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THE SPIRIT OF THE LABORATORY[1]

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WHY do we build a laboratory for physiological research? Because there have lived men like Theobald Smith. The discoveries and scientific advances made by such men have continually necessitated the building of new laboratories with more and more refined facilities in which other investigators might work to further widen the horizons of knowledge. Naming this the Theobald Smith Laboratory is dedicating it to one of the persons who greatly aided in its building. The Albany Medical College is to be congratulated on the realization of this fact, as well as on its peculiar right to adorn the building with such a name! Theobald Smith was a native son of this city, and the most distinguished graduate of the Albany Medical College. And it should be added, he probably was the most eminent contributor to medical science that this country has produced.

We may venture the fanciful conjecture that the earliest laboratory for physiological research was the Garden of Eden. Wherever this was, the story suggests that Adam tried out the effects of different plants as food for the human body and mind. These early instinctive experiments are still being performed by almost all members of the animal kingdom. But of all the animals, only Adam, with the valuable assistance of Eve, finally discovered the tree of knowledge and ate of its fruit. This food nourished the mind of Adam to develop beyond that of other animals, and he was driven out of the Garden and became capable of earning his bread by the sweat of his brow. The descendants of Adam ever since have been searching for this lost tree of knowledge, and though they have failed to find it they have learned much from the

[1] Address given at the dedication of the Theobald Smith Memorial Laboratory at Albany Medical College on March 19, 1937.

search. We are proud that the human race has gone a long way from the Garden of Eden, at least in some directions, and so to-day we are dedicating the latest laboratory for physiological research and teaching. However, the same old problem of the actions of foods and chemical substances on the functions of the animal body and mind is still the paramount issue to be studied.

What is meant at the present time by physiological research? Does this embrace a wide realm or a special field of study? Physiological research is the investigation of the functions and behaviors of all living arrangements: it includes investigations of the manner in which the ultimate life units or organic molecules exist with the power to induce the formation and multiplication of other units like themselves from the elements of their restricted environments. This power of self-synthesis is the fundamental feature of life. Physiological research includes studies of the genes within the chromosomes and their behavior in determining the constitution and the characters of the individual; it must reveal the miraculous processes by which the egg is changed into a fully formed child; it embraces considerations of the growth and differentiations which transform the child into manhood, as well as the actions and interactions of the organs, tissues and fluids of the adult body in maintaining its normal state; and finally, physiological research must include the study of the mysterious ways in which some arrangements within the brain give rise to consciousness and intelligence. Each and all these riddles are to be solved by physiological research founded on a sound background of morphology and allied sciences. The laboratory we are dedicating to-day will surely never have its activities restrained by the narrowness of its field for investigation. The subjects for study in this laboratory may actually include the behaviors of the investigators themselves.

The impulse to do research in its simplest form is a deep-rooted instinct. All young animals, including our own children, are curious and restless to become acquainted with their environments; this is a phase of the subconscious instinct for self-preservation. The desire to understand functions and behaviors is probably more nearly instinctive than is the interest in other classes of knowledge. From this supposition we need not infer that physiologists are necessarily more primitively minded than other persons.

The child's impulse to investigate its surroundings and learn about things is short-lived and is usually discouraged in most individuals during their stay in schools. It therefore becomes the primary necessity of a laboratory to create an atmosphere which will reawaken, stimulate and perpetuate the natural curiosity to learn, and thus promote the spirit for scientific investigation. The stimulus to do highly developed scientific research comes not alone from the essential "spark" within the investigator, but also from the inspiring spirit of the laboratory which fans this spark to its brightest glow. The laboratory must be invaded by that shy and intangible spirit which inspires enthusiasm and creates the devotion to research.

In building a new laboratory we have in mind two objectives. The one is material—a physical arrangement in which men may work and learn. Constructing such a plan is an ordinary accomplishment. Numbers of laboratories have been built in this country and in all parts of the world during the past few decades. Many of these structures are simple and modest, and others are elaborate and extravagant in both building and equipment. There is a broad possibility that modest buildings may well suffice for scientific work. The ingenuity of the investigator is not promoted by completely ready-made facilities. Discoveries of great scientific importance rarely if ever have come from palaces, but almost always from very simple surroundings. Few discoveries have been so fundamental in the advance of modern biology as the laws of heredity discovered by the monk, Gregor Mendel, in his monastery garden. The deductions which Darwin drew from studies made at his modest estate in England revolutionized the thinking of the intelligent world. Theobald Smith's discovery of the intermediate host in infectious disease and Walter Reed's experiments with yellow fever required very simple housing. Throughout the periods of history, monumental buildings stand more as final accomplishments than as markers of the beginnings of progress. In universities there has often been an exaggerated contrast between the grandeur of the laboratory buildings and the cramped conditions under which the family of an able scientist must live.

