SCIENCE

FRIDAY, AUGUST 17, 1917

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE FUTURE OF THE SIGMA XI[1]

IN a few weeks it will be thirty-one years since some students of Cornell University, feeling the injustice of the old-fashioned kind of education that gave all its honors, all its encouragement to the students of the liberal arts, planned an honor society in the sciences. They thought, as most of us now think, that not all of good was confined to Latin and Greek, that there was also merit in the natural sciences, that the student of geology or of engineering was as deserving of honors and of encouragement as the student of the classics. As they walked home from the commencement where the honors of Phi Beta Kappa had been liberally bestowed, they conceived a society that would recognize in an equal way the merits of the bachelor of science. And the Sigma Xi was born.

But higher education in America, as in all nations, has developed much since those days, and that exponent of the liberal education of those days has also changed. The Sigma Xi of 1886 would find little encouragement in most of our universities to-day, and we of the Sigma Xi may justly claim some of the credit for that change. The classical education of fifty years ago has but few proponents to-day, for science is now recognized as an essential part of any liberal education.

Perhaps some of us are claiming too much for science in education; I half believe that we are. When I received my bachelor degree, a good many years ago, my commencement speech was a diatribe on Latin and

[1] An address delivered to the initiates of the Yale chapter of the Sigma Xi, April 2, 1917.

Greek, which had exacted a full half of all my college work. But, I have frankly to admit that my debt to them is great, great because the science of those days was not a substitute for them, nor am I fully convinced that it yet is.

The Sigma Xi was founded, we may frankly admit, merely as a rival for the Phi Beta Kappa—perhaps there was a flavor of sour grapes in its origin! Has it justified its past? Is there justification for it to-day, and need for it in the future? Without reservation the answer to all these is yes. But, for the Sigma Xi of 1886 the need was brief. Science has won recognition as an essential part, though not the whole part of any liberal education. There was a time, not so very long ago, when studies of immediate bread-and-butter interest were debarred from the curriculum for the bachelor of arts degree as contaminators of a liberal education. I can remember a long and warm discussion in one of our large universities as to whether the study of human anatomy might safely be substituted for that of cat anatomy; not because the study of man was less worthy than the study of cats, but because the one was pursued for a practical purpose while the other was merely disciplinary. My colleagues of the language side feared that it would be, as indeed it was, a wedge to make education practical as well as cultural. Similar discussions are not often heard now in our faculty meetings. To preserve the degree of bachelor of arts in all its pristine aristocratic purity, the degrees of bachelor of science and of philosophy, and of I know not what else, were widely introduced for the proletariat in science. For a long time they were the penumbra of classical learning, and even yet in some places they have not won their full place in the sun. I hope that the time will soon be here when there shall be no distinctions anywhere between the student of Greek and the student of botany or chemistry, or of psychology. One is as useful in its way as the others, and has an equal place in liberal education, but not to the exclusion of others. This is now so evident that the statement would be a mere platitude, were it not that the Sigma Xi was founded expressly to help break down the distinction.

The Sigma Xi has long since ceased to look exclusively upon the other side of the Phi Beta Kappa shield. The ideals of our society are not those of its founders thirty years ago, when the simple recognition and encouragement of scientific studies were the most that it could do. Its higher ideal is now, as it has been for years, I can say with your unanimous approbation, the encouragement of productive scientific scholarship. The encouragement of scientific scholarship is but a part of its function. The student who, when he dons for the first time his academic gown, is able to talk learnedly of what his text-books and teachers have taught him about chromosomes, the mutations of *Œnothera*, dominant and recessive characters, the location of Cambrian rocks, the secret history of trilobites and dinosaurs, or the mysteries of ions and organic compounds, is a worthy candidate for membership with us, but he has not justified his right to full fellowship with the Spoudon Xunones until he has given evidence of his ability and desire to use that knowledge for the benefit of science. Our ultimate ideal, then, in a few words, is the encouragement of research. And the student may properly ask, what do you mean by research?

The word is something of a fetish with us. Is counting the number of feathers in a bird's wing, or the hairs in a mosquito's antenna research. Yes, if it leads the student better to understand the structure of all birds and all flies. Otherwise it might

as well be done by a properly constructed machine. We have been told that the mere accumulation of simple scientific facts never makes a leader in science, that, for instance, the collection of birds and bugs and brachiopods and their discrimination into species and subspecies is an inferior kind of research in natural history. But, every scientific man of repute in the past or present has begun in just that way, by the discovery and discrimination of scientific facts, however simple they may appear to others. Lamarck was a mere collector and namer of mollusks; Charles Darwin wasted years of his brilliant life in classifying cirriped crustaceans—I wonder how much those cirripeds had to do with natural selection, and I wonder how many of us would know a cirriped if we should meet one? Agassiz gave years of his life to the collection and study of poissons fossiles, and it requires no more acumen to classify fossil fishes than living bugs, for I have tried both. The collection and discrimination of mosquitoes was once a puerile pursuit. But, had there been no collectors and classifiers of mosquitoes, yellow fever would still be ravaging our seaports, and perhaps the Panama Canal would not now be a reality, and the safety of our nation endangered. Can any one see any possible relation between a mere entomological collector and the destruction of great cities by war? Had not Loewenhoek, in mere curiosity, found those organisms we call bacteria, and others wasted their time in studying and classifying them, there would have been no Pasteur, and antitoxins unknown. Is there no relation between such trivial pursuits, as some of our friends would call them, and typhoid fever?

