The First A.C. NEISH MEMORIAL LECTURE

by
R.H.F. Manske

The first A.C. Neish Memorial Lecture was held at Dalhousie University on October 21, 1975 under the joint sponsorship of the A.C. Neish Memorial Trust and the Nova Scotian Institute of Science. The lecturer was Dr. R.H. Manske, Adjunct Professor, University of Waterloo. Honored guests included Mrs. A.C. Neish, Mr. and Mrs. Iain Neish, Mr. Douglas Neish, and other members and friends of the Neish family. Dr. W.D.Jamieson, President of the Institute, was Chairman. Dr. C.R. Masson, Chairman of the Board of Trustees, gave a short appreciation of the life and work of Dr. Neish and a brief account of the purposes of the Trust. On behalf of the Trustees, he presented Mrs. Neish with a bound montage, prepared by Mrs. I.M. Hilchie, with excerpts from unsolicited letters of tribute to Dr. Neish. The speaker was introduced by Dr. A.G. McInnes and thanked by Dr. Ronald Hayes. The meeting was followed by a reception in the Faculty Club, Dalhousie Univeristy. The Lecture was given also in Ottawa on October 24 and in Saskatoon on November 13, 1975.

Introductory Remarks

C. R. Masson

Our purpose here this evening is to honor the memory of Arthur C. Neish, formerly Director of the Atlantic Regional Laboratory and Distinguished Research Scientist of the National Research Council of Canada. The death of Dr. Neish, just over two years ago, deprived us of a great scientist and a distinguished son of Nova Scotia.

Art Neish, as most of us knew him, was born in Granville Ferry in 1916. He received his early education at various schools in Nova Scotia, and attended the Nova Scotia Agricultural College in Truro. There he won the Governor General's Medal and was awarded a scholarship for Macdonald College in Quebec. He took his bachelor's training there and was awarded the B.Sc. degree in Agriculture by McGill University in 1938.

As a youth, Art wanted to be a lobster fisherman or a farmer and went to university largely to please his parents. His interest in research was first aroused when he saw freshwater algae through a microscope for the first time; it's fitting that later he should become an international authority on the subject of marine algae.

Art took his master's degree at Macdonald College in 1939 under W.D. MacFarlane and his Ph.D. in 1942 at McGill, under Harold Hibbert. He subsequently joined the staff of the N.R.C., in the Division of Applied Biology, where he worked with Adams and Ledingham on a project associated with the war effort - the production of butanediol by the fermentation of natural products. This was a subject which continued to interest him for many years and to which he made many contributions. It is possible that this work may have economic significance for the future, as a route to the synthesis of fuels.

He moved to Saskatoon in 1948 as Head of the Fermentation Section and later Head of the Plant Biochemistry Section of the Prairie Regional Laboratory of the N.R.C. His work there on fermentation processes, and later on the carbohydrate metabolism of bacteria and on the biosynthesis of cellulose, lignin and related compounds, using

radioactive tracers, is noted for its originality and ingenuity, and has won him international distinction. It is beyond our purpose and scope at this meeting to consider his many contributions to plant biology and biochemistry generally, and I would merely refer to the excellent review of his life and work published last year by J.K.N. Jones in *Biographical Memoirs of Fellows of the Royal Society.*

Art returned to Nova Scotia in 1961 and the following year he was appointed Director of the Atlantic Regional Laboratory, on the retirement of Dr. E. Gordon Young. Under his direction, the laboratories in Halifax were considerably expanded and arrangements were made for some of the staff at ARL to hold honorary positions on the staff of Dalhousie University. It was during this time that he became keenly interested in the possibility of growing seaweeds on a commercial scale (particularly Irish moss) and a seaweed culture station was set up on the Atlantic coast, near Sambro. During the last few years of his life he devoted almost his full time to this work and lived to see its success. He demonstrated for the first time that seaweeds could be grown, without their holdfasts, in an artificial environment and paved the way for commercial developments in this branch of the science of mariculture. This work is being continued at ARL and also has been taken up by his oldest son, Iain, who has established a commercial venture in New Brunswick for the growing of dulse under controlled conditions. We are particularly pleased that Iain and his wife, Michelle, are able to be with us tonight.