Solely from the standpoint of a new building for a laboratory there is little cause for rejoicing. But from the standpoint of the other element concerned in the creation of this building there is reason for great acclaim and enthusiasm. You intend not only to have the building, but you have proposed at its very beginning to induct into this laboratory the spirit of Theobald Smith. In so doing you have planned more wisely than you may know.

The creative spirit is the element most difficult to obtain and for that reason so often lacking within the atmosphere of laboratories. It has seemed to me appropriate, therefore, to devote my brief remarks on this occasion to that very strange thing—the spirit of the laboratory.

What do we mean by the spirit of the laboratory? Whence does it come, and how is it obtained? A

direct answer to these questions is almost impossible to give. However, we may consider them with some profit. Spirits are hazy things to describe. Their presence is realized by an appreciation of something in the environment that is not readily analyzable from the background of experience with our senses. A tour of several laboratories in different parts of the world may convey to you an idea of the thing which we hope is being introduced into this laboratory.

Some years ago there was established a tropical laboratory of marine biology on a small and isolated island in the Gulf of Mexico. The buildings were modest wooden shacks, and a small group of biologists were invited by the director to work in them. The workers slept in quarters adjoining the laboratory and ate in the same room that housed the aquarium. The temperature and humidity were uniformly high. Almost every piece of apparatus used was more or less improvised. Yet in the crudeness of this laboratory an inspiring spirit was present. Every one worked from dawn until darkness with a sense of joy in the doing.

The laboratory was new and without tradition or prestige; it was an affiliated part of the then new Carnegie Institution. Yet in spite of this newness, here was an atmosphere and a spirit that was quite inspiring and one continued to be enthused by this inspiration after years of absence from the place. The spirit emanated from the director, a simple, unassuming and unselfish person who made all feel that the laboratory would benefit greatly from their presence. The association was intimate, and the philosophy of the director peculiarly stimulating.

In the laboratories for marine biology built long ago by Anton Dohrn at Naples, there has been a spirit of inspiration from the start which has lasted for sixty years. Much of the history of modern biology might be written around this laboratory. Here Loeb started his studies in general physiology, and Wenckebach as a young student first observed the living development of the heart and vessels, and Wilson and Morgan and Driesch and many others did much to stimulate the early days of experimental embryology. Dohrn introduced a spirit, and a long line of workers in the same environment have kept it alive. The spirit here has not been due alone to one man but to the freedom of the place and the association of the workers.

The Marine Biological Laboratory at Woods Hole, which has been the great disseminator of enthusiasm for general biology and physiology in this country, is a prize locality for observations on the spirit of the laboratory. For years this laboratory had only the most primitive wooden buildings and little equipment. But the spirit was inspiring and the ingenuity of the investigators more than compensated for the inadequacy of apparatus. The high position which America holds in the field of experimental biology rests very largely on Woods Hole. The laboratory buildings are now all that could be desired, with modern equipment and apparatus. But the spirit and manner of the place have remained the same, as nearly as a large place can possess the properties of a small. The spirit at Woods Hole comes from many persons working together in free association. It is a scientific democracy and the "director" neither dominates nor directs. At the opening of one of the new laboratories Mr. Charles R. Crane, a wise benefactor, remarked that the most valuable element of these laboratories was the spirit that had existed within them. Presidents of universities and directors of various laboratories have come to Woods Hole to learn what makes the spirit here. They hoped to catch such spirit for their own institutions. Mr. Crane's wish was that the spirit would not shy away from the new buildings but would remain to find in them an agreeable home.

The laboratories thus far mentioned are peculiar in that the investigators working in them are not employed to do research. These persons come on their own account for the opportunity to work, and their relationships and associations are different in ways from those of members of a laboratory staff. Yet the rare spirit we are pursuing does not always dwell even in laboratories of this type. There are some such laboratories in which the true spirit of research has never been expressed, though able investigators may have worked in them.

