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THE HISTORY OF SCIENCE IN POSTWAR EDUCATION[1]

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THERE can be no doubt that the history of science as a subject of instruction has been greatly neglected in the past and is still very much neglected to-day. Few of our great universities offer any courses at all, and among them only a very few offer adequate instruction.

There was a time, not so long ago, when studies in the history of science were considered an unnecessary luxury, a hobby for retired scientists. Science was progressing rapidly, was becoming increasingly complicated and specialized, and everybody was looking ahead into the future. It seemed useless to look into the past and seemed wasteful to burden the students with historical considerations.

The attitude toward the history of science is changing rapidly, for reasons that we shall discuss in a moment. Leading scientists, historians and educators, presidents of great universities have come out openly in favor of instruction in the history of science and have repeatedly emphasized the great educational value of such studies.

They talked, beautifully, but as a rule did not act. When you have a chance to discuss these matters with such an educator and you ask him quite candidly why he does not provide, in his school, instruction in a field that he considers so important, you invariably hear the same answers. One is that funds were not available. Yet funds were available for many other purposes, and wherever there is a sound constructive program and the determination to carry it out, funds usually come forth.

Another and more serious answer is that the school intended to provide instruction in the history of science but could not find the right man to teach the subject. And in such a case the educator will usually

[1] Address of the retiring vice-president of Section L, American Association for the Advancement of Science, presented at the meeting in Cleveland on September 12, 1944.

add: "Why do you not train the people that we so urgently need?"

To this very justified and challenging question we reply that it is difficult to encourage young people to enter into a field in which so far there have been no outlets. A man has to make a living, and after many years of highly specialized training in the history of science, he usually ends up teaching elementary biology or chemistry or Latin in a college, and his training remains unused. If universities had chairs for the history of science, then, of course, we would be only too eager to train people for these positions. The problem, in other words, reverts to the old proposition whether the egg or the hen comes first.

There is, however, another and much more disturbing aspect to the question, namely, that it is becoming increasingly difficult, particularly in this country, to find young people who possess the elementary equipment required for studies in the history of science. We expect as a matter of course that a historian of philosophy have a profound understanding of philosophy but be at the same time fully trained in methods of historical research. A historian of music must understand music but must be a historian as well. The same requirement obviously applies to the historian of science. He must understand science. We do not expect him to be equally competent in astronomy, botany and chemistry, but he must know at least one field of science thoroughly. And he must be a historian in addition, that is, he must be able to read and evaluate and interpret historical sources.

In view of the fact that ancient science dominated the Western world for over two thousand years and that Latin remained the language of science for several centuries thereafter, it is pretty obvious that the historian of science who wants to work from first-hand sources, who wants to teach the subject and to guide student research must know Greek and Latin, and must know these languages well. It is not enough for him to be able to decipher a Latin text; he must be able to read it. Of course, it would be good for him to know also Arabic and half a dozen other languages, but a thorough knowledge of Greek and Latin is a minimum requirement for a man who wants to become an academic teacher in the history of science.

We all know that it is very difficult to-day to find young people who are equally well trained in the humanities and in science. It was different in the past when the humanities were the gateway to university studies. This is why in the nineteenth century great scientists and physicians, men like Berthelot, Du Bois-Reymond, Virchow and many others were able to make important contributions to the history of science. When they became interested in the history of their field, they had a background from which they could draw. To-day the scientist who becomes interested in history encounters almost insurmountable barriers. He is unable to read the basic texts, has to rely on translations and on secondary sources. In my own field, the history of medicine, a number of disgraceful books have been published recently that would have been inconceivable one or two generations ago. They were written by very competent doctors who, however, had not had the slightest humanistic training, had no appreciation of the historian's responsibility and were totally unable to distinguish between good and bad sources.

Young people who come to us for training have usually had a few years of high-school Latin and no Greek at all. Their knowledge of general history is extremely scanty. They can, of course, learn Greek and Latin and general history at the university, and we urge them to do it. But the result is that the time that should be spent for specialized training actually has to be spent in acquiring the most elementary tools. Our Johns Hopkins Institute of the History of Medicine offers the degrees of M.A. and Ph.D. in medical history, but in twelve years we have given only one M.A. degree and no Ph.D. We had candidates, but most of them gave up after a while realizing that their preparation was hopelessly inadequate.