Art Neish received many honors during his lifetime. He was a Fellow of the Chemical Institute of Canada and was selected to give the Merck Lecture of the C.I.C. in 1957. He was a Fellow of the Royal Society of Canada. He was President of the Canadian Society of Plant Physiologists in 1968-69 and was the first person to receive the Society's Gold Medal in 1970. He received honorary degrees from Mount Allison University in Sackville and from McGill University. He was elected a Fellow of the Royal Society in 1971. In 1972 he was appointed "Distinguished Research Scientist" of the National Research Council and is only the second person to receive this honor. He became an Officer of the Order of Canada in 1973.

Although first and foremost a scientist, Art Neish had many other interests. He was direct and forthright in his views and always believed that the best way to get things done was to set the example himself. He was always an active person and took a keen interest in a variety of sports. I have heard many accounts of his curling exploits on the rinks in Saskatoon. Bowling and golf were also among his activities. As a student he played rugby and soccer and received the "most valuable athlete" award from the N.S. Agricultural College. Those of us who knew him well will remember his keen interest in sailing and the two boats which he and his sons built at their home in Halifax. It's been placed on record (with what authority I have been unable to verify) that his attempts to play the bagpipes were not crowned with the same success as his other activities. Perhaps this was merely a lack of appreciation on the part of his audience!

After his death in September 1973, many of his friends in the scientific community and elsewhere expressed a desire to contribute to a memorial in his name. A Trust Fund was set up for this purpose with the intention that the income from the Fund would be used in some way in keeping with his ideals and aspirations. The way in which this can be done is flexible and many possibilities are open to us. The Trustees decided that, initially, the purposes of the Trust would be well served by instituting a series of lectures, to be known as the *A.C. Neish Memorial Lectures*, which would be given from time to time in Canada by distinguished scientists. The first Lecture is being given this evening under the auspices of the Nova Scotian Institute of Science. As you know, Art served on the Council of the Institute for many years and was its President during 1969-70. It is particularly appropriate that the first Memorial Lecture should be sponsored by the In-

stitute and I wish to thank the Institute for its co-operation with us in this venture.

One of the more pleasant aspects of the activities of the Board of Trustees has been the correspondence we have had with former friends and colleagues of Dr. Neish throughout the world. Letters of tribute concerning Dr. Neish as a person and a scientist have been received from all corners of the globe. The Trustees have prepared a montage with excerpts from these letters and, on their behalf, I would like to ask Mrs. Neish to accept this as a memento of this occasion. It is entitled "Letters of Tribute. Arthur Charles Neish, 1916-1973" and the inscription reads: "Presented to Mrs. A.C. Neish on the occasion of the first A.C. Neish Memorial Lecture, Halifax, N.S., October 21, 1975. These unsolicited letters of tribute were received by the Board of Trustees during establishment of the A.C. Neish Memorial Fund".

And now, Ladies and Gentlemen, I hand the meeting over to Dr. Gavin McInnes, who will introduce the speaker of the evening.

Introduction to Dr. R.H.F. Manske

A.G. McInnes

Before introducing tonight's speaker, I would like to take a few moments to mention what I believe are the underlying reasons why the Board of Trustees decided that the initial tributes to Arthur Neish should be in the form of public lectures on the broader aspects of science.

In spite of the material well-being and leisure which science (and compound interest) have won for mankind, there still exists a deep-rooted and widespread irrational fear and distrust of science. Why should this be? I believe there are two basic causes. Firstly, the ever increasing body of scientific knowledge seems incompatible with the unique, central and noble role which Man has assigned to himself in the Universe, and secondly, there are misuses of knowledge for which science is held to be ultimately responsible. In recent times these issues have caused scientists to acknowledge that they may have special responsibilities to society in as far as their specialized knowledge is concerned, and to realize that if the climate for science is to be improved, and the dangers from its misuse reduced, they must place their work in the public domain so that it can be understood and its implications examined by non-scientists and scientists alike. The function of the A.C. Neish Memorial Lectures is therefore to foster understanding of science by providing the opportunity for members of the public to hear the views of distinguished scientists on the broader aspects of science and by giving them a chance to express their opinions during a question period. I am sure that this format would have pleased Arthur Neish as he was always deeply concerned about the future devolopment of science and its impact on society.

