, VII (1905), 401-402; Katherine R. Collins, "The Application of the Reaction of Agglutination to the Pneumococcus," Journal of Infectious Diseases, vii (1905), 420-429; Park et al., "A Study of Pneumococci: A Comparison between the Pneumococci Found in the Throat Secretions of Healthy Persons Living in Both City and Country and Those Obtained from Pneumonic Exudates and Diseased Mucous Membranes," Journal of Experimental Medicine, CII (1905), 403-419; Charles Bolduan, "The Communicability of Cerebro-Spinal Meningitis and the Probable Source of Contagion," CSRL, I (1905), 140-171; Mary Goodwin and Anna Von Sholly, "The Frequent Occurrence of Meningococci in the Nasal Cavities of Meningitis Patients and Those in Direct Contact with Them," ibid., I (1905), 177-193.

¹¹³Ann. Rep., Bd. of Health, 1901, p. 34; 1902, p. 68; 1903, p. 65; 1904, p. 73. In 1904 the laboratory conducted 27,198 bacteriological examinations for suspected diphtheria. Ibid.

¹¹⁴Ibid., 1901, p. 34; 1902, pp. 39-40. Considerable pressure from pharmaceutical companies had led the Health Board to adopt a rule in June of 1903 to discontinue the sale of biological products to all locations beyond the city's boundaries. The move was so unpopular that the Health Board reconsidered and, in January 1904, rescinded the order. Ibid., 1903, p. 27; 1904, p. 37.

¹¹⁵Ibid., 1903, p. 143. Doctors filled out "free-slips," for cases where payment for antitoxin would be a hardship on the patient, which were accepted by pharmacists and returned to the Department. A 1903 investigation by the Commissioner of Accounts led to the discovery that certain physicians were abusing the privilege and were charging their patients for antitoxin they received free. Forty doctors were arrested and tried and, although only one was convicted, the practice certainly was reduced as the cash receipts for the sale of antitoxin leaped from \$17,840 in 1903 to \$22,265 in 1904. Ibid., p. 27; 1904, p. 36.

¹¹⁶Park, "Use of Diphtheria Antitoxin in the Treatment and Prevention of Diphtheria," JAMA, XXXIV (April 14, 1900), 904. Adolph Rupp, "Remarks on the Scientist, the Practitioner, and the Antitoxin Treatment of Diphtheria," Medical Record, LX (August 31, 1901), 338; "Reduction in Mortality from Diphtheria Due to the Use of Antitoxin," ibid., LIX (February 2, 1901), 179; "Conclusion Formed after Six Years Experience with the Antitoxin Treatment of Diphtheria," ibid., LIX (January 26, 1901), 146; "A Study of 1778 Cases of Diphtheria," Am. Jnl. of Med. Sci., n.s. XXI (March 1901), 350-357.

¹¹⁷"A Case of Postdiphtheritic Paralysis of Accommodation and Convergence," Medical Record, LXII (November 20, 1902), 831; "So-Called Scarlatina Eruption Following the Serum Treatment of Diphtheria," ibid., LXII (December 6, 1902), 904; "A Case of the Epiphenomena of Diphtheria Antitoxin," Am. Jnl. of Med. Sci., CXXVI (December 1903), 1019-1020.

¹¹⁸Andrewes, p. 268.

¹¹⁹Ann. Rep., Bd. of Health, 1896, p. 9; Park, "The Possibility of Eliminating the Deleterious while Retaining the Antitoxic Effects of Antitoxic Sera," Transactions of the Association of American Physicians, XV (1900), 380-384.

¹²⁰Ibid., pp. 380-388; Oliver, p. 186; Edwin Banzhaf, "Some Notes on the Concentration of Diphtheria Toxin," CSRL, I (1905), 35-36.

¹²¹Andrewes, p. 269; Park, American Journal of Diseases of Children, XLII (December 1931), 1443; R. B. Gibson, "The Concentration of Antitoxin for Therapeutic Use," CSRL, I (1905), 24-26; Park and Binford Throne, "The Results of the Use of Refined Diphtheria Antitoxin, Gibson's 'Globulin Preparation,' In the Treatment of Diphtheria," ibid., II (1906), 3-12.

¹²²See nn. 103, 106, 108.

¹²³A total of over 13,000 were immunized in 1903 and 1904. Ann. Rep., Bd. of Health, 1903, p. 64; 1904, I, p. 73.

