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THE ADDRESS OF THE PRESIDENT

THE MINISTRY OF SCIENCE

R. I. CRATTY

We are living in a very progressive age — one which when compared with that of our forebears, is filled with advantages for our welfare and enjoyment that challenges the attention of every thoughtful person. That knowledge is power was never a more self-evident truth than it is today, and science, which is simply classified knowledge, is every day coming more closely in touch with human lives, and ministers to us in innumerable ways undreamed of a century ago. Just how great our debt is for all this it is difficult to say. Captain Roald Amundson, that modern Viking whom all the world delights to honor, says, "We must realize that all we have and are we owe to scientists, those patient searchers after knowledge."

Every year in increasing numbers, men and women are devoting their time and talent in the various fields of scientific research. Some like Agassiz, delve into their chosen subject for the pure joy of discovering some hitherto unknown truth, while others do so with some utilitarian purpose in view, one which will have a remunerative value for themselves or will add to the physical or material well-being of mankind. The former contribute in no small way to the sum total of human knowledge, to broadening the vision, and to the intellectual, moral and spiritual uplift of all those who are interested in the deeper mysteries concerning the things about us, while the latter make a contribution which comes more closely in touch with our every day life, and is enjoyed and appreciated by the humblest individual.

The growth and diffusion of knowledge among men was for thousands of years a very slow process. It seemed at times almost a forlorn hope that the world would ever break away from the bondage of superstition, and the false opinions and beliefs that had been handed down from generation to generation, and which it was virtually considered sacrilegious not to believe, but in the past hundred years, with the rapid spread of scientific knowledge,

there has been a great change for the better, and the advancement in all lines of human endeavor has been truly wonderful.

In the days when science was young, opinions and theories were often accepted as facts, with little or no investigation to prove their accuracy. Even Aristotle is said to have taught that of two solid bodies of the same shape and material, the larger and heavier would fall to the earth in the shortest time, an opinion which could so easily have been disproven, but which waited over a thousand years for Galileo to demonstrate by a simple experiment. Nowadays when any new theory or hypothesis is advanced, the scientists of the world at once attack it from every angle in order that its truth may be established or disproven. To run such a gauntlet has been the fate of the nebular hypothesis and the tidal theory for the origin of the planets and satellites of our solar system; the undulatory and the corpuscular theories of light; theories concerning that Riddle of the Universe, the origin and constitution of matter; the theory of evolution by natural selection or by mutation; Einstein's theory of relativity and many others; some of which scientists will undoubtedly prove beyond the shadow of a doubt, some they will certainly find to be untrue, while others may remain as mysteries unsolvable by the mind of man. While these theories minister mostly to the intellectual side of our being, to that insatiable longing within us to search out and understand the unknown, they are nevertheless basic in character and deserve the closest scrutiny.

The major portion of the past century has by some been referred to as the Mechanical Age, because of the substitution of machinery for human labor which revolutionized the daily lives of all civilized peoples, a transformation brought about largely through the contribution of scientists to a better understanding of the forces of nature and the way to utilize them. May not this twentieth century in time to come be known as the Age of Science, an age filled with discoveries that astonish us not less by their frequency than by the marvelous character of the discoveries themselves?

It would require much time were one to attempt to name all the fields of learning which lay claim to the name of science, and to review ever so briefly what each has done in ministering to our various wants. While this Academy is particularly interested in those lines indicated by the titles of the different sections, its members, nevertheless are continually making use of anything accomplished in other fields of research that will be helpful to them, for the almost inexhaustible store of knowledge available

today is like a perennial fountain which gushes forth from many outlets and one has only to hold a vessel beneath to have it filled to the brim.

Perhaps nothing is more vitally important to us all than freedom from disease, and the prolongation of human life; and, in this twentieth century, we know how great a change for the better has been brought about by the scientists of the world. Ever since the germ theory of so many diseases was proved by the bacteriologists, and methods of vaccination and inoculation were perfected, many of the diseases which for ages had scourged the world were brought under control. It is said that in Germany during the eighteenth century there was a common saying, "*Von Pocken und Liebe bleiben nur wenige frei!*" — From small-pox and love few remain free! We now know that small-pox, diphtheria, typhoid, yellow-fever, and even hydrophobia and leprosy have been robbed of much of their terror by science. In a similar way the veterinarians are doing a great work in controlling or eradicating those contagious diseases which are at times so fatal to our domestic animals, and besides adding to the material wealth of our country, enable us to secure a supply of milk, butter and flesh for human consumption that is in a pure and healthful condition.