Tonight's speaker, Dr. Richard Helmuth Fred Manske, has not only attained pre-eminence in the scientific world but has made significant contributions to the business and academic life of Canada.

Born in Germany, Dr. Manske came to Canada in 1906, at the age of five. Later, he obtained his B.Sc. and M.Sc. degrees from Queen's University, and then went to England as an 1851 Exhibition Scholar to work for his Ph.D. degree at Manchester under Sir Robert Robertson. His interest in alkaloids, a branch of organic chemistry on which he is an international authority, undoubtedly dates from the work he did for his Ph.D. degree. However, in the introduction to a lecture he delivered to the Chemical Institute of Canada some years ago, Dr. Manske indicated that his interest in alkaloids occurred at a much earlier age. I quote "My first acquaintance with alkaloids was at the age of 16 months. I was victim of a disturbing kind of infant insomnia and instead of sucking my thumb or my bottle I became excessively vociferous. My mother was a peace-

loving woman and discovered that tincture of laudanum relieved my insomnia and relaxed my tension. I slept long and peacefully and became a model child".

After leaving Manchester, Dr. Manske spent a year as a Research Chemist with General Motors Corporation, and then did post-doctoral research at Yale for three years prior to becoming the first chemist employed by the National Research Council (1931) to do laboratory work. Over the next 12 years he not only did brilliant research, which was recognized in the form of a D.Sc. degree from Manchester University in 1937, but also helped develop the National Research Council's Chemistry Division which became one of the worlds great centers of fundamental research.

In 1943 Dr. Manske joined the Dominion Rubber Company (now Uniroyal Ltd.) and established that company's research laboratories at Guelph. Under his direction the Uniroyal laboratories developed many marketable products including fungicides and bacteriocides. He remained at Uniroyal until his retirement in 1966, after which he became adjunct professor at the University of Waterloo. For a brief period also, Dr. Manske served as a professor at Carleton University, and helped organize that University's Department of Chemistry. Although ostensibly in retirement he still remains active in research both on campus and also at Guelph. Over the past fifty years he has written more than 150 research papers plus many reviews, and is founder, contributor and editor of "The Alkaloids", a publication regarded as a definitive survey of research in this field - the fifteenth volume of which was published this year.

Dr. Manske has been the recipient of many honors in recognition of his pioneering achievements, but I will mention only a few highlights. He was medallist of the Chemical Institute of Canada in 1959, the highest honor that the chemical community of Canada can confer on one of its members, and he was President of the Chemical Institute from 1963-64. The Cleveland Section of the American Chemical Society awarded him the 1973 Morley Medal — a signal honor. Dr. Manske's distinguished career also includes honorary degrees from McMaster and Queen's Universities, and he is a Fellow of the Royal Society of Canada.

Dr. Manske became a Canadian citizen in 1924, the same year that he married. They have two married daughters and five grandchildren. We are delighted that Mrs. Manske also was able to come to Halifax and to be with us tonight.

Soon after settling in Guelph, the Manske's purchased a house located on about five acres of land. The property also had an old greenhouse on it, and Dr. Manske became interested in growing orchids, a subject on which he has become something of an authority. This early interest gradually developed to the commercial scale. His large greenhouses supplied Cattleya and Cymbidium orchids to florists in southern Ontario and as far east as Montreal. The techniques he uses are particularly interesting, and can only be compared to those used in bacteriology. From the time seeds are sown on a sterile, nutrient medium until plants come into bloom takes about six or seven years. Although he has given up the business aspect Dr. Manske still grows high quality orchids as a hobby and displays them at orchid shows. His attempts to produce a successful hybrid have at last been successful, and it is really in this area that his interests lie. The Manske's were charter members of the Orchid Society of Southern Ontario.

Dr. Manske's concerns have always extended far beyond the problems of research, and he is well-known in scientific circles for his breadth of knowledge and interests, and for his discourses on the general theme "science and philosophy" during which he exhorts scientists to have concern for the social implications of their work, and urges philosophers and humanists to increase their knowledge of science. Though well past retirement age, and though a gentle person by nature, Dr. Manske's eyes sparkle at the thought of controversy or a heated debate. His achievements and personal qualities

make him an outstanding choice for the first A.C. Neish Memorial Lecture, and we are honored by his acceptance of our invitation.