We turn now to laboratories closer to the kind being dedicated to-day: the scientific laboratories in the departments of the medical faculty in universities. Some years ago in the German university at Munich one of the scientific departments was housed in the most perfect physical plant that any institute of this particular kind then possessed. The building and its arrangements were famed throughout the world. There was a large staff and much activity, but the atmosphere was not inspiring and the spirit of research was weak and sickly. The soul was absent. Another biological laboratory in this university was located a short distance away in an old and dilapidated building. The staff was smaller. But the spirit of inspiration in this laboratory was so great that students came from all parts of the world to be stimulated by it. The spirit here seemed to radiate from a small, simple man with a proud but kindly interest in the scientific investigations of all students. He knew all the investigators who visited his laboratory and encouraged every one with scholarly enthusiasm.

The spirit of scientific research has flourished in an unusually conspicuous manner in the small Bavarian

University of Würzburg. Here in the ancient anatomical pavilion in the garden of the Julius-Spital, Albert von Kölliker at thirty years of age began, as professor of anatomy and physiology, to lay the foundation and build almost the entire subject of modern histology, and to add much to the physiology of the tissues. In this same pavilion Rudolph von Virchow, while in his thirties, developed the field of cellular pathology. Kölliker moved into a new and larger laboratory of anatomy, where his studies continued to rapidly expand, outgrowing this second laboratory, which was later used as an institute of hygiene. The third anatomical institute occupied by Kölliker still serves as a splendid laboratory of anatomy which after him has been directed by Stöhr, Oskar Schultze and Braus, all eminent investigators. Kölliker spent fifty-eight years of his long life in the small University of Würzburg, declining the many offers which came to him from universities in three different countries. The spirit of these laboratories has been so permeating that an almost lasting inspiration is derived from it. In the physics institute, two buildings away from Kölliker's Anatomie, Roentgen discovered the x-ray in 1895, and in the building across Kölliker Strasse, Boveri did much to lay the basis of experimental cytology and Spemann began his classical studies in experimental embryology. A host of eminent workers have passed through these laboratories and have been imbued with the scientific spirit which pervades them. However, other laboratories of the same university have been unable to entice the spirit to dwell within them, and some have actually lost the spirit they once possessed. The recent director of the fine new pathological institute would on occasion exhibit the crude old desk at which Virchow first wrote his cellular pathology, but the visitor's reaction was usually one of pity that such a desk should be in so spiritless a place.

No university is so fortunate as to be good in all departments, but to be worthy of the name, a university must have at least one department in which the spirit of research resides.

Returning to our own country, many of us know of laboratories which have this spirit—laboratories where persons work with joy and zest. But they are not all in the largest universities nor in the most elaborate buildings. Some are in small and simple places. Still we ask—what is the spirit? One laboratory in a research institution may have it and another may not.

The spirit of a laboratory may arise from one man or it may come from several. It may or may not radiate from a man of great eminence. It may emanate from a man who is neither great nor eminent. One thing seems certain: the spirit comes from a simple man; not from a pompous or proud person but from a generous and open-minded man willing to hear opposing sides and to stimulate different points of view. In the laboratory there should be no effort to suppress opinions, but an open consideration of all problems worthy of discussion. The laboratory should not be a sanctuary for the worship of authorities or heroes, but a free dwelling for students of nature conscious of and charitable to the faults and virtues of those that surround them.

The spirit dwells in the laboratory where there is a sense of proportion. When one idea is exaggerated at the expense of another, natural harmony may disappear and the spirit vanish. As Professor Pupin once said, every scientist must have a keenly developed sense of proportion. And, he added, they usually do—except when it comes to the proportion between the size of their families and the size of their salaries. The laboratory spirit, like ghosts of the night, is a fleeting and tenuous affair. It never exists where time and routine are important. It disappears with an eight-hour day or a six-day week or a nine-month year. The atmosphere is inspiring only where all time belongs to the spirit of science.

In a laboratory of physiology, teaching and research are an almost inseparable pair. One who teaches and does not investigate the problems of his subject becomes a pedant dispensing knowledge only at second hand. Association with students and younger investigators freshly approaching their problems stimulates the more experienced investigator and keeps him alert to the uninitiated points of view. Scientists who spend their time in purely research institutions and do no teaching have not always gained recognition on the basis of their contributions any earlier in their careers than have some of those who have taught while doing their research. One of our wisest university presidents once said that a man need not be given free time for research; if other duties took all his time he would still find chance to do research if he had the spark to do it.

