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SCIENCE AND HUMAN PROSPECTS[1]

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IN this fateful year, one should need no excuse for departing from the common practice wherein the president of the society devotes his final address to the field of his own research. It seems to me that the occasion calls for a subject of larger importance and one that has a more direct relation to the welfare of the nation. Therefore my remarks on this occasion will bear upon some aspects of education in science and its relation to the future welfare of humanity.

It seems to me that a teacher of geology, or indeed of any other science, should devote himself not only to giving his students information, and explaining processes and theories—however important those educational duties may be—but especially to training young people in the scientific way of thinking and helping them to acquire the scientific spirit. To my mind, that is his most important function.

Since geology is considered a science—albeit not one of the so-called exact sciences—and since we call ourselves scientists, it may be well to ask at this point—what, essentially, is science? In general terms the dictionaries say that it is knowledge established, organized and systematic. To me, however, this concept is not adequate. In the words of the great French mathematician, Poincaré: "A collection of facts is no more a science than a heap of stones is a house." Verified knowledge is one element, organization and classification are necessary and so is the testing of hypotheses, but I can not regard any of these as the core of science. To me the basic thing about science is an attitude or habit of

1 Address of the retiring president of the Geological Society of America, delivered at the annual meeting in Austin, Texas, on December 26, 1940.

mind, a way of thinking which is characteristic of those entitled to be called scientists. If that is so, most subjects of human concern may be dealt with in a scientific way. The essential condition is freedom from bias and prejudice. The major objective of the scientist is truth, no matter how unpleasant it may be or how much discomfiture it may cause among those who hold cherished beliefs which happen, nevertheless, to be errors. Dr. Crapsey once remarked that: "Truth is a brand new virtue." And it may be added that as such it is not yet as widely sought and valued as it should be. It has been well said that "the purpose of science is understanding." This is only a modern version of the well-known admonition of King Solomon to "get understanding."

The scientific method is relatively new. As recently as four centuries ago it was not in vogue even among the most learned thinkers of the time. To-day it is used only incidentally by most of the people in even the most civilized countries. It is hardly an exaggeration to say that the majority of educated persons —even those with college degrees—do not really understand it. Often it is confused with invention or the mere cataloguing and classifying of knowledge. Some years ago, in a nation-wide poll which was taken for the purpose of finding out who was popularly considered to be the greatest scientist in the United States, the choice fell upon Edison, the inventor. But inventions, however useful and ingenious, are only the outgrowth, the by-products, of science. Although invention was originally a matter of mere cut-and-try experiment it has made more and more use of science, until much of it is now highly scientific in the true sense. Even so, the one should not be confused with the other. Science is not invention. The purposes of scientists and inventors are fundamentally different, even when they use similar methods.

As for the majority of mankind, in the less developed countries, their lives have scarcely been touched by science except in the form of some of its tangible products such as machines, radio, or by the services of the sanitarian; and their understanding of science is hardly greater than was that of their ancestors a thousand years ago.

The critical testing of ideas, though a fundamental practice of the scientist, is a habit difficult for the average human being to adopt. An original idea is a brain-child and tends to be jealously cherished as such. To expose it to the cold light of reason takes a sort of Spartan courage that is too often undeveloped and yet is one of the essential attributes of any one who aspires to be called a real scientist. To be merely logical with facts selected for a purpose is much easier than to divest oneself of bias. Steadfast courage and a renunciation of false pride are required in the search for opposing rather than supporting evidence.

How high shall we appraise the value of the fortunate speculator who happens without much evidence to hit upon the right explanation far ahead of others, as compared with the patient investigator who carries a firm structure of fact and controlled theory with him all the way? The former has uses, but it is chiefly to the latter that steady scientific progress is due. Loose speculation is an ingrained habit of humanity, but the careful scientist realizes that many problems are now insoluble because the necessary data are not yet obtainable. He will, therefore, restrain his fancy, devoting his efforts to objectives that are within his reach, content to leave to his better informed successors those other questions which are not yet ripe for consideration.

Failing to understand what the real scientist must be and what the essentials of science are, part of the public to-day is led to accept as science various elaborations of intuition, speculation and fancy, such as were much more widely current a few centuries ago. It is regrettable, but in a free country perhaps unpreventable, that the cloak of science should be donned and worn by faith-healers and other mystics who have no comprehension of the meaning of the term. As a result, however, it is hardly surprising that part of the general public has a rather confused impression about science, when it reads serious accounts of such absurdities as a "science of astrology," "the science of phrenology," and many others.

