The city of Edinburgh, where Hutton made his home, was the stronghold of the Presbyterians and Calvinists, and it was in such an atmosphere a simple matter to blacken Hutton's reputation. "Britain," says Judd, "which had produced the great philosopher, Hutton, had now become the center of the bitterest opposition to his teachings."

Hutton died in 1797 without having been able to convince his contemporaries of the truth of the principles he had laid down; but in the very year of his death two men were born, Paulett Scrope and Charles Lyell, who were destined to establish the Huttonian doctrines as the foundation stones of modern geology. The greater of them, Sir Charles Lyell, possessed just those gifts which Hutton lacked. By a forceful and lucid literary expression and a diplomacy and tactfulness in dealing with those questions which were in conflict with church dogma, he succeeded completely where Hutton had utterly failed. Somewhat unfairly, Lyell wrote of Hutton—and throughout he has given less than due credit to his distinguished predecessor—"I think he ran unnecessarily counter to the feelings and prejudices of the age. This is not courage or manliness in the cause of Truth, nor does it promote progress. It is an unfeeling disregard for the weakness of human nature, for it *is* our nature (for what reason heaven knows) . . ." Lyell himself was most careful to avoid a frontal attack upon the citadel of the church. He preferred unobtrusively to sap and mine, and he did this with a success of which geologists are now well aware, and by so doing he reaped rewards which might have come to the pioneer, Hutton.

Those who are intimately familiar with the fierce controversy which raged in England over the appearance of the "Origin of Species" will remember that though Lyell was on terms of intimacy with the great figures in the controversy on the Darwin side—Darwin himself, Huxley, Wallace, Hooker and Spencer—he yet was careful to refrain from any public expression likely to bring himself into conflict with the church.

It has generally been supposed that Lyell derived his views as expressed in his "Principles" directly from Hutton's writings, though this has been disputed by Judd, who claims they were developed from Lyell's own studies and that later when he read Hutton's book and the Playfair "Illustrations" he was greatly impressed by the proofs of genius in the great Scottish philosopher.

To-day the place of James Hutton is secure among the great founders of geology, and he stands out from the others as the hardy pioneer who endured the hardships and took the hard knocks and thereby paved the way for the new era in geological science. He was the first to prove the truth of the doctrine of continuity or evolution within the inorganic realm of nature, as Darwin was in the organic. That Hutton was not acclaimed for his work while he lived probably caused him little concern. He seemed to be content to have the good opinion of the great men associated with him—those who knew his work intimately and whose esteem was, therefore, precious to him. Their opinion is shared to-day by all geologists who have carefully studied the history of their science.

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COOPERATIVE RESEARCH—THE PLAN OF THE NATIONAL TUBERCULOSIS ASSOCIATION

I

THE necessity for progress in medical research in tuberculosis has been recognized since the first presidential address by the great American pioneer, Edward L. Trudeau. In the natural course of events the urgency for organization and education held research work in abeyance during the first fifteen years of the association's existence, even though its importance was emphasized from time to time. This abeyance of activity was justified by the fact that there had been devised no sure method for the expenditure of money for the development of research. Methods had been tried by foundations and other interested bodies, but had not proved sufficient in production to merit the expenditure.

While the association was anxious to increase its knowledge through research work, its funds were so limited that it was not warranted in making use of them for research unless a way was offered which insured a certain measure of success.

II

In 1920, at the suggestion of Dr. Charles J. Hatfield, at that time managing director, the president, Dr. Gerald Webb, appointed a small committee to study the question of research in tuberculosis and, if possible, to offer to the executive committee of the association a plan for its development that promised success and that would require only the limited sums of money available. This committee was composed of Dr. William Charles White (chairman), Dr. Paul A. Lewis and Dr. Allen K. Krause.

III

One year was spent by the committee in the study of this problem. Surveys were made (1) of research facilities in the tuberculosis hospitals and their labo-

ratories and in research laboratories in general; (2) of the funds that were available, not only for tuberculosis research, but for all scientific research and of the way in which these were used; (3) of the methods employed by other institutions to stimulate research; (4) of the progress that had been made in tuberculosis research and in other fields of scientific research.

IV

The result of this study led the committee to several fundamental conclusions. It decided that the first necessity was the choice of specific problems. This meant a study of the evolution of research in tuberculosis, a decision as to the most important problems yet unsolved, and a determination of the most hopeful leads toward the goal which the association had set for itself. (This goal was, primarily, the relief of those sick with tuberculosis, although phases connected with prevention and with animal industry were also serious matters.) Determination of problems thus was found to be the most important function of the committee, and a clear outline of certain specifications for each problem was required before the committee could take further steps.