Ladies and Gentlemen, it is with great pleasure that I introduce Dr. Manske who will give his views about "Science, Society and Survival".

Science, Society, and Survival

R.H.F. Manske

Fates do not always deal kindly with human souls, a redundant observation put into dramatic form by Sophocles. Consider a situation in which the roles of Neish and Manske are reversed. Imagine, if you can, that it is the Manske Memorial Lecture and that A.C. Neish is giving it. I assume that everybody would be happier, everybody, that is, except R.H. Manske. Under the circumstances I take full advantage of the fate that has been my lot and I give this address with great pleasure, humbly and fully aware of the honor occasioned by doing so.

The many scientific contributions of merit and the administrative duties of import that A.C. Neish fathered are in the records and I do not propose to deal extensively with them. They have been acknowledged by learned societies in the form of memberships and medals, by universities in the form of honorary degrees, and by scientists in the respect he has earned. His thorough training in organic and biochemistry was put to practical and theoretical use in the study of plant tumors, in bacterial and mycological fermentation, in the biosyntheses of many plant products, in the culture of marine algae, and in other relevant disciplines. There was always the well planned experiment, the careful observation, the critical assessment, the reasoned conclusion, and finally the precise publication. These are the marks of a scientist worthy of the name and A.C. Neish bore it confidently but modestly. The world is a better one for him having lived in it.

The life sciences, biology and biochemistry, loom ever larger in these decades of the 20th century. Less spectacular than nuclear physics, with its mushroom cloud, the life sciences are the very stuff of our living and an understanding of what takes place in the living cell is germane to our survival, so much so that not only scientists are involved, but politicians and theologians are getting into the act. I deem it right therefore that we should attempt some kind of assessment of the status of our civilization with respect to its involvement in science and the impact that science has had and is likely to have. The term science has been often defined, sometimes cryptically and at other times in a whole volume. For the present purpose it suffices to define science as the objective study of our enviornment. Newton, without necessarily defining science, possessed a compelling drive to find order in what appeared to be chaos, to distil from a vast inchoate mass of materials a few basic principles that would embrace the whole and define the relationships of its component parts. Thomas Aquinus has written, "There can be no place for contradiction in a quest for truth! To tolerate contradiction instead of avoiding it is to be indifferent to truth". This, by its very nature, implies that we will never know the whole truth but that we will approach complete knowledge only asymptotically. I recall the early attempts to formulate a cosmogony founded largely on pseudotheological preconceptions.

You are familiar with the Platonic and Aristotelian views of the cosmos and how Copernicus revived the helio-centric theory of Aristarchus of Samos; how Galileo and Kepler laid the foundation for Newton's synthesis; and how Einstein modified it without destroying Newtonian gravitation. Parallel progress in geology and biology led to Darwin's great achievement, and in the realm of chemistry we progressed from the Arabic Alchemists to the discovery of 92 elements. The discovery of oxygen and the interaction

of elements to form compounds was a truly great achievement. It is this particualr aspect of science and of chemistry that I wish to dwell upon. Chemistry now plays an important role in every conceivable occurrrence in life processes. Viruses are crystallizable organic compounds; genes are helices of chains of amino acids with sugars, phosphates, and other nitrogen-carbon compounds; those messengers that come from the endocrine glands are derivatives of isoprene as is rubber; those accessory food factors that we call vitamins are simple or very complex organic compounds which sometimes need another element to be formed (cobalt); the colors of flowers, the flavors of drinks, the foods that sustain us, the drugs that cure us, the drugs that harm us, these are but a few of the compounds, largely organic, that are the stuff of life. It is the organic chemist who learns about these compounds and it is the biochemist who learns how they react with each other and how they function in the cell; how their transformations give rise to energy; how their presence stimulates or retards an action; how they transmit characters from one generation to another; how they provide nerve stimuli so that we can see even in color; how they aid in the union of sperm and ovum; and in fact how virtually every life process is mediated by some specific chemical compound or compounds.