That the scientific method had its beginning in the ancient Greek and probably even earlier civilizations is clear enough, but it was displayed by only a few of the philosophers of that era and not consistently even by that few. This is all the more strange in view of the fact that mathematics and the very art of reasoning, logic, was highly cultivated by the Greeks. True, men like Anaxagoras at Athens had many sound ideas and employed the scientific method to a notable extent, but at the same time they entertained, as firm beliefs, some notions that would now bring a laugh to any schoolboy.

No true scientist would have seriously put forth as a conclusion so fantastic and wholly unverified a notion as the great Aristotle's dictum that earthquakes are due to the surging of the wind through caverns in the earth. Even allowing for the inaccuracies of translation from the Greek, one can find only the slenderest evidence to support this opinion. It was a result of pure speculation upon a subject about which the author probably had not even the most elementary knowledge. Yet it was quoted with approval for twenty centuries. This is all the more inexcusable because a considerable body of definite information about earthquakes was available in the Greek world of Aristotle's day and there were many pertinent observations on geology that could easily have been made in that epoch, even without modern instruments, if serious attention had been devoted to the problems.

It must be admitted that dogma has been the fashion of the past. For millions of the earth's inhabitants it still remains so. To-day we see the current of progress being reversed in the despot-ridden countries of Europe, where the privilege of freely drawing conclusions from evidence is being restricted and the blind acceptance of official dogma is exalted as a duty if not a necessity.

Even in the last century or two the history of science was marred by many a bitter controversy, between rival leaders and their followers, over theories. A theory was defended like a home citadel, and doubters were deemed enemies actuated by the blackest of motives. Among such bickerings there was by contrast the magnanimity of Charles Darwin who said, regarding the storm of criticism that raged after the publication of "The Origin of Species," "If my book can not stand the bombardment, why then let it go down and be forgotten."

Fortunately, rancorous disputes have nowadays largely ceased to afflict the relations of real scientists. Yet there is still far too much of that spirit in the world at large. It has been well said that "Most men think with their emotions rather than their intellects." The ancient method of verbal combat is still employed in our law courts and legislative halls. Each participant adheres to his thesis. Search is then made for evidence to support it and at the same time to refute its opponents. An equal effort is made to suppress or depreciate any facts that may prove to be embarrassingly adverse.

The debating society may be a good place to train lawyers, but the partisan attitude of "win the argument and confound the opponent" is an unhealthy state of mind for a young scientist. Indeed, he can never become a true scientist until he outgrows that mental habit. Rather he should cling to the advice of the wise old Quaker, William Penn: "In every debate, let *truth* be thy aim, not victory." Perhaps it is our sporting instinct, derived, it may be, from our age-long struggle against each other, that makes us usually more interested in winning a contest than in finding the truth.

Although the gathering of facts can not in itself develop a science, yet facts we must have, in infinite number and variety, even though they are only the bricks to be used by the builder. The mere multiplication of facts, the piling up of observations closely similar to hundreds of others is properly regarded as of less value than the search for explanations, principles and laws. While the layman thinks of Major Powell as the intrepid explorer of the Colorado River and its Grand Canyon, discovering, even at the risk of death, the wild beauty of its scenery and the details of its geologic section, it is fitting that geologists should honor him even more for his clear exposition of the principles of the base-level of stream erosion and the antecedent river.

In view of the fact, already mentioned, that we can seldom foresee what utility any scientific fact or principle will eventually have, we can not afford to neglect any aspect of science. Discoveries in one field often release obstructions that have held back progress in other branches of science, and thus permit further advances. On the other hand, by regimenting scientific work and even opinion, along with all other phases of life, for their own immediate purposes, modern tyrants are violating this principle. This they can do with some measure of success for a short time, but eventually their countries will almost surely suffer a degeneration of science, and therefore of the civilization which is based upon it.

Along with the increasing complexity of modern life there has grown up an urgent need for the scientific expert. The demand is being met by many persons who are real scientists but unfortunately by others who do not deserve the name. On that score Dean Roscoe Pound lately said in sarcastic vein that "the administrator is not appointed to office because he is an expert but he is an expert because he has been appointed." We all know of cases that fit this satire, but in all seriousness we may trust that they are not numerous.

