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THEOBALD SMITH; INVESTIGATOR AND MAN[1]

By Professor SIMON HENRY GAGE

CORNELL UNIVERSITY

To understand even imperfectly any human being, it is necessary to know something of his heredity and his environment.

Theobald Smith's hereditary endowment came from skilled workers and teachers. Engrained therefore in his very being were the sterling qualities of industry and intellectual appreciation.

He was born in Albany and spent his childhood and early manhood in the state of New York preparing for his life-work. In 1884 this began in the Bureau of Animal Industry in Washington, and continued there until 1895. In 1895 he was called to Boston to aid in the State Board of Health and to join the staff of the Harvard Medical School, where he remained until 1915, when he removed to Princeton to assume the directorship of the Department of Animal Pathology of the Rockefeller Institute for Medical Research. In this position he remained as director and emeritus director to the end of his life in 1934.

Theobald Smith had his beginning and entire career of seventy-five years in one of the most stirring periods in human history, 1859–1934.

As the study of astronomy had taken the material universe out of the maze of superstition and made the earth, not the center of the universe, but only a minor part of it, so organic evolution had put living things

[1] Address at the Theobald Smith Memorial Session of the American Association for the Advancement of Science before the joint meeting of the Section on Medical Sciences (N) and the Central New York branch of the Society of American Bacteriologists, the president of the association, Dr. E. G. Conklin, presiding. The address was given in the room where ten years before at the dedication of the Rochester School of Medicine and Dentistry, Dr. Smith had lectured on "Immunity, Natural and Acquired." A large portrait of Dr. Smith at the age of 62 was hung on the wall in front of the audience.

in the realm of orderly development subject to definite laws.

Disease likewise was being taken from the regions of mystery in which it had been considered the arbitrary infliction of supernatural forces and was being proved to be the result of natural causes and subject also to laws which were slowly being discovered. Dr. Smith was destined to be one of the foremost leaders in that discovery.

Education, too, was feeling the pulsations of the inspiring period, and it became increasingly clear that study of the humanities alone was not sufficient preparation for the new era, but that there should be added the acquisitions that science and engineering were increasingly ready to give.

Theobald Smith heard the inspiring call and added to the thorough discipline that mathematics and the classics offered a thorough grounding in physics, chemistry and biology. To these he added what medicine, that great mother of science for countless generations, could give. In a word, he had prepared himself to play a part in his day and generation. This was in 1883.

It may be recalled that in this period the country was confronted not only with the deadly scourges of tuberculosis, malaria, diphtheria, typhoid and yellow fever for human beings, but that animal diseases were causing such appalling losses among the live stock that the food supply of the country was menaced and the government had established a Bureau of Animal Industry to meet the demands for help. It was Dr. Smith's good fortune to join the group that was to make the crusade and, as pathologist and bacteriologist, to act as leader in finding out the causes of the deadly plagues that were destroying the live stock.

It will be remembered, too, that in this period was proved absolutely untrue the long-held belief in spontaneous generation in all living forms, even the lowly bacteria demonstrated by Van Leeuwenhoek in 1675. And it was being shown with increasing certainty that the microscopic forms of life were the active agents for many types of disease and death. Lister was showing month by month that the sepsis that had haunted the hospitals might be eliminated by the exclusion of the deadly microbes from wounded surfaces, thus making surgery safe for all the world.

Dr. Smith appreciated deeply the significance of the microscopic forms of life for medicine, promptly became master of the methods of bacteriology already known, and soon added other methods and refinements of his own, which gave increasing certainty to the findings.

Of course, in dealing with a life so rich in accomplishments, only a few high points can be touched in a short appreciation like this.

The first great field of battle Theobald Smith entered was that on which was made the fight against the diseases that were mowing down the pigs by the thousands and threatening that important source of the food supply. He found the pigs such a favorable culture medium for multitudes of bacteria and parasites that it had up to that time proved impossible to separate the deadly ones from those less harmful. Here then was a field for the full exercise of his penetrating mind and his persistent quest. He brought something like order out of the chaos by showing that not one but two special diseases were attacking the pigs, swine plague and hog cholera, the first affecting the respiratory and the second the digestive system. Further, there were made the beginnings by which swine diseases were to be controlled; it may be added in passing that the efforts are still being made.