I say, and say with deep conviction, that the ability displayed in the observation and discrimination of what often appear to us to be trivial things may be as great as that required for the formulation of far-reaching laws in science. Even the tyro can draw conclusions, that is, recognize laws, when facts are numerous enough, and the best of us can do nothing without facts. And the discovery of natural laws is sure to come when facts are numerous enough. It is the trained student who anticipates them. How many great discoveries or great inventions have uncontested claimants? Who was the discoverer of electricity, photography, telegraphy, telephony, aviation, or even evolution?

Let us not, then, deride the student because he is doing what we in our conceit think is unimportant. There are fashions in science as in everything else, and we are rather inclined to ridicule him who is not quite up to fashion. Shall we tell the candidate for honors in Sigma Xi that he must be in fashion? That research is research only when it leads to worldly recognition? No, train him aright, and nothing will be too trivial to merit his study. It is not *what* he does but *how* he does it that makes the leader in science as in everything else, for there is nothing small in science.

One of our noted chemists, not long ago, I have been told, after the publication of an important paper, when asked by the president of his college of what use his discoveries were to the world, replied that he hoped they had none. We would not wholly agree with him, because the ultimate end of all our research is the benefit of mankind, and there surely must be some practical use of every fact in science. He did emphasize, however, the first essential of every true scientist, the desire to learn new truths for the sake of truth.

Research ability I would define as the ability to observe, to discriminate, and to judge, coupled with an intelligence that is always asking the reason why. Given this ability to observe and to understand, and its possessor has the foundation for success, whether in science, in arts or in the

everyday affairs of life. Every day life is but a continual round of original research for every successful physician, lawyer, statesman or business man. And this is the highest aim of our society, to encourage the training of such students. As teachers our pupils look to us for inspiration and he only can give inspiration who knows the joy of research himself.

As a society for the mere giving of honors for scientific scholarship we have outgrown our past, and indeed that was our function only for a brief time. But we still have a duty to encourage scholarship, for without scholarship there can be no research. It is human nature to seek honors. Scientific men, like all others, from the humblest to the greatest, welcome them, whether it be membership in the Sigma Xi or in the National Academy of Sciences. When honors come as rewards for meritorious work accomplished they cheer and encourage; and they stimulate ourselves and others to higher efforts. We would not, if we could, abolish honors for scholarship from our society, we would not restrict them to accomplished research.

And our colleges and our nation need us for the higher work; never was there greater need for the work we can do, and these dangerous days are impressing us with that need. Until the millenium comes when we shall all live in peace and harmony, and like the dinosaurs grow big, fat and vulnerable and like them become extinct, the nation will need the utmost we can do in science.

Is it merely a coincidence that the life of the Sigma Xi has been nearly synchronous with the marvelous development of science in America? When this society was born there were but a few score of noted research men in science, and but one or two special societies in science. Now we number our alumni by the thousands, active research men by the hundreds, and scientific societies by the score. Then it was necessary for young men who would do things in science to go abroad, and chiefly to Germany, for their training. Who is there now who finds it necessary to go abroad for lack of suitable instruction here? It was not many years ago that I heard the justly famous Dr. Koch, of Germany, say that America was becoming the leader in medical education and that soon it would be necessary for foreign students to come here for their best training. We have been told so many times by our scientific friends abroad that we are precocious but still undeveloped in science that we have been inclined to believe them. But that time has passed. I say, not in boastfulness, but in conscious truth, that to-day America is doing more research work in nearly every branch of pure science than any other nation upon the globe. And the quality of our work suffers not in comparison. I have grown a little weary of the common assumption that we are still looking across the water for our inspiration and guidance in scientific research.

We are doing more work, we are doing quite as good work in pure science, not because we are any abler or better than other people, and especially Germany, but because ours is a democratic nation that gives to every one opportunity and stimulus; because we are less bound by precedent, because the teachers of our colleges and universities are less creatures of control. In Frankfurt-on-the-Main I was told, a few years ago, that the national government would not permit the privately endowed university they were founding there to appoint its own faculty. It reserved the privilege of making every professor a creature of the controlling government. Fancy what our progress would have been in America had a self-perpetuating cabinet of the national government had the power to

nominate every teacher in every college of our land!

These are some of the reasons, I am sure, for our remarkable development in pure science during the past forty years, some of the reasons why we may look forward to still greater progress in the coming years. Has our society had no part in this progress? Shall its part in the future be greater, or less? Do our colleges and universities still have need of us to strengthen, to sustain?