Since the public must depend on its experts, it is essential that it should be well justified in placing confidence in them, to the end that such respect will endure. That puts a heavy responsibility upon the individual expert. As Grover Cleveland once said that " a public office is a public trust," no less so should any degree of leadership in science be regarded as a public trust; and so the expert scientist is under great obligation to deserve the confidence of the public. His intellectual honesty will need to be outstanding and unwavering. To-day, in this country, the scientist has already won such esteem to a large degree, although he is compromised and discredited now and then by the shortcomings of the less conscientious and careful of his colleagues.

Many years ago, a former president of our society, R. A. Daly, speaking informally as a visitor to one of my classes, advised the boys to "think to scale." It would be hard indeed to pack more meaning into three words. The person who *thinks to scale* sees the relative value of each fact he uses and of each objective before him. He can then economize his time by confining his attention chiefly to the important and significant problems. On that point the wisest of the Roman emperors, Marcus Aurelius, is said to have remarked that: "Every man is worth just so much as the things are worth to which he devotes his earnest efforts." It might be somewhat disquieting to many of us if we should measure ourselves by that principle.

More than three centuries ago Sir Francis Bacon urged the application of the scientific method, as he then conceived it, to human affairs and problems in general, but we are still far short of having adopted his advice, although all our experience since his day confirms its value. The greatest progress has been made thus far in the physical sciences and scarcely less in the biological. The scientific method and attitude of mind also pervade to a very large degree the related professions of engineering and medicine.

In such fields of study as economics and sociology, the complex and fluid nature of the basic data that must be used and the influence of human prejudice, which closely touches these subjects, has greatly impeded their emergence from speculative philosophy and their rise toward the scientific level. In addition they need a more general adoption of the scientific attitude and method. Can we not apply these to human affairs, subdue the emotional considerations, and brush away the cherished errors of the past? Then we should be able to move more rapidly toward a real understanding of principles, for we are justified in believing that such principles do exist.

In ethics, which is in some respects the most important of all subjects of human inquiry, we have made no great progress beyond the Greeks of Aristotle's day. Even now the study of human conduct is but slowly emerging from its age-long status as an appendage of religion. Would it not bring fruitful results to study ethics in the same scientific spirit that already pervades such a field of research as physiology? Without a firmly based and widely accepted science of ethics, the other natural sciences alone may allow us to stumble eventually to ruin for want of adequate guidance. Under the direction of the engineer, dynamite is an effective aid in construction and promotes industrial progress; but in the hands of the criminal it means murder and destruction. The difference is only one of ethics.

But for the deficiency of science in politics, statecraft and ethics perhaps we should not find ourselves now threatened by the plague of military despotism, which is more deadly in its modern form than any pestilence. We have used the scientific method in engineering and medicine for a century and have found it good—far more effective than the old ways of speculation or of trial-and-error. In spite of the difficulties involved why not then extend it to other fields?

To have science flourish, there must be complete freedom of inquiry and discussion. The beneficial influence of such freedom is indicated by the extraordinary development of philosophy and the sciences among the Greeks in the fourth to sixth centuries B.C., in the Germany of the nineteenth century and in modern America. Scholars properly insist on this necessity and guard their hard-earned right to intellectual liberty; nor is this freedom of research so firmly held but that it takes a little defending, all the while, from the bigots who would close to discussion certain trends of thought of which they chance to disapprove.

But if the scientist is to deserve and therefore keep his freedom, even in a republic, he should be equally scrupulous about his own responsibility to the public. He has no right to claim on the one hand immunity from restraint, and on the other hand license to be unreliable. It is the less responsible members of our profession who most endanger our freedom of thought, for it is their words that tend to discredit the very science to which they are nominally attached and thus bring all science into disrepute.

Jefferson, Franklin and other founders of our American Union fully realized that a well-informed people was essential to the success of the republic. Although a lover of freedom, Goethe understood the difficulty of making a democracy succeed, remarking that "the trouble with democracy is that it has to wait for an enlightened public opinion." More pessimistic commentators, like Disraeli, were confident that the experiment could end only in disaster because they believed that even the best popular education that was practically attainable would be inadequate.