And yet, in spite of these undeniable difficulties, we are fortunate in having in the United States to-day a number of scholars who are fully prepared to fill chairs of the history of science. George Sarton, the foremost authority in the field, has been active in this country for more than a quarter of a century and has developed a flourishing school. Scattered all over the country, in various positions, are young people, scientists, philosophers, philologists and historians who in spite of sometimes considerable difficulties have become very competent in some field of the history of science. What they need is a few years of leisure without academic duties that they could spend with Sarton at Harvard or in some similar center. This would give them an opportunity to accomplish a solid piece of research and to broaden their training whereupon, I am sure, many of them would be prepared to teach the history of science competently.

An interesting and promising experiment in this direction was undertaken recently by the Johns Hopkins University. In 1940, the university with the aid of the Carnegie Corporation created two Carnegie Fellowships in the History of Graeco-Roman Science. They were each for two years and carried an annual stipend of $2,000 with the usual privileges granted to research fellows. The idea was to steer young classical philologists into the field of ancient science where so much remains to be done, so that later while teaching the classics they would devote their re-

searches to the history of science and would also be able to teach the subject.

When the fellowships were announced, we received over 20 applications. The two candidates accepted were both doctors of philosophy in classics, and in addition one of them was an excellent mathematician and physicist who had already published a number of papers, while the other had engaged in studies of botany. The two fellows were attached to the Institute of the History of Medicine. They attended all courses of the department and took an active part in the seminars. As a matter of fact, the research seminar was turned over to them repeatedly for a number of weeks, so that they had an opportunity to present their problems in detail and to have them discussed. One was working on Theophrastus, the other on Caelius Aurelianus and on several other problems. Both were also permitted to teach in a postgraduate course that the department gave in 1942.

The war somewhat interfered with the program, in that one fellow interrupted his work after one year to take a position with the Navy. The other, however, completed his two years very successfully. He is a solid researcher and excellent teacher who, in my opinion, would be an asset to the faculty of any university. I very much hope that these fellowships will be resumed after the war and possibly even extended, because they seem to be a step in the right direction. It is obvious that not every college can have a department of the history of science, but every one has a department of classics, and to have one man in such a department who combines classics with science and is prepared to teach the history of science should prove to be a great advantage.

At any rate, competent teaching personnel is available to-day, not in large but in sufficient number to make a start, and it is therefore up to the schools to take the next step by creating teaching positions. Once they are available, without any doubt more personnel will be trained.

A great deal of planning is being done to-day, and this is a very sound symptom. It shows that we are trying to learn from the experience of the war. We feel that much was wrong, in many fields, in the prewar world, and we endeavor to improve conditions by planning intelligently for the post-war world which, we feel, must and will be different.

The war has revealed dramatically the inadequacy of our educational system. Not only has it shown that with 341,200 registrants rejected for military service (up to September 1, 1943) for being unable "to read and write the English language as well as a student who has completed four years in an American grammar school," we have an amount of illiteracy for which there is no excuse in a democracy, but the mere fact that we did nothing to prevent this war is an indictment of our educational system. We marched merrily through the boom years into the depression, watched the rise of fascism and nazism without moving a finger, let the Spanish Republic be crushed and supplied Japan with the raw materials she needed to fight China—and us—until we ourselves were drawn into the maelstrom. We can not blame the politicians, because their actions are determined by public opinion, and public opinion is the result of the educational status of the population.

Whenever we have an opportunity to probe into the present situation, we find appalling conditions. A poll conducted in July, 1943, revealed that in spite of all means of information, newspapers, radio, movies, 79 per cent. of the population had never heard that at that time there was a hotly contested National Social Insurance Act before Congress, a bill which, if passed, would take 6 per cent. of all wages and give the people great social security benefits. The poll showed that 84 per cent. of the farm population had never heard of the bill, one which for the first time included the farm laborers. This reveals a lack of education in citizenship that is simply staggering. How can we expect a democracy to function effectively if the majority of the citizens take no interest in some of the most vital issues that concern their own security? And what is to blame but our educational system? Education in citizenship, however, presupposes an intelligent teaching of history.