The use of anaesthetics and antiseptics in modern surgery is a striking example of what science has done to alleviate human suffering, and it has also made it possible for the skilled surgeon to perform operations which were formerly extremely hazardous or impossible. In diagnosing cases the X-ray has proved to be of great value, and it and radium are being used in remedial ways that are full of promise. Men of science are gradually drawing us away from the fatalistic belief of our forefathers and making us realize that to a great extent we are our own as well as our brother's keeper, and that health and long life depend far more upon the individual that he had been taught to believe. Fifty years ago when a member of some civic society died, it was the custom to publish a set of resolutions in which the preamble ascribed their loss to the will of a Divine Providence, a phraseology rarely used nowadays, for experience teaches us that by strict attention to sanitation and the rules of hygiene, and using wisely the aids which science offers, most people, barring unavoidable accidents, should live out the natural span of life. That old Greek, one of their Seven Wise Men, wrote better than he realized when he left on record that brief saying, "Know Thyself," as his contribution to posterity.

The food question has been and always will be one of great

importance. In primitive times the products of the chase, and the simple fruits, vegetables, and grains of the country supplied the wants of the sparse population, but now, thanks to the botanists and zoologists who have searched the land and water of every clime we are able to have on our tables a variety of food which Solomon in all his glory could not obtain.

The development and improvement of animals and plants used for human consumption has received much attention, and since the geneticists, one of the most recent groups of scientists, have taken up the problem of plant and animal breeding, the work done by them on the chromosomes has given us a clearer conception of some of the life processes, and has enabled the intelligent breeder to carry on his work more successfully. A late writer says that the plant and animal breeder directs the spark of life itself, and that the possibilities of his art are infinite. We see this illustrated in the animal world in the development of the wild cattle of India into the milk and flesh producers of our dairies and stock-farms, and of the wild jungle cock into our extremely valuable domestic fowls. Perhaps even more wonderful has been their success in the multitude of plant creations which delight us with their flowers and foliage, and add so much to the charm of our homes and their surroundings, a source of perennial pleasure to all lovers of the beautiful. In this way, too, the breeder of vegetables, grains and fruits has made a contribution, the value of which can scarcely be overestimated, and has added greatly to the quality, as well as to the quantity produced, and the chemist and geologist by studying our soils and supplying the elements lacking therein, have been able to greatly increase the productiveness of our fields and gardens.

The plant pathologist has done much for the food problem in devising means to control or eradicate the numerous fungus diseases which at times are very destructive of our food and forage plants, and in the development of plants which are resistant to disease. The zoologist, too, has done very valuable work in aiding the agriculturist to keep in check the countless hosts of insect enemies, and agreeable to the old adage that an ounce of prevention is better than a pound of cure, both groups of scientists have been active in securing efficient quarantine regulations to keep out foreign pests which are likely to do great damage if they once get a foothold.

Perfecting the art of canning has made it possible for us to have on our table at all seasons, fruits, vegetables and flesh which retain

much of their original flavor and nutritive qualities, and contributes greatly to a well balanced food supply. The value of this to the health of our people when supplies in a fresh condition are not obtainable is certainly very great. In the beet sugar industry the chemists have done their work so well that we use this product and that of the cane without recognizing any difference, thus making available a domestic supply of this modern necessity which was practically unknown to the ancient world, and now corn sugar is offered us and is clamoring for a fair trial, which if the result is favorable will be a great boon to the state where the tall corn grows.

For thousands of years the human like the lower animals has been guided in his selection of food and the quantity to eat, almost solely by his taste and appetite, but we are being taught by the dieticians in these latter days that those are not always safe guides, and that most people usually eat more than is necessary, and often some things which are positively injurious to them. They have also been quite insistant in calling our attention to those rather mysterious nitrogenous substances, the vitamines, minute quantities of which man and the lower animals seem to require if they are to maintain perfect health and develop properly. Experiments prove that both animal and vegetable foods are much richer in these elements when produced in direct sunlight where they come under the influence of the ultra-violet rays. One facetious writer has even gone so far as to advise us that 'in order to prevent our children from having rickets, we should furnish them with vitamine D by feeding them eggs laid by sun-kist hens!