To be good, a system of education must be suited to its time in history. The boys of ancient Persia were taught "to ride and to shoot and to speak the truth." In their day, nearly 3,000 years ago, that was education enough, but now it would be of little avail, although the last item (speak the truth) has eternal value.

If we were willing to accept the "Nazi" plan of society we should need only a small highly educated upper caste. The rest of the people would be given only training and indoctrination. But if we want freedom and the so-called democratic way of life, then we need the most widespread and effective education that our mental equipment will permit. In our own system, a few wise leaders would be helpless in the face of a grossly ignorant populace, swayed chiefly by its emotions and prejudices. Too often this has been true in democracies thus far, and in America it is still a dangerous factor. So I conclude that we must have, as soon as we can provide it, far better and more extensive education, and a general adoption of the scientific attitude of mind. Is that a large order? It surely is—perhaps too much to expect—but it may well be the price of our liberty and the survival of our own type of civilization.

Hitler is quoted as having said that no people is capable of governing itself or even of planning its own affairs. If the majority of the people are to be kept in ignorance, he is doubtless right. As our life becomes more complex our problems become more difficult. To solve them badly may mean disaster. To solve them well requires adequate knowledge and especially clear thinking. Bias and prejudice are liabilities or handicaps that we can not well afford and hence should try by all means to reduce. If, in a republic, we are to have our affairs well handled, we must rear millions of capable unbiased persons to make those varied problems their life concerns. That, it seems to me, demands the scientific attitude of mind and an efficient system of education expressly devised for that purpose; for it is not something which we gain by inheritance or in the common experiences of life.

To insure a well-informed and intelligent people is a most difficult task. History affords no good example of such a nation. It is by no means certain that it is even possible. The eugenicists will probably assert that their advice must be followed, and no doubt there is some hope in their principles and plans; but beyond that it seems evident that education is our best chance. It means educating more people and educating most of them longer—perhaps continuously throughout life. Most important of all it means educating them far more wisely and efficiently. As a scientist I am perhaps biased in believing that the most important element in this education is the scientific attitude of mind. That does not mean that every person must become a scientist, but that he must acquire the habit of thinking as a scientist. It means that the great majority should understand what science is, what it stands for and its value to society. They should then be able to recognize the true scientist and distinguish him from the impostor. It will also enhance their capacity to judge the merits of their leaders and the general issues of the day.

Having harped at length on the importance of science, I must ask you not to misunderstand me as implying that science is all we need. It is no panacea for our troubles. Indeed, if we were exclusively scientific, we should not be human at all. There are other things that are also necessary—love, art, imagination, intuition, loyalty, industry, and many others. It is my purpose merely to emphasize the opinion that science is one of the most indispensable factors in civilization. We must become more scientific and especially more widely scientific.

To say that one vital function of society is more important than another is as pointless as to say that the lungs are more important than the heart. We may, however, be sure that effective education is one of the indispensable concerns of a free civilized nation. In the opinion of Dr. Copeland "education is incomparably the most important function of Society." Without it the state could not endure for even a century, for in no other way can the long slowly won progress of the past be effectively transmitted. Good education is one of the greatest means of national advancement. Poor education insures the decline of a people and even their disappearance as a nation.

Conditions in our schools and even in our colleges and universities to-day are far less satisfactory than they should be in view of our acute need of the best education we can provide. Curtis[2] is inclined to ascribe this partly to the fact that many teachers, as well as students, have had little or no training in science and partly to the type of teaching that is all too prevalent, especially in our lower schools. Too much of it is dogmatic, and the student is not trained to think for himself. There is far too much emphasis upon the learning of facts, on the mistaken supposition that knowledge, as distinguished from understanding, is the chief object of schooling.

Since in order to progress we must constantly improve our education, we shall have to have more teachers, especially better and wiser teachers, and teachers who are not only competent to train youth but who are allowed to utilize their competence in teaching under a minimum of administrative control. In my opinion no mature teacher who needs to be told by a principal or a dean how to teach deserves to be employed as a teacher. There has grown up in recent years a widespread tendency to overstress the importance of teaching methods and to give school executives wide powers of direction over the daily work of the individual teacher. Such practice overlooks the fact that good teaching is a matter of individuality, that the teacher, to be successful, must be a true scholar, and that scholars can not be regimented. Also our system has always been less effective than it should be because we have left so much of the education of our rising generation to relatively inexperienced young persons. This seems almost as shortsighted, and in the long run as likely to prove disastrous to the nation, as to leave our military defense largely to young recruits. The only apparent advantage to this is that it is less expensive than the alternative; but the cheapest system may prove in time to be the least economical.