¹²⁴"Prophylactic Injections of Diphtheria Antitoxin," Am. Jnl. of Med. Sci., CXXII (September 1901), 352; "The Prophylactic Use of Diphtheria Antitoxin in School Children," ibid., CXXVII (February 1904), 170; Andrewes, pp. 349-350.

¹²⁵Ibid., p. 351; Park, "Antitoxin Administration," Boston Medical and Surgical Journal, CLXVIII (January 9, 1913), 73-76.

¹²⁶New York City Health Department, Hand Book of Information Regarding the Routine Procedures of the Division of Communicable Diseases (New York, 1913), p. 149.

¹²⁷Rosen, "The Bacteriological, Immunologic and Chemotherapeutic Period, 1875-1950," Bull. of N.Y.A.M., XL (1964), 491; Abraham Zingher, Diphtheria Prevention Work in the Public Schools of New York City, New York City Health Department Reprint Series, no. 96 (New York, 1921), pp. 3-5; Park and Zingher, "Diphtheria Immunity--Natural, Active, and Passive," American Journal of Public Health, VI (May 1916), 431-435.

CHAPTER 6

EPILOGUE

By the end of 1922 over a quarter of a million school-aged children in the city had been given lifelong protection against diphtheria under the general direction of the municipal laboratory.¹ It was only fitting that the final stage in the practical eradication of the illness occurred in New York City and under the watchful eye of Park. The effort culminated thirty years of determination, of successes and failures, that saw the Health Department laboratory institute workable means for bacteriological examination, pioneer in the production and utilization of a safe, effective antitoxin, and, finally, play a key role in implementing massive immunization. The laboratory thus served as an institutional agent in bringing to large segments of the population three of the foundations of medicine: accurate diagnosis, effective treatment, and successful prophylaxis. Without the existence of the municipal laboratory in New York City, it is inconceivable that the basic insights into the disease process provided by the early work in bacteriology could have been turned to practical advantage to such an extent during the 1890s and the early decades of the twentieth century.

Just as the earlier sanitary reform movement had led to the creation of the public health department, the public health laboratory developed as a practical outcome of the bacteriological revolution.² Due to circumstances already described, it was in New York that this

phenomenon occurred most rapidly and successfully. Under Biggs' vigorous leadership the bacteriological division evolved as an institution that exemplified the government's ability to play a crucial role in protecting the health of its people. As there developed an increasing awareness of the successful applications of bacteriological procedures, representatives from around the world--from private and governmental research and public health institutions--visited or corresponded with the New York City laboratory to learn its methods. During the years immediately following World War I, especially, scores of foreign scientists and health officials came to the city, often under grants or fellowships provided by the Rockefeller Foundation, specifically to work with Park and to study the laboratory's research techniques and the manner in which it delivered health services to the public.³

Although the bacteriological division of the Health Department served as a model facility, its role as a vital center for innovation in research had faded and had been supplanted by others. From the turn of the century, private foundations and universities became the major force in providing the operational framework for health research. Concerted efforts by the American Medical Association, the American Public Health Association, and private and public organizations for greater federal involvement led to the act of Congress in 1930 that formally created the National Institute of Health (from the old Hygienic Laboratory) and eventually resulted in the massive role of the national government in supporting scientific investigation through a variety of agencies.

In the interval following the scientific breakthroughs of the 1880s and 1890s, and prior to the creation of well-supported facilities

to pursue the gains of the bacteriological revolution, the New York City Laboratory served an important function as a transitional institution. It not only brought about a marked improvement in urban health and set the standard for other municipal and state laboratories, but it also served as a catalyst to hasten the development of those institutions which would take over the complex experimental problems that emerged.⁴ At a time when the opportunities for advanced scientific study in American universities were few, the New York City Health Department laboratory--and others throughout the country fashioned after it--provided the training grounds for many of those scientists who would make important discoveries in later years.⁵

The laboratory's function as a focal point for the direct implementation of public health procedures--a role it appeared to be assuming during the 1890s--was drastically reduced by the actions of the medical community. During an age when "regular" physicians felt that their status and, with it, their incomes were being eroded by excessive competition--from both fellow allopaths and sectarians--doctors reacted with hostility to health innovations that seemed to come between them and their patients, especially when such interference emanated from governmental agencies. Seizing on the successful centralizing tendencies of the Progressive era, physicians began to respond to the calls of those colleagues who warned "organize or perish."⁶ In a period of only about ten years, the American Medical Association went from being an ineffectual, factional society to a powerful voice for American medicine.⁷

Along with centralization of power came a new approach to bring about the desired transformation of the public's image of the physician.

The medical community began a campaign to establish firmly its claims to professionalism--a status that would bring with it the privileges of autonomy and society's license to shape the direction of health-related matters. In an urban-industrial age which looked to the "expert" for the solution of highly technical problems, the path chosen by organized medicine was to demonstrate its possession of some special area of knowledge that it alone could employ in the behalf of society. Bacteriology--in the past largely associated with the efforts of public health reformers--was thus embraced by the medical profession in an effort to substantiate its "expertise" and thereby elevate its social status.⁸ Although many private practitioners felt uncomfortable alongside members of the newly emerging medical elite, i.e., types like Welch--university based and often with German training--they nonetheless joined forces with them.⁹

During the Progressive era physicians thus involved themselves in campaigns directed against impure milk, tuberculosis, and venereal disease, and played a key role in the mental health movement. These crusades gave the profession the opportunity to take a public stance as scientific reformers on matters of social pathology. Furthermore, each of these movements emphasized the need for environmental manipulation and so diverted attention from public health procedures that would have dealt directly with the individual and thus interfered, in some way, with the doctor-patient relationship.¹⁰

To enhance their image in an era when public health reformers were generally admired, an increasing number of physicians joined the American Public Health Association.¹¹ A small group of the medical elite--

most notably Welch--figured prominently in the drive for graduate schools of public health and dominated these institutions once they were created.¹² Upon obtaining the power to establish standards of medical education and gaining virtual control over the licensing of physicians, the sovereignty of the American medical community over the structure and operation of the nation's health system was almost absolute.¹³ Under such circumstances public health institutions, like New York City's bacteriological laboratory--having no political muscle and no powerful champions, and no longer posing a real threat to the private practitioner--continued on and accommodated themselves to a subordinate position in the overall health care picture. Then, too, there was a sizeable decline in the incidence of infectious diseases in the early decades of the twentieth century so that more and more attention was directed to non-microbial ailments, i.e., heart disease, cancer, congenital disorders, diabetes, etc., that were outside the realm of public health laboratories.¹⁴

Despite its diminishing impact, some of the municipal laboratory's practical efforts went on uninterrupted. During the First World War it increased substantially its production of vaccines and serums on the request of the Army, Navy, Red Cross, and other relief organizations.¹⁵ Throughout the 1920s the number of bacteriological diagnostic services was expanded and the manufacture of various medications continued. By the early 1930s the laboratory's activities had outgrown its facilities and so a new eight-story building was erected at East Sixteenth Street and opened in 1936.¹⁶

On September 30, 1936, after forty-three years of service,

William Park retired as Director and was replaced by Dr. Ralph Muckenfuss, who had been appointed Assistant Director in July 1935.¹⁷ In the year of Park's retirement, a non-profit corporation, Health Research Incorporated, was organized to receive and administer funds for research, in connection with the municipal laboratory. Mayor Fiorello LaGuardia had become convinced of the need for the Health Department to play a greater role in basic research and approved the program. Soon it was decided that extensive reorganization was essential to establish a solid research commitment and so long-term contractual agreements with the city were arranged. The result, although brought about through the efforts of LaGuardia and persons outside the Health Department, was the Public Health Research Institute; formalized in 1941, it was the first American municipal public health research institute. The State government agreed to match the funds spent by the city, which began at \$100,000 and reached \$400,000 annually by 1952.¹⁸

The municipal laboratory division continued on and was essentially unaffected by the creation of the Institute. The laboratory set up a Tropical Diseases Diagnostic Service for returning personnel after World War II, branch laboratories for cancer detection, Rh testing facilities, and a Virus and Rickettsial Laboratory.¹⁹ Its duties thus remained largely routine and in 1959, in an attempt to breathe new life into the division, Health Commissioner Baumgartner appointed Morris Schaeffer its director and, at the same time, chief of the Division of Laboratory Diagnosis in the Public Health Research Institute.²⁰

In 1963, after years of planning, construction of a new building was begun on First Avenue, between Twenty-Sixth and Twenty-Seventh

Streets, to house the research laboratories of the Institute and the municipal division. Beginning in 1968, all units of the Public Health Research Institute, and most of the laboratory and clinical subdivisions of the Health Department's laboratory branch, had moved into the structure.²¹

The imposing, modern building on First Avenue stands directly across the street from the old Carnegie Laboratory (now serving as a Basic Science building for New York University's College of Dentistry) and the Bellevue Medical Center. These two facilities played a part in the creation of the New York City Health Department's bacteriological laboratory which thus, in a sense, returned to the location of its birth seventy-six years earlier. It is doubtful that, today, more than a handful of the staff are aware of this, or appreciate the rich and important history of the institution which played such a gigantic role in the development of modern bacteriology and the public health movement.

NOTES

¹Park, "The Use of the Schick Test before and after Injection of Toxin-Antitoxin for Immunization," New York State Journal of Medicine, XXVI (April 15, 1926), 347-348; Park, "Toxin-Antitoxin Immunization against Diphtheria," JAMA, LXXIX (November 4, 1922), 1584-1590; Park and Zingher, "Immunity Results Obtained from Diphtheria Toxoid (Modified Toxin), and One-Tenth L+ Mixtures of Toxin-Antitoxin in the Public Schools of New York City (Manhattan and the Bronx)," American Journal of Diseases of Children, XXVIII (October 1924), 464-478.

²Rosen, A History of Public Health, pp. 334-335.

³Letter from B. Tohary, Hungarian health official, to Park, September 17, 1936; Letter from J. C. G. Ledingham, Director of the Lister Institute of Preventive Medicine, London, to Park, September 18, 1936; Letter from H. H. Dale, British National Institute for Medical Research, to Park, September 15, 1936; Letter from D. Louis Martin, Director of the Pasteur Institute, Paris, to Park, September 9, 1936; Letter from A. Sorelli, Director of the Argentinean Institute of Bacteriology of the National Department of Hygiene, Buenos Aires, to Park, September 15, 1936; Letter from L. Hirszfelt, Director of the Department of Bacteriology and Experimental Medicine of the State Institute of Hygiene, Warsaw, to Park, December 10, 1936. The laboratory continued to be a model in America too. Some of the activities of the Laboratory Section of the American Public Health Association, and its operating assumption that the "public health laboratory is an essential part of government health organization," stemmed from the work done in New York. Howard Bodily, "The First Section: Laboratory," American Journal of Public Health, LXIII (August 1973), 668-669.

⁴Fosdick, p. 5; Shryock, Medicine in America, Historical Essays, p. 201; Shryock, The Development of Modern Medicine, p. 33; J. Scott MacNutt, A Manual for Health Officers, 1st ed (New York: John Wiley and Sons, 1915), pp. 54-57; Stimson, pp. 1-5; Dupree, pp. 296-297.

⁵Among those who received some of their training at the laboratory and who were to make important contributions to bacteriology were: Aristides Agramonte, Georgia Cooper, Josephine Neal, Bela Schick, and Abraham Zingher. Oliver, pp. 181, 319-324, 357-359, 441-444.

⁶Samuel P. Hays, "Introduction: The New Organizational Society," Building the Organizational Society, pp. 1-3; Markowitz and Rosner, p. 87.

⁷From about 8,400 doctors in 1900, the membership of the AMA leaped to 70,000 by 1910. Ibid.

⁸Kunitz, pp. 18-20.

⁹Markowitz and Rosner, p. 87.

¹⁰Burnham, pp. 20-29.

¹¹Terris, p. 62.

¹²Fleming, pp. 182-184.

¹³Kunitz, pp. 22-26; Markowitz and Rosner, p. 100; Woodworth, pp. 496-503.

¹⁴The assumption that bacteriological discoveries have been a major factor in bringing about significant improvements in the general health over the last one hundred years has been challenged in Thomas McKeown, The Modern Rise of Population (New York: Academic Press, 1976), passim. Another very recent work notes the losses to the patient, the doctor, and society resulting from too great a dependence on the findings of diagnostic laboratories. Stanley Joel Reiser, Medicine and the Reign of Technology (Cambridge: Cambridge University Press, 1978), pp. 171-172, 183-188.

¹⁵Ann. Rep., Bd. of Health, 1918, pp. 85-87.

¹⁶Charles Neisdorf, "History of the Bureau of Laboratories," Report on the history of the laboratories in their later years, prepared for the dedication of the Public Health Research Institute Building in 1968, p. 11 (typed).

¹⁷Oliver, pp. 448-471.

¹⁸Neisdorf, pp. 11-12; Duffy, A History of Public Health in New York City 1866-1966, pp. 369, 404.

²¹Neisdorf, pp. 19-24.

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