Perhaps the discovery of greatest significance in these investigations by Dr. Smith was that immunity might be produced by the help of the very agents of death themselves, by using the products of their life activity. It will be recalled that immunity itself had long been sought by the use of the actual virus transferred from one human being to another, as for smallpox, but often with fatal effects, until Jenner in 1776 proved conclusively that the harmless cowpox gave the immunity; and Pasteur and others showed in 1880–82 that the aging of some and the moderate heating of other microbic cultures might, while rendering the bacteria comparatively harmless, also induce immunity against the fatal effects of active cultures of the same germ. Dr. Smith's discovery was the possibility of gaining the immunity, not by the virus itself, but by the metabolic products of the living organisms composing the virus. This finding was published on February 22, 1886, and the three short paragraphs of the conclusion state the case so clearly that they deserve to be quoted verbatim:

(1) Immunity is the result of the exposure of the bioplasm of the animal body to the chemical products of the growth of the specific microbes which constitute the virus of the contagious fevers.

(2) These particular chemical products are produced by the growth of the microbes in suitable culture liquids in the laboratory as well as in the liquids and tissues of the body.

(3) Immunity may be produced by introducing into the animal body such chemical products that have been produced in the laboratory.

Dr. Smith continued the study of immunity all his life, and gives the subject a prominent place in his last great work published in 1934. That artificial immunization is not a panacea for all microbic diseases is in accord with the complexity of nature so fully comprehended by Dr. Smith, and implied in his re-

peated assertions that man must work with nature and recognize as best he can the varying constitutions of different forms and their reaction to morbific agencies.

While the work on swine diseases was in full progress, Dr. Smith wrote in 1884, "We shall soon attack that still unsolved mystery of Texas fever." And it was a mystery that had baffled the most expert pathologists of Europe and America for a generation. It was both deadly and mysterious. Apparently healthy cattle from the South when brought to the North left a trail of death for northern cattle, and when northern cattle were taken South they were almost certain to become infected and die, although the southern cattle among which they were herded seemed entirely well.

As Jenner had listened to the dairy maid when she told him of the protection against smallpox that the cowpox would give, so Dr. Smith acted on the hint of the southern cattlemen that in some way the cattle ticks, almost universally present on southern cattle, were the agents that carried the disease from animal to animal. He insisted, however, that for the final elucidation of the mystery there must be a herd of southern cattle near the laboratory and under absolute control. With these tick-infested animals under laboratory control, it was proved conclusively by experiments continuing over several years that with the ticks the cattle were a menace to northern cattle, but without them they were harmless. In a word, "No ticks, no Texas fever." Let me quote Dr. Smith's own statement of the final solution of the real problem:

> You see that after it had been shown that the disease failed without the ticks, everything was still to be done. Nothing was known of the nature of the disease, whether it was a liver or an intestinal and septicaemic disease. However, the very first case gave me the clue, and then the existence of blood parasites naturally suggested some ectoparasite to draw them out. But how did the animals become infected? Did they eat the ticks? Did the young ticks produce a toxin? Were the intraglobular bodies degenerated red cells? To say that a protozoan parasite passes from old to young ticks through the egg and then into the mouth parts required some proof before it would be accepted at that time. The entire work fell on me as every case had to be blood-examined and the corpuscles counted. The final experiment of breeding the young ticks from the eggs and putting them on the cattle I did myself. It required four years of slavery at the microscope, at autopsy, at watching tick broods, at the long labor of preparing the report.

As in nature Texas fever never appears without ticks, it follows logically that to avoid the disease the ticks must be eliminated from the cattle. That relatively simple process is saving the cattle industry of the South, and making it safe for northern cattle to be taken South, and for tickless southern cattle to be brought to the North.

While the economic significance of the Texas fever work of Dr. Smith can hardly be over-valued, it has even greater significance for human medicine and for biology. It showed unmistakably that, in mammals, insects (arthropods) may carry deadly disease germs from individual to individual; and still further, that in some cases the germs may be carried over from generation to generation of the insects through the eggs. These demonstrations (the first for insect-borne diseases) opened the road to others to find out how insects transmit malarial parasites from person to person, also the germs of sleeping sickness, yellow fever, typhus fever, spotted fever and many other diseases; the list is increasing year by year. Subsequent investigations have also shown that the Texas fever tick is not the only animal that transmits germs through the eggs to the next generation; this method has been found in several other insects, and even in forms as high in the zoological scale as some birds.[2]

Since I deeply appreciate that a speaker must always keep in mind the danger of the bias that personal friendship may induce, I shall quote the estimate of one whom all men revere on this work. At the banquet on the opening of the Theobald Smith House at Princeton, Dr. William H. Welch said, after he had spoken of the swine diseases:

> Then came quickly the study of Texas cattle fever, that work of the time in the study of infectious diseases, and simply immortal work, one of the most brilliant pieces of one of the most important contributions made in the history of medical research, beginning first with a thorough study of the insect conveying the disease, one of the dis-