A survey conducted by *The New York Times* several years ago revealed that thousands of young people graduate from colleges every year with a bachelor's degree without having had any instruction in the history of their own country. How can we expect them to become enlightened citizens prepared to take an active part in determining the destinies of the nation?

It seems that many people still consider the study of history some kind of a luxury. Oh, they will gladly admit that it is interesting to know what happened in the past, and how people lived in the early days. They will concede that an educated person should have some knowledge of history, but after all we are living in to-day's world with its hard realities, in ever changing situations and, they usually add, nobody has ever learned from history.

At this very moment important inter-allied conferences are being held at which plans are elaborated for reshaping the world. They are attended by statesmen and diplomatists with staffs of experts in economics, geography and other fields, but it is striking to see that historians are hardly ever consulted. Historians are considered as college professors who

know all about the past but, of course, have no idea of the world in which they live.[2]

Nothing could be more erroneous than such an attitude. History is not a luxury. The knowledge and views we have of our past are the most powerful driving forces in our life. Every situation in which we find ourselves, every event that takes place, whether it be a world war, a revolution, a strike or merely the enactment of a city ordinance, are all the results of certain developments and trends. We are usually not aware of them and are therefore often surprised when the event takes place. The historical analysis that makes these developments and trends conscious, that reveals the factors that have led to a given situation, permits us to understand what is happening around us and helps us to act more intelligently.

The study of history must be given a prominent place in postwar education if we are determined to train not only specialists but citizens of a democracy. This has been recognized in various quarters, and efforts are being made to give history more hours in the curriculum. Criticism of existing conditions, however, has been more along quantitative than qualitative lines. Much has been said about the number of courses and hours the students should have, yet it is obvious that a great deal depends on what kind of historical instruction is being offered. And this is where the history of science comes in.

Science has played such a tremendous part in shaping our world and is bound to play an increasingly important part in the world of to-morrow that it is impossible to understand historical developments without considering science. It is strange, therefore, that there are still many text-books of history in which the word science hardly occurs.

The time is fortunately gone when the teaching of history centered around dynastic quarrels, boundary disputes and wars. We are primarily interested in the history of man's achievements and creations, in the history of that broad complex of phenomena commonly called civilization. Man's efforts to understand and master nature certainly represent one very important aspect of it. We do not neglect to study the many factors that have advanced or retarded the development of civilization. Dynastic quarrels, boundary disputes and wars may have been such factors and therefore will not be overlooked. The basic importance of economic factors is generally recognized, and history has in many hands become primarily economic history. Economic history, however, must always consider the history of man's tools, of his technology, and technology is to a large extent the result of science.

Science has not only revolutionized our economic life but has also profoundly influenced our views of life, our religion, philosophy, literature and art. It is impossible to understand the naturalist school without knowing Claude Bernard, the physiologist. The influence of Darwin is still widely felt. In other words, from whatever angle we approach history we are bound to encounter sooner or later the phenomenon, science.

The historical analysis will also explain the frustrations of science. Why is it that in times of war we are willing to make free use of science, while as soon as peace is achieved we refuse, or so far at least have refused, to apply principles of science to the basic processes of social life, to production, distribution and consumption?

If the teaching of history is to be more than an intellectual recreation, if it is meant to help young people to understand the world in which they live and to play their part in it intelligently, it must by necessity include the history of science, which must become an integral part of all phases of historical instruction.

To-day universities only, and only a few, offer instruction in the history of science, but I feel very strongly that in postwar education the teaching of the history of science should begin in the primary school. At that stage the biographical approach may be the most appropriate. Children are interested in nature and in technology; the story of the great scientists and of their discoveries, presented in simple terms, would be most inspiring. I first heard the name of Benjamin Franklin in my French school when I was seven years old. Our teacher, an old lady—she may not have been so old, but to us she seemed so—told us about the great American who had come to France, and she described his experiments with a kite and his invention of the lightning rod. She also told us about his stove. We were so impressed that although it was a very long time ago, I remember that class as vividly as if it had been yesterday. And we never flew kites without thinking of Franklin. When we were struggling with the multiplication table we heard about Pythagoras because in France the multiplication table is called *la table de Pythagore*. Later at the age of about ten, we learned a great deal about Linnaeus because we were gathering plants and were grouping them according to families. We built a sundial in the school garden as the Babylonians and Chinese had done thousands of years ago.