At this point it may be asked what results we can fairly expect from such improvements in our educational arrangements in the next decade or century. The experienced scientist will understand that sound improvement in human affairs will come only by evo-

[2] SCIENCE, August 4, 1939, pp. 100–101.

lution and after cautious experiments on a small scale rather than by sudden revolutionary changes on a large scale.

One of our greatest dangers lies in the impatience of many people to gain great results quickly. This is natural enough, in view of the brevity of our individual lives. But it is inconsistent with the principles which govern all life. We are a part of nature and, however much we may seem to influence natural processes, it can hardly be denied that we are in fact and on the longer view controlled by nature. Whether we like it or not, slow evolution is nature's way. And so we can scarcely hope to elaborate some theoretical new scheme of social or economic organization, put it into practice on a national or worldwide scale in a few years and have any reasonable prospect of success. Hidden faults and weaknesses are likely to cause failure, and that in turn may exhaust for decades even the healthy impulse toward improvement. The fascination that these schemes have for our youth doubtless has a complex cause, but it may well be due in part to the faulty character of our current education, which has not given them the advantages of the scientific viewpoint. Again, as Daly said, they should learn to "think to scale."

However difficult it may be to forecast future trends more than a few years ahead, the geologist can hardly be expected to overlook the longer view; and so I may now raise a few questions about what may be in store for humanity in another epoch—not a matter of centuries but probably of tens or even hundreds of thousands of years.

There are many who expect that man will make continuous progress toward higher and better things, becoming in the course of time so much wiser, more sensible and reasonable that the world's life will be vastly more happy than it has ever been in the past. War, sickness and poverty would then be abolished. Cruelty, hate and injustice would become obsolete, and we should be living in a sort of Golden Age the like of which we have never even approached. That is a beautiful vision to contemplate, especially in these dark times.

The lessons of historical paleontology may throw a beam of light ahead on this speculation—for of course it is no more than that. As we look back over the history of man we find evidence of great progress since the time of the primitive cave-man, who made crude stone implements but lived in isolated families competing with the wild beasts of the day for such food as could be found or seized. He was indeed only one of the beasts, and it is hard to point out more than a few respects in which he was superior to them. Did the early Stone Age men gradually develop, by slow practice and learning, into modern man? We do not know, but there is little reason to suppose so. All that we know to-day of human paleontology indicates that what we loosely refer to as man comprised a group of at least five and probably eight or more distinct animal species which are generally grouped by zoologists in several genera. These may have originated in various parts of the world, each lived many tens of thousands of years, but eventually with one exception all become extinct. At certain times two or more such species may have coexisted, although probably in different regions. Perhaps they eventually killed off each other, just as the white race in historic times has exterminated the Tasmanians and certain other primitive tribes. But to-day only one species survives, and he has apparently had the field all to himself since the middle of the last glacial epoch, or about 30–50,000 years ago, according to current estimates. Each of these species appears to have been as distinct from the others as species and genera of animals usually are.

There is nothing to indicate that the very primitive *Sinanthropus* made much progress in culture during his long career in China. He learned to use fire—probably to make it—and to fashion a few simple tools of stone and bone; but that seems to have marked the limit of his inventive capacity. For shelter and safety from attack he seems to have crept into caves, like many another beast.

Neanderthal man, generally placed in the genus *Homo*, shows evidence of a distinctly higher culture. He made more varied and better tools of chipped flint, of wood, bone and other materials ready to his hand. But with a brain which appears to have been inferior, even his long career as a species seems not to have sufficed for him to invent pottery, polished or ground stone tools, to learn to domesticate and use other animals rather than to hunt them, or to grow crops—not to mention building houses or using metals. Apparently he had some ideas about spirits and a future life, for he buried his dead with some care and placed in their graves some of their ornaments and weapons; but we have no evidence that he developed any art of drawing or sculpture, and none of his tools were finely wrought. There is evidence of only slight progress during the long age through which he lived, and at his best his cultural level was distinctly lower than that of the most primitive savages now known to anthropologists.