[2] To readers not familiar with the Texas fever malady, it may be stated that it is characterized by high temperature, often to 106 or 107 F., rapid pulse and breathing on the least exertion and frequently haemoglobinuria. It is essentially a blood disease with destruction of the red blood corpuscles. The number may fall from the normal five to six million per cubic millimeter to less than two million; sometimes to even one million. Toward the end, the loss may be one million in twenty-four hours. This loss of the blood corpuscles can not be accounted for by the relatively small amount of blood drawn by the ticks attached to the cattle. It is not a bacterial disease, but one due to a protozoan parasite which destroys the red corpuscles. The wonder increases as it appears that the parasite is introduced into the cattle by the bites of the young ticks that have carried the parasite from its mother through the egg from which it was hatched, that is, from one generation to the next through the egg. This is the first instance conclusively demonstrated where insects (Arthropods) carry disease germs from animal to animal. Pasteur showed in the 60's that disease may be carried in the eggs to infect the new generation of silkworms, but this demonstration of Dr. Smith showed that insects may transmit disease to an entirely different species, a proposition so novel that it was designated at the time in America as "a romance in pathology" and in some famous foreign laboratories as the "American fairy-story and humbug."

eases of the group to which malaria and yellow fever belong. The significance of Dr. Smith's work on Texas cattle fever is hardly yet realized. . . . This discovery of Theobald Smith's, which I regard as one of the greatest ever made in this country, and as being the first in this whole group of insect-borne diseases, including the mosquito-carried malaria and yellow fever, had a very real relationship to human disease of this nature.

Let us now consider another investigation by Dr. Smith which poured new light upon that great scourge affecting both animals and men, namely, tuberculosis. In 1886 he presented a paper before the American Association for the Advancement of Science—"On the Variability of Pathogenic Organisms as Illustrated by the Bacterium of Swine Plague." From time to time afterward, he returned to this variability in discussing diseases and their manifestations, the inevitable necessity for variability with changing environment and the stress upon the organism when adapting itself to a parasitic life. The first and fundamental postulate is that parasitism is not an original condition in any form, but has come about by adaptation in the struggle for existence, and from the general law of the survival of the fittest. Only those which can adapt themselves to their changing environment will finally survive. As environments are so varied and changing, it follows inevitably that adaptation requires compensating changes in the parasitic organism.

With these broad principles in mind, Dr. Smith, in his investigations on tuberculosis from 1894–1898, was prepared to find modifications in the tubercle bacilli of different animals, contrary to the prevailing belief ever since the discovery of the tubercle bacillus as the etiological factor in tuberculosis by Koch in 1882, that in all mammalian tuberculosis, at least, there was but one form of bacillus, and that it might pass freely from one species to another. With his usual skill and persistence Dr. Smith commenced in 1894 to determine the facts. In 1896 he stated his preliminary conclusions before the Association of American Physicians. In 1898, in the *Journal of Experimental Medicine*, he published "A Comparative Study of Bovine Tubercle Bacilli, and of Human Bacilli from Sputum." In the sixty pages of this great paper, he presented the evidence backed by experiments as rigid as those used in the Texas fever work and decided that there were two types, one for the human being, the *human type* and the other for the ox, the *bovine type*. The two types were recognizable, first, by their form; second, by their growth and reaction in culture media; third, in the vital test of interchange between humans and bovines; and fourth, by the change in virulence in the two forms.

The wholesale transmissibility from bovine to human and the reverse did not occur. In spite of the possibility of the transmission by way of the milk and meat of the bovine so universally used as food, the bovine tubercle bacillus was very rarely found in human beings, and then mostly in the intestinal tract of children who had eaten the raw milk of tuberculous cattle. The relief that this brought can hardly be overestimated. It was a terrible outlook when it was thought that every piece of beef and every cup of milk might carry the dreaded germs of tuberculosis to adults and children.

It seems too bad to omit so much of Dr. Smith's important work, not to follow that work to the end of his life; but time will allow only a brief characterization of him as a human being. After all, we like to have some idea of an individual's human qualities as well as his purely intellectual achievements, so in the remaining time I shall speak of him as a man.

If in the eyes of his colleagues and fellow workers Dr. Smith seemed a model investigator, to those who knew him intimately he seemed also a model man. He was considerate, absolutely honest in mind and heart, a most delightful companion, whether in outings in the mountains of New York and New Hampshire or at the national scientific meetings. He was always ready to take his full share of the necessary labor and by his intellectual vivacity to add brilliancy as well as happiness to the occasion. Then, in addition, we felt instinctively that he was one of the great of the earth.