Even so, it is not my aim nor my privilege to sing the praises of chemistry or more specifically of organic chemistry. Parenthetically though I remind you of the birth of anesthetics. Originally alcohol was about the only such pain alleviator. It was followed by one of the oxides of nitrogen, by chloroform, by ether, and more recently by the local acting cocaine. It was the last named, which by a series of brilliant researchers, gave us our modern anesthetics, both general and local. Even a major surgical operation is no longer a painful one. I wonder how many of my audience are old enough to have experienced a tooth extraction without the benefit of an anesthetic!

But there are unforseen and probably unforseeable consequences of the advance of science even though we live less painfully and longer. The prolongation of the life of the possessors of genetic and heritable defects defeats the natural process by which many of these carriers of defects are eliminated before they can transmit their defects to following generations. We have the knowledge and the tools to prevent such transmissions but politicians are too timid to apply them and scientists are too voiceless to arouse political action.

It is rare that scientists made themselves heard on matters of human concern, and when they do they are often pilloried by the churches and by priviledged groups. The world population problem is possibly the greatest unsolved one in the long history of humanity. It is, of course, associated closely with the world food supply. In every minute of every day of every year, *etc.*, seven people die of starvation. Since I began this address 105 people have died that way. But let us note that even if there were sufficient food to feed everyone adequately, problems associated with increased population would still be with us. It would be only a matter of a few centuries before every square meter of the earth's surface would be occupied by one human being. And note that these statements are not those of the doomsters but are mathematically certain. These are profound facts and if we do not heed them soon our so-called energy crisis will pale into insignificance. It has been estimated that many more species have become extinct in the last 200 million years than are in existence today. In virtually all of the examples, which have been studied in detail, the end of a species has been the result of overspecialization and the inability to adapt to a changing environment. Does man too face the same fate? Even those species that have disappeared because of man's action failed because they could not adapt to a new environment.

We live in an era in which practically all human activity is dependent upon some aspect of science or its daughter, technology. Our eating habits are conditioned by

synthetic additives and much of our food comes out of a can; our homes are heated and cooled by gadgets that are activated by electronics; our travel is controlled by gadgets dependent upon the second law of thermodynamics and more electronic gadgets; our news comes to us via electromagnetic waves mediated by still more electronic gadgets; we are amused, entertained, disgusted, or left indifferent by the play of light on and in a vacuum tube; we hear music, good, bad, or just noise, from a vibrating diaphram again mediated by electronic gadgetry; much of our sexual activity is or should be mediated by organic chemicals; our ills, real or imaginary, are tempered by still more organic compounds; we go to sleep on sedatives and awake on stimulants. I do not praise this dependence on science nor do I condemn it. But I, for one, would not like to revert to an existence without the amenities wrought by science. Strangely enough there are two important forms of human activity in which science has had no recognizable impact; I have in mind, of course, religion and politics, both activites making full use of the gadgets without absorbing any of the philosophy of science.

This then calls for some comments upon the nature of science. At the risk of being repetitive I emphasize that the function of science is not one to generate amenities even though the by-products are amenities in abundance. Science is an intellectual exercise directed to understanding the universe around us. It is not concerned with values, esthetics, ethics, purpose, or morals. These are human inventions and are possessed in abundance by scientists, many of whom justly concern themselves with ethical issues not only because these men are intuitively ethical, but because they have information that has relevance to controversial issues. But science, *per se*, is a creative effort in the same way that writing a poem or composing a symphony are creative efforts. The building materials of science are of only one kind, facts - facts that incidentially never are absolute but are accessible to anyone skilled in the art of observation. As science progresses and as our measurements improve, so we approach ever closer to the asymptotic absolute. Having garnered facts, pointer readings as Eddington called them, we attempt to correlate two or more of them and having done so we call it a theory and write an equation. This *modus operandi* is that of Pythagoras and we have yet to find anything better. Hopefully the equation will reveal ideas or further truths not readily apparent without it and then we put the theory under stress. A scientific theory rapidly ceases to be science unless it lives dangerously, open always to rebuttal and to revision. Unless there is in the theory a hint at experiments which may disprove it, it is useless as a tool of science.

For some years now there has been a hint from many quarters that scientists have discovered and are discovering too much. The nuclear bomb was instrumental in bringing about this attitude and indeed the exponential proliferation of nuclear capabilities is cause for worldwide concern. But that famous Einstein equation was not conceived with a view to anihilate Hiroshima. Rather it was an intellectual exercise of superhuman brilliance, and if such intellectual exercise is discouraged or halted we are in the intellectual doldrums. The Lysenko case in the U.S.S.R. is a good example. You will recall that Lysenko attempted to put the study of biology on a Marxist — Leninist basis. I repeat that science, *per se*, is not concerned with ends but scientists, members as they are of all humanity, are and should be so concerned. The list of those who have done so is a long and an honorable one. But in spite of their logic and their obvious dedication they have had only minimal influence. There are evident reasons for their lack of impact. Not only are powerful lobbies interested in the proliferation and sale of military hardware, but society has evolved no political mechanism for shunting armament expenditures to human and humane projects. While the journeys to the moon are technological achievements of spectacular moment, they have added little to scientific knowledge and

the promised fall-out has not given rise to noticeable amenities. "In short man is not grown up enough to be trusted with nuclear reactors", a quotation from Sir George Porter who continued "Twenty years also I felt that the world was getting better socially. But the world is now nearer to anarchy than it has been for a century. What chance is there that man will survive even one half-life of plutonium".

It is now more than 10 years ago that I attempted, feebly it transpired, to have a scientific society expend some of its expertise on the sociopolitical issues of our times. As chemists we have expert knowledge on a host of disciplines and by combining our labors with biologists, physicists, ecologists, climatologists, and statisticians we could provide possible means of dealing with current and foreseeable problems of society. It is unlikely that problems associated with population increase will find political or theological solutions. (210 people have died of starvation since I began my talk!)

Nor will the destruction of our environment be halted by methods currently in vogue. Were each of our great problems separate ones not related to each other the solutions of at least some might be achieved by political methods now available. But pollution is intimately related to population, to energy, to nuclear technology, to food supply, to virtually all of our activities and these are each related to the others. From here it appears as though our civilization, in the Toynbee sense, is in a curve typical of biological growth. It is S-shaped and is well illustrated by the growth of yeast cells in a medium suitable for their growth. They increase at an exponential rate polluting their environment with alcohol until it kills them (around 12%) or they use their food (sugar) until there is none left. In either case growth ceases abruptly and only a few cells survive and those in the form of spores. We are doing precisely to our environment what yeast cells do to theirs, but we have nothing equivalent to the spores of yeast to provide future generations in a changed and habitable environment.

Historically peoples have devastated an area and then moved to another, frequently by conquest, but conquest is of no survival value if there are no virgin lands to conquer. In passing, I recall that someone in the United States of America did not rule out the possibility of taking the Arab oil by force should industry in America be in jeopardy because of another oil embargo in the Near East. Except for this oil rich area there are few lands that are worth conquering. It would seem therefore that, if we wish to survive, we will have to husband our resources and cease polluting our environment. These are hard facts and the remedy requires strong medicine. Are we willing to face a zero growth rate? It means that the so-called underdeveloped countries have little prospect of raising their standard of living while we retain our affluence. I have no answers, except some generalities; but as a scientist committed to the objective method, I am confident that there are solutions, not spectacular ones but realistic ones that may gestate slowly. It is, I urge, the duty of scientific societies to formulate plans and to compel their adoption. And be it understood that the arrival at a concensus is not a prerequisite for action. Historically it has been the minority that foresaw problems and offered solutions. The majority often see no need for change, almost by definition. Change would be inevitable if the majority favored it.

Let me change the subject a bit and consider the present state of science and hazard a look into the near future. In organic chemistry we are approaching the point where structural problems find easy, almost routine, solutions. Even the proteins have largely revealed their secrets and it is almost possible to write the structural formula for a gene. While it is still science fiction there is talk of genetic engineering. Should we succeed in solving problems of population, energy, and nuclear annihilation we will inevitably face new problems and among these I can envisage genetic control.

It has been possible and feasible to cleave DNA and splice it into a carrier molecule thus making it possible to transfer genetic information from one organism to an unrelated one. There the DNA replicates and expresses itself. Genes from a toad were incorporated into *E. coli* (Scientific American, July 1975, p. 25)

But let me go on record as one who welcomes the continuous presence of important problems. A society in which all possible problems have been solved and which puts a premium on conformity would be one without change and therefore without progress. It would be as exciting as an anthill. My plea is therefore, not necessarily the solution of all problems, but rather an attack on them by objective assessment of facts and procedures. This was the *modus vivendi* of A.C. Neish, who happily integrated scientific research and discovery with technological disciplines. Were it not for their practical application his scientific contributions could stand alone. Were it not for his scientific contributions, his practical applications could stand alone on their merit. Scientists have much to learn from him, and many are of course advocates, but that portion of society which is not aware of the scientific method is woefully apathetic.

I take the liberty, and pleasure, of quoting from *Chance and Necessity* a volume from the pen of Jacques Monod. "In the course of three centuries, science, founded upon the postulate of objectivity, has won its place in society — in men's practice but not in their hearts. Modern societies are built upon science. To it they owe their wealth, their power, and the certitude that tomorrow even greater wealth and power will be ours if we so wish. But there is this too: just as an initial 'choice' in the biological evolution of a species can be binding upon its entire future, so the choice of scientific practice (an unconscious choice in the beginning) has launched the evolution of culture on a one-way path; on to a track which nineteenth-century scientism saw leading infallibly on to a vast blossoming for mankind whereas what we see before us today is an abyss of darkness.

Modern societies accepted the treasures and the power offered them by science. But they have not accepted, they have scarcely even heard, its profounder message: the defining of a new and unique source of truth and the demand for a thorough revision of ethical premises, for a complete break with the animist tradition, the definitive abandonment of the 'old covenant', the neccessity of forging a new one. Armed with all the powers, enjoying all the riches they owe to science, our societies are still trying to live by and to teach systems of values already blasted at the root by science itself. No society before ours was ever torn apart by such conflicts. In both primitive and classical cultures the animist tradition saw knowledge and values stemming from the same source. For the first time in history a civilization is trying to shape itself while clinging desperately to the animist tradition in an effort to justify its values, and at the same time abandoning it as the source of knowledge, of truth. The 'liberal' societies of the West still pay lip-service to, and present as a basis for morality, a disgusting farrago of Judeo-Christian religiosity, scientistic progressism, belief in the 'natural' rights of man, and utilitarian pragmatism. The Marxist societies still profess the materialist and dialectical religion of history; on the face of it a more solid moral framework than that of the liberal societies but perhaps more vulnerable by virture of the very rigidity which up to now has been its strength. However this may be, all these systems rooted in animism exist outside objective knowledge, outside truth, and are strangers and fundamentally hostile to science, which they are willing to use but do not respect or cherish. The divorce is so great, the lie so flagrant, that it can only obsess and lacerate anyone who has some culture or intelligence or is moved by that moral questioning which is the source of all creativity. It is an affliction, that is to say, for all those who bear or will bear the responsibility for the way in which society and culture will evolve.

The sickness of the modern spirit is this lie at the root of man's moral and social nature. It is this ailment, more or less confusedly diagnosed, that provokes the fear if not the hatred — in any case the estrangement — felt toward scientific culture by so many people today. Their aversion, when openly expressed, is usually directed at the technological by-products of science: the bomb, the destruction of nature, the soaring population. It is easy, of course, to answer that technology and science are not the same thing and moreover that the use of atomic energy will soon be vital to mankind's survival; that the destruction of nature denotes a faulty technology rather than too much of it; and that the population soars because millions of children are saved from death every year. Are we to go back to letting them die?" I have repeatedly inferred that many of our problems ultimately require political solutions and that politicians are either unaware of the implications or unwilling to take courageous actions. I do not retract this accusation but I do not at the same time condemn them entirely. Politics, as is well known, is the art of the practical and few politicians would survive a second election if they were to advocate some of the long range programs that objective assessment might recommend. We do not get a better government than we deserve, and until scientists and other men of goodwill prepare society for taking it 'on the chin' we will have band aid measures enacted by an expedient parliament. (315 people have died from starvation since I began this talk). May I, in closing, summarize my thesis by a quotation; "Eventually we will run out of food to feed ourselves, fuel to warm ourselves, and air to breath. This is something we must learn to live with".