Once these had been defined, the next fundamental step was the choice of that man or woman whose knowledge and technique was most likely to insure success in the solution of such a problem.

After the research worker had been chosen, it was next necessary to devise some way to induce him to undertake the solution of the problem so as not to interfere with progress in his own field.

V

It was obvious from the beginning that the best research workers were not to be found to-day in the laboratories attached to sanatoria: these laboratories had become sterile as a factor in research simply because the sanatoria had been developed in isolated places and along lines which made administration and care of the sick the chief duties. It was evident, on the other hand, that in the laboratories connected with our great universities the facilities for research were most abundant. Here the spirit of research had been kept alive, and a constant supply of new workers were advancing through the years of a university career to follow in the footsteps of those who preceded them and to add to the knowledge already gathered. The men in charge of these laboratories were trained in research and its technique and direction. It was but a step to the conclusion that, the problems once determined upon, there was greater chance of success in their solution if the men in these university laboratories could be induced to undertake the task, for they had all the natural research facilities. But in these laboratories the spirit of so-called pure research was in the ascendency, and it was necessary to prove to the research workers there that their methods and principles could be worked out on a specific problem of economic importance just as well as on a problem which was of less economic interest.

In carrying out the details of such a plan the committee soon determined that no money should be invested save where the published work indicated that the research worker chosen was the best fitted in initiative and knowledge to undertake the study. In other words, it was decided to invest in brains only.

VI

Shortly after its appointment it was suggested to the committee that the most likely way to proceed was to establish a national institution for tuberculosis research on a plan often followed in this country and in Europe. But to provide such an institution was out of the question, as the funds of the association were not available for such a project. This compelled thought along other lines. Already there were institutes, such as the Henry Phipps Institute for the Study and Prevention of Tuberculosis at Philadelphia and the Edward L. Trudeau Foundation for Research and Teaching in Tuberculosis at Saranac Lake which could function as national institutes to provide housing for researches that should temporarily be together for more intimate work, since the sympathy and guidance of those in charge were part of the national program.

It was also evident that the institute plan had disadvantages. It interfered at times with the research worker. It often uprooted him from his environment, from the place where his work had developed; it lost for him his line of advancement and brought him into unfamiliar surroundings; it caused loss of time during the change and it did not guarantee success in the new environment. Further than this it made the institute responsible for his future. So in the natural course of thought the plan here described evolved, which permits the research worker to remain in his own environment; allows him to pursue the problem which he is asked to undertake in familiar surroundings and with no loss of time.

But this was not enough. Such a worker must come in contact with workers in allied fields, both for the sake of correlation of results and for the stimulus and addition to knowledge which such a contact would supply. For this purpose a counsellor or jury system was devised.[1]

At the end of the first year an outline of the plan described here was laid before the executive committee of the association, with the result that an allot-

[1] See Section IX.

ment was made in the next budget of the association for medical research. Although the details of the plan were not yet completed, it was felt that it was in such shape as to justify such an appropriation and an initiation of active work.

VII

It was essential that the committee be small, not only that it might meet with ease, but because its members were required to study constantly the past and current literature in the special field of tuberculosis research and general research, in order that the committee could appreciate every significant fact bearing upon its task and could choose well the man or woman best fitted to undertake its problems. It must be able to talk the language of the workers whom it desired to induce to solve its problems. It must be cognizant with all phases of science allied to the immediate question, so that it could suggest, wisely, ways to attack any given research. It must be able to retain the interest of the worker when once aroused and, finally, and most important, it must be able to correlate the results of its different researches and bring associated researches into conjunction with each other. If it was to be a success untiring study must be its program.

There are times, however, when the committee must efface itself and the officers of the association take up the activity. Such a circumstance arises after the research committee has decided upon a problem, has chosen the research worker and has induced him to accept it. When these preliminaries have been attended to by the Research Committee the president of the National Tuberculosis Association must write to the president and trustees of the university where the research is to be carried on, tell him what is desired, announce the grant and ask in return that the research worker be relieved as much as possible from teaching duties so that he may pursue his research more rapidly. This is an important duty, for the care and dignity with which it is done means much to the spirit with which the work is carried on.

VIII

A grant provides for assistants, technicians, money for publications of results, scholarships and necessary equipment. It provides also for expenses for the research worker when he must travel in order to meet in conference with his confrères. None of it goes to him personally. His return comes only in the privilege of following his problem in research with greater ease and in having his position enhanced in his university by national recognition.