Much has been said of late regarding the synthetic manufacture of foods, but Dame Nature has little to fear from competition in this direction at present when quality is taken into consideration. However, it is not safe to prophesy just what our chemists may or may not yet be able to accomplish along this line.

The ever present question of material for clothing has not received the amount of attention from scientists that has been given to supplying some of our other wants, largely because the world's supply of wool, cotton, linen and silk meets our demands so well. There is, however, a notable exception in the manufacture of synthetic silk, commercially known as rayon, of which the world's output for this year is estimated at 75,000,000 pounds. It is surely a triumph of the chemist's art that those factories can take in spruce logs at one end and at the other turn out shimmering skeins of rayon, which manufactured alone or in connection with wool,

cotton or natural silk into hosiery and other wearing apparel minister somewhat to our needs and probably much more to our vanity.

The synthetic manufacture of indigo long ago cheapened that necessity, and at the same time ruined a profitable industry in India, and the German product menathol now threatens the wood alcohol industry in this country. It is very probable that in the future we will have to adjust ourselves to a good many changes which will be forced upon us by discoveries in science.

No doubt every one realizes how great a debt the civilized world owes to science for unlocking the door to the great stores of energy hidden unused in the fields of coal and oil, and in every stream hurrying on its way to the sea. Hydro-electric power is yet in its infancy and no one can predict with certainty how universal its use in the future may be. By making available these stores of energy, science has enabled America to lead the nations of the world in material wealth and the general prosperity of her citizens. While there is no immediate danger of exhausting our natural resources, yet wisdom would counsel us not to waste our inheritance, but to conserve it so far as possible that future generations may not have just reasons to censure us for our prodigality. Agreeable to this thought is the attention that has been given to utilizing the many by-products obtained in different lines of industry. Perhaps nothing more remarkable has been done along this line with anything once considered practically useless than has been accomplished in the distillation of coal tar. Who but a chemist would ever have thought of searching in such a black, uninviting compound for the many brilliant aniline dyes which have revolutionized the dyeing industry, and for the astonishing number of other products obtained from it? In the early days of the petroleum industry, the by-products obtained in its distillation for kerosene were for years almost valueless. Now we know how with the development of the internal combustion engine, gasoline has become the main product and of great commercial value, and the many other by-products obtained from the crude oil by scientific research have made this business one of the most profitable as well as a model in the industrial world. Likewise the proprietors of the great packing houses by utilizing all the waste products have added greatly to their profits, so much so that the country slaughter-houses with their wasteful methods have been unable to compete, and have practically disappeared, and the changes wrought in these two industries are duplicated in many others.

Besides providing for our physical and economic wants, science

has not even neglected our entertainment, and the phonograph, radio and movies are modern marvels whose value no one would care to question. Science has made a great deal more leisure possible for every one, and if some devote an undue proportion of it to the lighter class of entertainment, that fact can not or should not militate against the great value of these discoveries if wisely used.

Electric power, heat and lighting have added greatly to the pleasure and conveniences of modern life. Could our forefathers see the lighting effects now used in our best theaters and amusement parks or in the business sections of our larger cities, and see the people transported through their streets by some invisible force they might well think themselves in fairyland. Modern photography and the lanterns now used in our lecture rooms and elsewhere, have made possible the visual instruction that is now so popular, and is by all acknowledged to be of the greatest educational value. In no other way can more lasting impressions on the mind be made. Color photography and the photogravure process have added greatly to the value of our newspapers, magazines and books. The features of noted people, the scenes and happenings near home and in distant lands are now pictured to us in a most realistic manner.