In one great side of science, however, for which our society stands, we, as a nation, have failed as compared with others, and especially Germany. Applied science, I mean, or at least some branches of it. England is awakening to its negligence in the past; never in the history of the empire has the scientific man of Britain been more appreciated than he is at present. And there is a new epoch for America coming soon. We have our Langleys, our Maxims, our Bells, Edisons and Wrights of whom we are proud, but our colleges have not had much share in their production, and we in the pure sciences are still a little inclined to look askance at them as the antithesis of that supposed ideal of our famous chemist. Has the Sigma Xi done all that it should in the past to encourage the applied sciences? Shall we give greater encouragement to the student who counts the bristles in a mosquito's proboscis or the plasmodia in its stomach than to him who applies that knowledge to the prevention of yellow fever? Does it require less ability, less research to observe, to discriminate, to judge in the construction of an airplane or a talking machine than to trace the fibers of a cerebral ganglion, or reconstruct the backbone of a dinosaur? Have we done what we should? Or shall we frankly restrict ourselves to the encouragement of research in pure science and leave its application for others to further, to encourage? I believe that the decision is now before us, and upon our answer depends much of the future of our society. Trained as a young man in two professions of applied science, and the most of my life given to research in science so pure that its application to things practical seems remote in the extreme, perhaps my sympathies with both are more pronounced than usual. I can see no difference in the quality of research that I gave to locating a railroad line, the treatment of a patient with measles, or the reconstruction of a paleozoic reptile. It would be a misfortune for us, I earnestly believe, to restrict ourselves to the encouragement of research in pure science.

A great future, I am sure, for science in America is its application, and the greater efficiency we reach in making use of the many discoveries of pure science for the amelioration and improvement of our conditions as a nation, the higher will be the honors, the greater encouragement we shall receive in the discovery of new facts and of new laws; the more honorable, the more appreciated will be the profession of the research student in pure science.

Because we as a society have not done all that I think we should have done in the encouragement of the applied sciences, numerous rival societies in our technological schools have come into existence. We are all working for the same objects, why should our efforts be weakened by rivalries? Why should we not all be united in a single great organization for the promotion of all branches and sides of science? I feel sure that the greater extension and the greater usefulness of the Sigma Xi has been hampered by our lack of accord in our ideals. Some of our chapters grant membership almost wholly for high scholarship, others exclusively to graduate students who have accomplished or are accomplishing meritorious research work. And this lack of unanimity has prevented, I am sure, the

greater extension of the society. We have but thirty chapters, an increase of but ten in the past ten years or more. There are at least a hundred institutions in America that need such encouragement as we can give. We have hesitated to extend our society, not because we are aristocratic, but because we earnestly desire to keep its ideals high, and know no way by which to ensure their preservation.

A step has been taken, one that I have hoped for for years, to define more precisely our ideals that we may entrust them fearlessly and safely to every institution where a few of us are gathered together. And I am still further encouraged to believe that in the end, even though it be slowly, it will lead to the results I have long hoped for, the extension of our society throughout our nation. Other organizations are doing much for the promotion of scientific research; ours is the nobler duty to train men and women for research in science, both pure and applied, to sustain, to encourage the university in the development of the science of the nation. Yale has done very much in the past, I am sure it will take its full part in the advancement of the future. Its ideals have always been high and they have been reflected in the chapter of the Sigma Xi. I can say with assurance that in no chapter of the society is the honor of election to membership greater.

In conclusion, I would say a few words to the initiates of this evening. You have pledged yourselves to uphold and sustain the ideals of the Sigma Xi. An honorable, a useful future lies before you. The world needs you as it has never needed such men as you before. Your vocation in life is more honorable than it ever has been before in the estimation of the world. I am sure that when you shall have reached my age, science will have won far greater honors yet for its earnest and sincere devotees, even as it has changed marvelously since the time when I was as young as you are.

New facts and new laws awaiting your discovery are as numerous as ever. Your work may be greater, but you are equipped to do that work more easily than we were a score or two years ago; your footsteps will be more direct, and the harvest that awaits your reaping is very, very great. And I would encourage you with the assurance that, no matter how humble that work may seem to you, if you have learned rightly to observe, to discriminate, and above all, to judge, there are no limits but your energy and your ambition to the heights you may climb.

Samuel W. Williston
University of Chicago

THE WORK OF DEAN H. L. RUSSELL

During commencement week his colleagues, friends and former students celebrated the twenty-fifth anniversary of the doctorate of H. L. Russell, dean of the College of Agriculture of the University of Wisconsin. In 1892 Johns Hopkins University honored Professor Russell by conferring this degree upon him. This year (1917) also marks the completion of twenty-four years of service to the University of Wisconsin. The last ten years of this period have been occupied in directing the activities of the College of Agriculture and the Experiment Station.

At the anniversary last week bound records of the results of the work accomplished by Dean Russell were presented to him. Three sturdy volumes there were—nearly two thousand pages.

"What Dean Russell has meant to Wisconsin and her farmers purely as an investment cannot be estimated, so extensive have been his activities and so far-reaching their results," said E. G. Hastings, professor of bacteriology, in speaking of the relation of Dean Russell's work to Wisconsin and her farming industry. Professor Hastings has been closely associated with Dr. Russell in his work as a bacteriologist, having worked with him when he was head of the department of bacteriology