To-day boys and girls are very keen on building airplanes. This presents a great opportunity to tell them about Leonardo da Vinci. I am sure that a

[2] There may be another reason why statesmen often distrust historians. They know that sooner or later they will have to appear before the tribunal of history and that the judgment of just such historians will determine whether their descendants will be proud or ashamed of them.

class devoted to Leonardo with lantern slides showing some of his machines and also his paintings would make a lasting impression on children. And the history of flying from Leonardo to the Wright brothers makes a fascinating story.

Much history of science can be taught in the primary school in such an informal way. It not only adds color to the teaching and is inspiring, but also gives young people a certain historical perspective and respect for the past. They come to realize that it is not accidental that they enjoy the fruits of science, but it is the result of the labor and genius of generations of men who preceded them.

In high school, instruction will be more systematic. One may consider giving a special course in the history of science wherein Sir William Cecil Dampier's new book, "A Shorter History of Science" (New York: Macmillan, 1944), will be found equally useful by teachers and students. I hear that in England the introduction of the subject into the curriculum of the grammar school is being considered very seriously.

Whether a special course is given or not, the history of science should, in the secondary school, become an integral part of the teaching of history as well as of science. In other words, a study of ancient history should not be limited to the history of political events and economic conditions, but should also picture the development and the contributions of ancient civilization of which science was an essential part. A history of Elizabethan England that ignores science remains fragmentary by necessity. A certain knowledge of Elizabethan science is needed for the mere understanding of Shakespeare's plays. Good examples of historical text-books that include science, at least to a certain extent, are James H. Breasted's "Ancient Times, a History of the Early World" and Carl L. Becker's "Modern History, The Rise of a Democratic, Scientific and Industrialized Civilization."

The teaching of science, on the other hand, can gain a great deal if the historical approach is used as a didactic method. The teacher will soon find that there is no better way of making complicated matters clear to the student than by presenting the subject genetically. The history of oxidation discussed in a course of chemistry or the history of the circulation of the blood in a biology course enables one to explain and clarify a great many basic concepts. And in presenting a subject historically, the science teacher can draw the attention of his students to philosophical problems. He can impress upon them that physics and chemistry are not a collection of rules and formulae but are an attempt to understand and interpret nature.

The need for instruction in the history of science in colleges is so obvious that it hardly requires any elaboration. If the purpose of the undergraduate school is to give young people a broad general education and to help them to understand the world in which they live and in which they are called upon to play a part, the course must include both the humanities and the sciences.

Students as a rule feel more attracted to one or the other field, and many enter school having a definite major subject in mind whereby they are inclined to neglect the other fields. It should be impressed upon them, however, that science and the humanities are not two separate worlds. In the past, philosophy was the connecting link, and there is no reason why it should not be to-day. Unfortunately many professional philosophers have developed an ivory tower attitude and a language that nobody understands who does not belong to the brotherhood. They have lost contact with the realities, and thus have lost their grip on students. The history of science that combines the humanities, the social and the natural sciences, and is philosophic in outlook could to a certain extent fill the gap and take the place in college education that philosophy once held.

I think that every college should make an effort to provide not only some but competent and thorough instruction in the field. Courses should be supplemented by seminars in which the students would be encouraged to read and study texts, classics of science. Unfortunately we have not a series of classics comparable to Ostwald's "Klassiker der exakten Naturwissenschaften," but many texts are available in English translation. We also have intelligent text-books such as Sir William Cecil Dampier's "A History of Science and its Relations with Philosophy and Religion" (Cambridge, 3rd ed., 1942) and Charles Singer's "A Short History of Science to the Nineteenth Century" (Oxford, 1941).

In the graduate school, finally, the history of science has an extremely important function to fulfill. The graduate school is training specialists, physicists, chemists, bacteriologists, engineers, physicians, etc. Knowledge has accumulated tremendously in science with the result that every scientific discipline has become extremely complicated and specialized. The danger is obvious that we train mere technicians, men highly competent and highly skilled in one limited field of science but unaware of the social function of science and unprepared to play their part as citizens.