The mental hunger of civilized man requires to be taken into consideration, and the different sciences have contributed to supplying this want in a most efficient manner. The botanist and zoologist have revealed to us the mighty maze of Being at present living on this planet, and the infinite forms of life presented to our view have greatly augmented our conception of the organic world. The geologist has opened the pages in the rocks and helped us to read their story, and from their fossils learn something of the flora and fauna in the dim ages of the past, freeing us from the incubus imposed upon the Christian world for centuries by the early theologians, and giving us a clearer conception of the vast period of time that has elapsed since our earth took her place among the sister planets. Besides contributing greatly to our physical and economic welfare, food for our mental enjoyment is being furnished by the chemists and physicists to a degree that excites our wonder and admiration, and gives us a wider knowledge of the material universe, and of the different forces of nature. The chemistry of sixty years ago with its theory of the indivisible atom, and the modern view that that same atom is a little universe

of rapidly revolving electrons is surely sufficiently revolutionary to challenge our attention.

Dare we prophesy that science will make as many great contributions in the next half-century as it has in the one just passed? Fifty years ago when the speaker attended the Centennial Exposition at Philadelphia, the City of Brotherly Love was lighted by gas, the street cars were all drawn by horses or mules, and the Bell telephone there exhibited was the only one in existence. Wireless communication on land and sea; air mail across the continent in less than thirty-six hours; transmitting pictures thousands of miles by wire or wireless; the radio enabling the millions of the citizens of our country to sit quietly in their homes, and by "tuning in," to hear every word of their president's inaugural address delivered on the steps of the capitol at Washington, and now wireless telephony across the Atlantic, then mostly undreamed of, are now realities. That other equally great surprises may yet be given us by our scientists is very probable, for as a recent writer has said, it is those who know little and not those who know much who so positively assert that this or that problem will never be solved by science.

To those who love to wander in intellectual fields Psychology and Mathematics make a strong appeal. For many centuries the human mind and its various attributes has been a subject of study by some of the world's most profound thinkers, but it is only in recent years that the great value of Psychology has come to be generally recognized, and has received anything like the attention that it deserves. A knowledge of the science is now considered practically indispensable for the teacher, the minister, the physician, the lawyer and for every one who has any dealing with the human element.

Mathematics, the exact science, besides its great value to us in the simple affairs of our every day life and in the industrial world, is also intimately associated with many of the other sciences, especially Physics and Astronomy. The late Professor Keyser says that while Mathematics is the oldest science in the world, it is unsurpassed in modernity, and is flourishing today as never before and at a rate unsurpassed by any rival, and he refers to Analytical Geometry and Calculus as the two most powerful instruments of human thought. Physics, Mathematics and Astronomy working hand in hand as they do have furnished and solved some of the most profound problems that have ever engaged the human intellect. Aside from the great value of Astronomy in sur-

veying and navigation, the good it has done in giving us an intelligent conception of our universe, and of the law and order everywhere displayed is of very great worth. Sir Richard Gregory says that in spite of all man has learned about the heavens, infinite space remains to humble his pride. Sixty years ago, less one, a boy of fourteen who had been reading several popular works on Astronomy while herding sheep on an Illinois prairie, and while lying on the ground and gazing up into the blue vault of the summer sky, used to wonder were it possible to fly off into space in a straight line, would he ever come to the end, and now that time has whitened his hair, he finds no one to give a positive answer. Possibly after all the angel was right in that wild dream of the German poet, when in reply to the despairing cry of his human companion he answered, "End is there none to the Universe of God, lo, also, is there no beginning!"

If approached in the right spirit there is no science that calls up more serious thoughts or suggests questions of deeper significance. Pope was probably right when he said, "The undevout astronomer is mad." Standing on a clear night under the star-lit canopy, and realizing the vastness of the scene before him, one may well ask himself the question, "What is the meaning of all this?" Recently Sir Oliver Lodge wrote, "Depend upon it, nothing is haphazard, things are not left to chance. Everything is amenable to law and order. Everything points to a rational Plan, of which we know neither the beginning nor the end, but toward which we can help."

When our young scientist reads of all that has been accomplished in the various fields of research, and sees the flood of literature coming from the press, he may at first think that the field is exhausted, but instead of this he will find that the solving of any one problem only brings in view others awaiting solution; so, let him not think for a moment that there are no new discoveries to make, no more problems awaiting solution, or no more opportunities to contribute to the welfare of humanity, for as Herbert Hoover says, "There are continents of science in which we have penetrated but the coastal plain."

In conclusion when we think of all that has been done in recent years to minister to our physical and material wants, and to our moral, intellectual, and spiritual uplift, we must realize in some measure the debt we owe to scientists, "those patient searchers after knowledge."