How he was looked upon by those working with him may perhaps be best expressed in their own words. In 1895, when Dr. Smith was about to leave Washington for Boston, Dr. V. A. Moore, who had been Dr. Smith's assistant and had been recommended by Dr. Smith to become his successor as director of the pathological laboratory in the Bureau of Animal Industry, wrote:

Whether I can do work enough to keep up the reputation of this division is a difficult problem for me to face. Dr. Smith is the most wonderful man I ever met; and the amount of work he can accomplish is phenomenal.

The following is the testimony of the beloved emeritus president of Harvard University, who had with Dr. Walcott induced Dr. Smith to go to Boston to develop a laboratory for the production of safe vaccine for protection against smallpox, and for the preparation of antitoxin to safeguard against diphtheria and tetanus, and to build up a department of comparative pathology in the Harvard Medical School. President Eliot said:

Dr. Theobald Smith has stood for me ever since I have known him as a completely satisfactory type of the modest scholar; simple, modest, candid, diligent, accurate, inventive, imaginative and conscientious, loving truth, seek-

ing truth for its own sake and also for a remoter object, the welfare of mankind, the good of his fellow men.

At this same banquet when President Eliot spoke in farewell to Dr. Smith as he was leaving Boston for Princeton to create the Department of Animal Pathology in the Rockefeller Institute for Medical Research, Dr. Simon Flexner said:

Indeed, it was Dr. Smith's vision of such an independent department of animal pathology, itself conceived on broad lines, that made it attractive first to his colleagues in the directorate of the Rockefeller Institute, and then to the founder, John D. Rockefeller, Jr., who was to give it his financial support. This support, you may be interested to know, came promptly as soon as it was known that Dr. Smith would undertake the direction of the new work himself. I need not, in this company, who hold Dr. Smith's services at so high a value, say that he of all men, not only in this country, but in the world, is the best fitted to fill that office.

Here is another tribute which came after his service as Harvard exchange professor at Berlin in 1911–12. The director of the Bureau for Exchange Professorships wrote to President Lowell concerning the impression Dr. Smith had made: "The whole learned world looks upon Dr. Smith as the best type of the American scholar and the American gentleman."

From this list of tributes I can not leave out that of Dr. Conklin, chairman of the Princeton Chapter of the Sigma Xi: "Although he was one of the most illustrious members of this society, he was so modest, so simple in manner, so sincere in word and deed and so kind a friend, that our admiration for his achievements was ever mingled with affection for the man."

But after all, it is from his letters and addresses that we can gain the truest glimpse of Theobald Smith's real character. In an address upon research he thus depicts what seems to him the right spirit:

It is needless to say that the position of the research worker of the immediate future will not be an easy one. . . . The gap of years and even generations may yawn between the problem in hand and its actual solution. It may be wholly impregnable from the point of attack. It may be solved by some obscure genius with slight facilities who happens to hit the combination which unlocks the secret. . . . The researcher does not march with the procession, but he must do lonely, outpost duty.

Again, in the address upon "Scholarship in Medicine":

The scholar's rewards will always be small. The distinguished men who have gone before have not been in the habit of thinking of themselves, and this habit should not be encouraged. In the future ideal state of society, when we shall be doing our tasks instinctively, when we shall say with Luther, "I can do naught else, God help me," we shall not be thinking much of ourselves.

Take also this sentiment expressed near the close of his career:

We who have dealt with the finitely small living things have, perhaps, as much a sense of the highly complex, unfathomable, the eternally elusive in the universe as do those who look for the outer boundaries of space. Each group contributes a different story of the same final significance.

How truly do these quotations sum up the noble character and lofty spirit of Theobald Smith!

The great Newton said near the end of his life:

However I may appear to others, to myself I seem to have been only like a little boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me.

So Theobald Smith near the close of his life wrote:

As I walk home from the laboratory, I think how little I really know about the things I am working upon.

Yet these two brave spirits did not cease from labor as the shadows lengthened, but lived what Longfellow said in his "Morituri Salutamus":

What then? Shall we sit idly down and say
The night hath come; it is no longer day?
The night hath not yet come; we are not quite
Cut off from labor by the failing light;
Something remains for us to do or dare. . . .
For age is opportunity no less
Than youth itself, though in another dress,
And as the evening twilight fades away
The sky is filled with stars, invisible by day.