At the time of the great depression, I was once standing on the Grand Coulee Dam while it was under construction and was shown around by an agricultural engineer. Pointing to the waste land, he gave me a glowing picture of how irrigation would turn this desert into a flourishing garden, how at my next

visit I would find miles and miles of the finest orchards producing the best fruit in the world. When I asked quite naively who was going to eat this fruit, his answer was, "That's none of my business." The thought had never occurred to him that the fine fruit produced by so much labor and skill might be left rotting on the trees because so far we had been unable to organize distribution and consumption along scientific lines. And yet he was a citizen of a democracy who had had the best possible education, whose voice might have been very influential.

To-day when science is having such a strong impact upon the life of society, the scientist can no longer afford to remain cloistered in his laboratory and let the world be damned. He must assume responsibilities toward the community and must take an active part in determining the destinies of the nation. This, however, requires a broader training than he had in the past. Instruction in the history, sociology and philosophy of science by teaching him humanities and social sciences in a language he understands, will open his eyes to many problems and will undoubtedly contribute toward making him a better scientist and a better citizen.

The graduate school is also training historians, philologists, philosophers, economists, sociologists who must have some knowledge of science and must be familiar with its history. The historian of science who is both scientist and historian is best prepared to interpret science for them, presenting it in a language they understand.

The great educational value of the history of science is gradually being recognized, in England probably more than in the United States. But in this country, more and more educators are also beginning to realize that education at all levels can be broadened and enriched considerably by giving history a more prominent place in the curriculum and by including the history of science.

The war has ruthlessly destroyed many values; but just as it has cleared slums and made room for better housing, it has also cleared or at least exposed educational slums and has opened the way for improvements. It is to be hoped that in planning for postwar education, the men who are at the head of our great institutions of learning will avail themselves of the opportunities that the history of science offers for training the citizens of to-morrow.

OBITUARY

SIMON HENRY GAGE

SIMON HENRY GAGE, emeritus professor of histology and embryology, Cornell University, Ithaca, N. Y., died at his home in Interlaken, N. Y., on October 20, 1944, at the age of 93 years. He collapsed in his laboratory on October 11 and thus ended a long career of continuous devotion to his university and to his favorite field of science.

Professor Gage was born in Otsego County, N. Y., on May 20, 1851. After a brief career as an itinerant photographer he entered Cornell University as a freshman in 1873. Upon graduation in 1877 he became an assistant in the department at Cornell, then embracing all there was of animal biology, under the direction of Professor Burt G. Wilder. With the recognition of his ability his rise was rapid: instructor, assistant professor, associate professor to associate professor of anatomy, histology and embryology and finally professor of microscopy, histology and embryology, subsequently designated professor of histology and embryology.

With the founding at Cornell University in 1896 of the New York State Veterinary College, he was made head of an independent department housed in that college. In 1901, three years after the establishment of the Cornell University Medical College, Professor Gage moved to the newly erected Stimson Hall, which has been his scientific home ever since.

In 1908 under a special grant from the Carnegie Foundation, he retired that he might devote his whole time to research. This he continued to do until his death. His last published scientific article bears the date of 1942. On the ninetieth anniversary of his birth, May 20, 1941, appeared the seventeenth edition of his well-known book, "The Microscope." At the time of his death he had completed a book, "The History of the Comstock Publishing Company" and was completing a work on the "History of Microscopy in America." The microscope and its use—a first love of Professor Gage—thus retained a high place until the end. His interest in biology and its problems was, however, broad, as may be seen by consulting the list of nearly 200 articles, books and reviews from his pen.

His published work brought him merited recognition from the scientific world. He was twice president of the American Microscopical Society and twice presided over the meetings of the Zoological Section of the American Association for the Advancement of Science. Professor Gage was one of the original members of the American Association of Anatomists when it was established in 1888 and until recent years took an active part in its proceedings. When in 1901 the *American Journal of Anatomy* was founded, he helped in its establishment and became a member of its editorial staff. When the Wistar Institute of