How these various species of men came into existence is unknown and may well remain so. But there is nothing to suggest that their origin differed in any way from that of the other animals. To suppose that it did would be gratuitous speculation. Indeed, had it not been for the achievements of the latest of these species, the *Hominidae* would never have been entitled to special notice as anything more than somewhat peculiar mammals.

From biological friends whom I have consulted, I learn that they are not yet agreed upon the question of how a new species originates. In fact, there is some difference of opinion as to just what constitutes a species, as contrasted with a race, a variety or even a genus. While waiting for the biologists to work out these problems, we may use the term *species* a bit vaguely in its current meaning, and we may tentatively adopt the now preponderant view that new species originate not by gradual imperceptible changes, but by sudden mutations, either extensive enough to produce a distinct species at once or occurring in series which eventually culminate in full specific status.

However any new species actually originated, its parental species doubtless continued to exist for a time without much change. The new kind expanded in numbers and, if more effective, eventually overran and exterminated the older one. It then went on living without important physical change until it was in turn crowded out by more efficient animals or succumbed to other adverse factors in its environment.

Have we any reason to suppose that *Homo sapiens* is not subject to the same process or that his fate will not be similar? He differed from earlier species of men very slightly in physical form and structure. His achievements and the shapes of his crania suggest that he possessed, from the outset, not only a larger but probably also a distinctly better brain, which has enabled him to learn more extensively, to devise complicated languages, and eventually to develop what we now call civilization. This progress seems to have gone forward on a steadily rising curve. For perhaps 20,000 years *Homo sapiens* was only a savage, a wandering hunter. In the next 5,000 years or more he advanced locally to the status of a shepherd and even a village farmer. In another 3,000 years he learned to extract and use metals, form cities or states and even nations, and become skilful in many of the finer arts. Accelerated advance in the next 1,000 years led to books, commerce, literature and philosophy. The last century or two has witnessed a rapidity of material progress, in communication and far-flung organization that exceeds anything previously known; and with it has come much growth in ideas and in the complexity of economic and social arrangements.

Are we justified in assuming from the contemplation of that curve that it will continue to rise indefinitely, and at a similar rate? Is there in all geologic or human history any precedent for that? Other animal species of the past have followed career curves that involved a rise, culmination and decline. We have seen the same law controlling the nations and even races of humanity. Will our own species also reach its climax and then deteriorate? And if that happens, how and when will it occur? As yet we have but little basis for answers to such questions.

In contrast with his progress in ways and ideas, *Homo sapiens* seems to have undergone only slight physical changes, even in the estimated 30,000 years of which some records have come down to us. Anatomically there seems to be no evidence whatever of any progress—no increase in cranial capacity, probably no appreciable change in brain anatomy. In the last 3,000 years, for which some evidence is available, there is no sign of any improvement in native intelligence. Man's actions are still governed more largely by his emotions and subconscious mental elements than by his intellect. His savage instincts, that we like to think began to be conquered thousands of years ago, are still present beneath the surface and reappear at unexpected intervals even in civilized man. Among the more backward modern races of humanity they have scarcely changed.

In short our surviving species of *Homo,* being one of the mammals, is probably as definitely limited in his possibilities as are the other species of that class. Just as we do not expect a dog to learn algebra, although he can learn to open a door, so we probably ought not to expect more from present-day man than his brain is capable of attaining. As Hawkins,[3] the English paleontologist, sees it: "Our mental capacity is a specific character." If this is the truth of the matter, it may be overoptimistic to expect our own species to rise far above his present stage of mentality. Notable improvement along lines already established, and a raising of the other two thirds of the Earth's population to or above the level of the present civilized minority, may well take place over the centuries and thousands of years yet remaining in the expectable future life of this species. His contribution to biological progress will then have been made, and if history is to repeat itself, he will then be ready for conquest, if not extermination, by some other type of being—perhaps some new species of the *Hominidae* that has more innate capacity for progress.