When a grant is accepted, a revolving fund is placed with the treasurer of the university where the research operates. On the first of each succeeding month, against his account, receipted bills, signed by the recipient of the money, approved by the research fellow and the treasurer of the university, are sent to the chairman of the research committee for approval. In his office the expenditures are examined and, if correct, the bills are forwarded to the executive offices of the association for payment to the university, reimbursing it up to the amount of the original deposit. In this way records of the purchase of permanent equipment are kept and, in the event of the completion of a particular piece of work, such permanent equipment can be moved to the service of another research worker. The status of each grant is likewise controlled and notices are sent out if irregularity appears. It is generally necessary at the opening of a grant for a member of the committee to hold a conference with the treasurer or comptroller of the university, in order to adjust the university accounting system to conform with that of the association.

IX

It was soon found desirable and necessary to have the help of a broader critical knowledge than that represented on the committee, both for discussion of the specific problems and to make sure that the researches chosen for study were sound. To accomplish this a counsellor or jury system was developed. The association, through its committee, invites a body of experts in a given field of research to listen to a presentation of the research work pursued by different workers in allied fields under grant from the association. At a jury meeting is presented the plan of attack, the present status of knowledge, the course and probable outcome of the study in each research, and then the counsellors are asked for frank criticisms and suggestive advice. These meetings have at times meant revolution in the plan of study and always have added a great deal to the success of the plan. They have provided opportunity, quite essential, for the correlation of existent knowledge and education of individual students in other fields of research.

The National Tuberculosis Association, organized as it is for the public welfare, receives an unusually generous response from those who are best qualified by knowledge and experience to offer constructive criticism and who would not be willing to give the time save where the spirit of altruism and the love of mankind prevailed.

X

To establish further correlation of research work the members of the committee find it advisable to go to the several laboratories where research under

it is carried on and, wherever possible, to assist the progress of the individual research by reporting the information gained in other laboratories.

The association has found, at its annual meeting and its different sectional meetings, that the presentation, in symposium form, of the progress of its several researches has greatly enhanced the interest of its members in the new knowledge available from time to time. It has often invited those concerned with the same type of work, even though not members of the association, to take part in these discussions. In this way it has focused more of the attention of the association upon the field of scientific research and enabled it to recover, in a measure, from the dominance of its educational program.

XI

Very early in the execution of such a plan by a voluntary organization it was necessary to try and secure the interest and guidance of more permanent agencies responsible for tuberculosis as a disease. The United States Public Health Service includes tuberculosis as one of its problems and is in touch with the various state health departments and laboratories. The Bureau of Animal Industry handles the whole question of cattle tuberculosis and tuberculosis in other animals. These two bureaus also serve as the government powers in licensing biological products, such as tuberculin, for diagnostic and therapeutic use.

In addition, there are the manufacturing chemists who prepare and sell biological products and come into direct contact with all health agencies through this distribution.

Also, two great business interests benefit tremendously by progress of knowledge in this field and are factors of importance. One is the cattle industry, with its branches of farmers, stock-breeders, packers, slaughter houses, etc., and the other, the insurance companies, whose annual loss from tuberculosis among its policy holders is one great cause of the high cost of insurance.

Both federal bureaus have been generous in lending their advice and cooperation. The chairman of the research committee is the officer in charge of tuberculosis research at the hygienic laboratory, which makes it the clearing house for all the research work under the national association. The manufacturing houses, too, have welcomed the opportunity to be of assistance in this matter of public health, employing their plants whenever possible to aid in bulk production of substances or in other ways.

Several attempts have been made to interest the cattle industry and the life insurance companies, but so far they have taken no part in this work of the association.

With the present cooperation and guidance of the United States Public Health Service and of the Bureau of Animal Industry, any advance in knowledge can be rapidly disseminated to the whole interested public, such as health officer, physicians, nurses, etc.

XII

One example in illustration of the working of this machinery of cooperative research may be cited to make its work clearer. In the department of chemistry there has been developed a wholly new method of bacterial-chemical analysis. Each new substance isolated by this department is sent to the research committee and by it distributed to other laboratories for biological study in the field of cytology, serology, physiology and bacteriology. In no one laboratory are there the experts who can do all this work. The reports of these individual studies are returned to the committee and are made the bases of the lines of future research.

XIII

Finally, it is necessary to supplement the pure research work with clinical studies in the sanatoria where those sick with tuberculosis are segregated. The sanatoria have been grouped in relation to the university centers, and plans have been completed to man the laboratories of the sanatoria with research students from the university laboratories, giving them definite problems to work out under the direction and help of the chief of research in the university laboratory.

A research problem for each is defined and fitted to the machinery of the sanatorium where it is to be carried on. Opportunities are made for careful supervision and reporting of the results to the research director.