NOTE: The career of Theobald Smith may be summarized thus: He was born in Albany, N. Y., on July 31, 1859, and died in the New York Hospital on December 10, 1934. His early education and preparation for college were gained in the schools of Albany. In 1877 he entered Cornell University and graduated with the degree of Ph.B. in 1881. In 1883 he received the medical degree (M.D.) from the Albany Medical College. During a part of the time between 1882 to 1884, he did graduate work in biology at the Johns Hopkins University, at Toronto and at Cornell Universities. From 1884 to 1895 he was director of the pathological laboratory of the Bureau of Animal Industry in the United States Department of Agriculture at Washington, D. C. On May 17, 1888, he was married to Lilian Hillyer Egleston. Three children were born in this family—Dorothea, Lilian and Philip. In 1886 he established the department of bacteriology in the Columbian (now George Washington) Medical School, and taught the subject until 1895. So far as can be found this was the first department of bacteriology in a medical school in America. In 1888 he gave some lectures on bacteriology in its relation to hygiene in Cornell University and thus established bac-

teriology in that institution. From 1895 to 1915 he was director of the pathological laboratory of the State Board of Health of Massachusetts and developed means for the production of vaccine for protection against smallpox and for the production of antitoxin for diphtheria and tetanus. From 1896 to 1915 he also served as professor of comparative pathology in the Harvard Medical School. In 1915, he accepted the position of director of the department of animal pathology of the Rockefeller Institute for Medical Research at Princeton, N. J. Here he served until 1929, when he became emeritus director. In 1911–12 he was Harvard University exchange professor at Berlin. In 1926 he was president of the International Society against Tuberculosis and of the Congress of American Physicians and Surgeons. He was a member of many of the great societies and associations for the betterment of mankind and the advancement of science and medicine. In 1886 he became a member and in 1887 a fellow of the American Association for the Advancement of Science. He was a member of the great college societies of Phi Beta Kappa, Sigma Xi and Phi Kappa Phi. He received twelve honorary degrees from leading universities and eleven medals, among which was the Copley gold medal of the Royal Society, generally regarded as the highest scientific award in the world. His additions to knowledge are contained in the 280 publications noted in the "Theobald Smith Bibliography" so painstakingly and accurately compiled by Dr. Earl B. McKinley and Ellen Grey Acree, of George Washington University Medical School. S. H. G.

PRESENTATION OF THE 250 THOUSANDTH BAUSCH AND LOMB MICROSCOPE TO PROFESSOR FREDERICK G. NOVY

ADDRESS OF WELCOME BY THE PRESIDENT OF THE BAUSCH AND LOMB OPTICAL COMPANY

ROCHESTER is particularly proud and fortunate to have this meeting of the American Association for the Advancement of Science. We feel that it is a particularly fitting thing that you should meet here because of the close association between the type of industry and manufacture that is carried on in our city and the aims and ambitions of the association. We think also that it is particularly fitting, because here there is a close association of industrial effort and education, all in the interest of furthering the same types of objectives which prompt the American Association.

From the educational standpoint we have in Rochester, of course, our University of Rochester, with which you are all reasonably familiar. This is an institution without ambitions of great size and magnitude, but an institution that has for its objective a very high-grade, perfected job of education. Then we have here the Mechanics Institute, which is, we believe, an outstanding educational endeavor. Mechanics Institute was founded by Captain Henry Lomb, who was one of the co-founders of the Bausch and Lomb Optical Company. In the Mechanics Institute there is a program of education of a vocational nature which we believe is outstanding. I need not tell you anything about the public school system of Rochester. We have here also an outstanding project in the sphere of education.

I won't begin to mention the many industrial establishments which are located in our city but which are intimately interwoven with the scientific endeavor of the country. We are here making contributions to science, just as in turn science is making contributions to our own industrial efforts.

We are very, very proud to have this ninety-eighth meeting of the American Association, and we of the Bausch and Lomb Company are particularly pleased because there is a certain amount of coexistence in your organization and ours. Our company is to-day eighty-three years old and an institution which has been conducted, I am glad to say, very effectively, dependent in many respects on the assistance and help of people like yourselves in this country, interested, as you are, with us in this scientific endeavor, and at the same time we are trying to make our contributions to assist you in the fine work which you are doing.

The Bausch and Lomb Optical Company is also very pleased to have you here as our guests to-day. It was a problem of considerable magnitude to know just how many of you were going to be here, but I am glad to say that as I stand here it looks as though we have a capacity house. We are glad to have you as our guests, and we hope as the years go on you will be so favorably impressed by what we have to offer in Rochester that in a not too far distant time you will want to come back and visit us. I am now going to turn this meeting over to Dr. Conklin, president of the association, who is going to introduce the other speakers. Thank you very much.

M. H. EISENHART

RESPONSE BY THE PRESIDENT OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

President Eisenhart, Mr. Bausch, Professor Novy, Distinguished Guests and Friends and Citizens of Rochester:

PRESIDENT EISENHART said that the citizens of