Just as it would have been difficult for even a most intelligent trilobite to imagine the fish, which was destined to drive him from the scene, so it is not easy for us to forecast the nature and potentialities of that new species of *Homo* which may appear in the distant future—unless indeed our genus itself has by that time run its course and is not destined to offer the world anything further. It is of little consequence whether such a new species may have smaller teeth, a skin less hairy or taller stature. The only way in which he is likely to outstrip *Homo sapiens* effectively is in the quality of his brain. Will he be able to

[3] Herbert Leader Hawkins, "A Paleontologist Looks at Life," *Proc.* Cotteswold Nat. F. C., Vol. 23, 1930, p. 219.

absorb knowledge more rapidly and remember it better? Will his imagination be keener, will he reason out his problems more effectively; and, above all, will his life and conduct be controlled by his intellect rather than by his feelings? If so, he may be able to take knowledge in larger doses, profit more by the stored-up experience of others, instead of merely his own, and by the lessons of history. He should be far more educable than any earlier species in the family.

It may be objected that these speculations are hardly optimistic, that they do not present a hopeful picture, and that they do not necessarily envisage continued progress toward a far higher and better human world. To this I must reply that a scientist is under no obligation to be an optimist. His only concern must be to approach nearer to the truth. If the truth offers hope, we may all rejoice. If it fails to do so, we are not thereby justified in denying or even ignoring it. As King Solomon long ago advised, let us get understanding, and by so doing we may reach a serenity of outlook that will fit us better to play a worthy, even though minor, part in the great drama of human evolution.

OBITUARY

CHARLES WALLIS EDMUNDS

CHARLES WALLIS EDMUNDS was born on February 22, 1873, in Bridport, Dorset, England, the son of Thomas Hallett and Caroline (Wallis) Edmunds. In 1883 Thomas Edmunds moved his family to America and established their new home in Richmond, Indiana. There Charles Edmunds received his preliminary education, including a year at the University of Indiana, and from there he went to Ann Arbor in 1896. In Ann Arbor he completed his undergraduate training, found his life work, and established his own home. He was graduated from the University of Michigan, Department of Medicine and Surgery, which later became the University of Michigan Medical School, in 1901. In the following year, as an interne, his keen observation in a cardiac case attracted the attention of Professor Cushny, and thus his association with pharmacology was begun. Keen observation indeed became the keynote of his laboratory teaching. He believed that students too easily lost the purpose and meaning of an experiment in concentration upon the proper handling of mechanical devices.

In 1902 Dr. Edmunds became assistant to Professor Cushny in the Department of Materia Medica and Therapeutics of the University of Michigan and in 1905 assumed the direction of the department when Cushny returned to England, an early recognition of his leadership. In 1907 he was named professor of materia medica and therapeutics and later the phrase, director of the Pharmacological Laboratories, was added. The former title was retained to carry out the connection between the old materia medica and the new science of pharmacology, at that time still in the pioneer stage.

In 1905 Dr. Edmunds worked with Gottlieb and Magnus at the University of Heidelberg, in 1907 with Cushny at University College, London, and in the summers of 1908 and 1909 he worked at the Hygienic Laboratory, now the National Institute of Health, in Washington. The connection with the last institution was of the greatest importance, as it led to the close cooperation of the laboratory at Ann Arbor with various national organizations.

Dr. Edmunds held many responsible posts in and out of the university whereby he demonstrated his keen interest in medical education and in the development of pharmacology, and he brought to these tasks an unsurpassed art of gracious dignity and diplomacy. He was secretary of the Medical School from 1911 to 1921, assistant dean from 1918 to 1921, a member of the executive committee of the Medical Faculty from 1936 to 1939, and in 1937 he was appointed to the executive committee of the Graduate School. He was a member of the U. S. Pharmacopeial Convention from 1910 onward, served as chairman of its most important committees, and was elected to its presidency in 1940. He served on the Council of Chemistry and Pharmacy of the American Medical Association from 1921 and was chairman of the committee of the Council on Grants to support research on problems connected with therapeutics. He was prominently identified with the executive committee of the National Research Council in 1939 and was a member of its drug addiction committee from 1930. As a signal distinction he was appointed to the International Committee on Drug Standardization, Health Committee of the League of Nations, and in 1925 participated in its deliberations in Geneva.

Standards might be termed the theme of Dr. Edmunds's life and work. Recognition of his abilities in this respect came to him early. For example, he was a member of the committee for revision of the U. S. Pharmacopeia in 1910–1920, 1920–1930 and 1930–1940. In the first instance he was chairman of the committee to make recommendations regarding bioassay methods, and the studies of this committee led to the introduction of such methods into U.S.P. IX, the first pharmacopeia in the world to make bioassay methods obligatory.

Standardization of digitalis was an early and con-