A laboratory should be a home in both the proprietory and time-forgetting senses of the word. In the laboratory one must be completely at ease and feel that it is there he belongs. It is not a place to go to work, in the drudgery sense of that word. The laboratory is a place for the joy of learning in which one should always remain a schoolboy with nature as the only true teacher.

This laboratory has the great future of physiology before it. To appreciate what the future may hold we need only look back on the recent past to the beginning of the century when deficiency diseases were dark mysteries and vitamins were unknown; when the study of the internally secreting glands was

just beginning; when the constitution of the cells and tissues on the basis of their genetic nature was a blank page, and the mind-body relationship was almost entirely mystical; and when the question of whether vitalism or mechanism was the basis of physiological processes was a subject of serious debate. We need strength and courage to dare dream what the next thirty-seven years may bring and to realize how crude and even false many of the scientific positions of to-day may then seem.

The new laboratory is a new home for physiologists. It has all the future of this science within it. Who can say that the greatest discovery may not happen there; the arrangements which bring forth life itself must some day be found in some laboratory. May all those who work in this laboratory be inspired by the spirit of Theobald Smith, and with a quiet modesty may they whisper their questions to nature, and if she answers, may they have the simplicity to understand.

AGRICULTURAL RESEARCH IN CHINA.[1] II

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Entomology: Courses in entomology are taught in each of the agricultural colleges previously listed and courses are given also in the private colleges of Yenching University, the Peiping Union Medical College, the Soochow University, the Chen Tan University and in Fukien Union College. Research work of various sorts is carried on at most of these institutions. Mr. F. C. Woo, head of the department of plant pathology and entomology of the National Agricultural Research Bureau, furnished a list of entomological workers in China. This list consisted of 26 professors, 4 assistant professors, 11 instructors, 17 senior entomologists, 7 assistant entomologists and 12 assistants. This list of 77 workers in entomology, many of whom have had advanced training, gives some idea of the status of entomology in China. It should be appreciated that in entomology and other fields of agricultural research there is a large body of students who have graduated from middle schools, and other schools of a similar nature, and who make admirable assistants but who have not been listed in this survey.

Several special schools have been conducted for the purpose of training research assistants and extension workers. A one-year short course was held by Southeastern University in 1928–29 and 20 students completed the course work. The Bureau of Entomology of Chekiang conducted a similar training school for each of three years from 1931 to 1934 and 87 students completed the short course. In 1936 the National Agricultural Research Bureau conducted a National Training School for Insect Control. Eighty-seven technical workers or agricultural school teachers from 15 provinces were in attendance.

The first application of scientific methods for the control of insects in China, since the formation of the Republic, was in 1919 when private funds were given at the request of Dean Tsou, of Southeastern University, to aid in controlling an outbreak of the cotton looper. A few years later the Kiangsu Provincial Bureau of Entomology was established at Southeastern University, now called Central University.

In 1924 the Chekiang Government established a Bureau of Entomology, which was located at Kashing but moved to Hangchow in 1934. This laboratory has made many important studies of injurious insects, has an extensive insect collection and a good library. The provincial governments of Szechuan, Kiangsi, Kwangtung and Honan have Provincial Departments of Entomology connected with their local departments of agriculture.

The Entomological Department of the National Agricultural Research Bureau consists of six experienced entomologists, one senior chemist and fourteen assistants. Studies of the rice borer and of stored-grain insects are conducted in cooperation with the National Rice and Wheat Improvement Institute. Other research studies are carried on with the migratory locust, forest insects and insecticides. The most important contribution of this department in cooperation with the Cotton Improvement Institute is the invention of cotton-seed-oil emulsion for aphis control. The new insecticide is more satisfactory and the cost is only about one third as great as kerosene oil emulsion.

This brief summary gives some idea of the status of entomology in China and indicates rapid development of this important field in recent years.

Horticulture: Several of the agricultural colleges have departments of horticulture. The more important of these are the Colleges of Agriculture of the Universities of Nanking, Chekiang and Lingnan, the Hopei Provincial Agricultural College and the Northwestern College of Agriculture at Wukung. Horticultural crops in China are of great importance and China is particularly fortunate in the large variety of

[1] Address of the vice-president and chairman of the Section on Agriculture, American Association for the Advancement of Science, Atlantic City, December, 1936.