In order to obtain the necessary contact with the sanatoria, a new clinical research committee has been appointed by the American Sanatorium Association, which will oversee, in cooperation with the research committee of the National Tuberculosis Association, such clinical study as is undertaken in this way. It is hoped that this clinical research will be of value further in testing substances offered for alleviation of those that are sick with tuberculosis, and thus save the suffering which follows the premature distribution of such products, as well as in assisting the federal bureaus in their duty of licensing such substances.

This plan of cooperative research inaugurated by the National Tuberculosis Association has been in operation now for five years. It came as a recognition of the fact that knowledge has increased beyond the capacity of a single brain and that, therefore, progress was more likely to follow some method of

group activity. That brilliant discoveries occur in isolated work is not forgotten, but it is remembered that they are always based on the correlation of past efforts. As a practical method of utilizing the facilities of the country for progress in research, the plan has met with unlooked-for success, although it is still in an evolutionary stage and has, daily, difficult problems to meet. It offers a machinery which makes use of existing research opportunities and which yet fits in perfectly with the present operation of society as represented by the universities and other institutions. As a result of its five-years' work interest in tuberculosis research has grown to proportions such as would not have happened in the same length of time without the stimulus supplied by the grants from the association. It has not only advanced our knowledge, but in some measure completely changed our conception of this disease.[2]

XIV

More money than is now available could be used with enormous advantage to the whole research. New studies defined in the committee's program are immediately urgent, and if not actively in operation will delay the progress of the whole study. The students have been chosen to do the work, but no step can be taken until the money is forthcoming. Loss of interest only can result from approaching a research worker unless the committee is prepared to go ahead and carry through the project.

In closing, it is essential to the success of the association plan to have: (1) A small committee so constructed that it shall have time to study the progress and literature of the whole field of science: watch for development in any field that may help the solution of the tuberculosis question: define clearly its problems: interest those best fitted to undertake each research it desires to have studied; correlate the results: outline future advances: stimulate interest and cooperation among individual research workers: secure the cooperation of other bodies and institutions whose interest is necessary to complete the work.

[2] The work undertaken so far under this plan has to do with the fixing of standards such as a base line for living bacterial chemistry, a base line for living cell chemistry, anatomical factors in the spread of lung infections, standards for X-ray pictures of normal lungs and similar problems so that published work from research in this field will be comparable and truths more quickly reached by the delineation of the laws underlying the processes involved. There have been published under the grants of this committee sixty-five papers in fourteen journals, a list of which may be obtained from Dr. Linsly R. Williams, National Tuberculosis Association, 370 Seventh Avenue, New York City.

(2) A spirit within the whole association which will justify it in asking and enable it to receive the criticism and guidance of those qualified to assist the work of the committee. (3) A plan of accounting which will insure constant supervision of the use of its funds. (4) A machinery which will use, in its attack upon the tuberculosis menace, existent facilities for research, directors of research, hospitals, students, and laboratories, and which will fit into the present operation of our social organization. (5) An institute such as the Phipps Institute at Philadelphia where more closely knit researches can be pursued, if, in the course of the work it is deemed necessary to bring into closer contact one or more of the workers whose problems are allied. The workers, under this plan, would be only borrowed for a time in order to finish a task, and would not therefore lose any of their own academic position.

This plan as it has been outlined allows the association to conduct its research very economically: it provides little overhead expense but does enhance the status of the research worker taking part in its program. It adapts itself to the conditions encountered, and at the same time accomplishes its purpose through the medium of trained skill and science.

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U. S. PUBLIC HEALTH SERVICE

THE THIRD PAN-PACIFIC SCIENCE CONGRESS

A SECOND announcement concerning the Third Pan-Pacific Science Congress, which will be held in Tokyo this fall, has recently been issued by the National Research Council of Japan and gives additional information concerning the congress in extension of that published in SCIENCE for July 24, 1925.

The period for the scientific sessions of the congress will extend from Saturday, October 30, to Thursday, November 11. Excursions have been arranged for those attending the congress and will occupy a number of days both preceding and following the scientific sessions. The excursions will include trips to Hokkaido, October 18 to 25; to Nikko and Hakone, October 26 to 29, and to Kyoto, Nara, Osaka and Kobe, November 12 to 15, and to Miyajima and Kyushu or Shikoku, November 16 to 19. These trips will make it possible for the members of the congress to see parts of Japan which are noted for their scenic and historic interest and also a number of regions of particular scientific significance, such as the Ainu villages of Hokkaido, geologic and mineral deposits of importance and localities of special volcanic activity.

The announcement continues as follows in regard to the tentative scientific programs: