SCIENCE

VOL. 86 FRIDAY, DECEMBER 31, 1937 NO. 2244

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

SCIENCE AND ETHICS[1]

By EDWIN GRANT CONKLIN

PRINCETON UNIVERSITY

THE American Association for the Advancement of Science met last in Indianapolis in 1890, and on that occasion the retiring president, Thomas Corwin Mendenhall, delivered the annual address on "The Relation of Men of Science to the General Public." Following forty-seven years later in his footsteps, I know of no matter of greater concern to men of science and the general public than science in its relation to ethics. I know full well that there are many scientific specialists who maintain that science has no concern with ethics, its sole function being to seek the truth concerning nature irrespective of how this truth may affect the weal or woe of mankind. They may recognize that the use of science for evil threatens peace and progress, but they feel no responsibility to help avert disaster. The world may be out of joint, but they were never born to set it right; let the shoemaker stick to his last and the scientist to his laboratory.

During the dark days of the world war I once spoke to a distinguished scientist of some major event in the course of the war and he looked up from his work and said sharply, "What war?" Concentration upon our various specialties is essential, but it should not cause us to lose our sense of orientation in the world. It is pleasant and at times necessary to avoid "the tumult and the shouting," but there is no excuse for the scientist who dwells permanently apart from the affairs of men. At the present time it is probable that nothing else so deeply concerns the welfare and progress of mankind as ethics.

In the early years of the association a favorite theme in the annual address of the retiring president was the

[1] Address of the retiring president of the American Association for the Advancement of Science, Indianapolis, on December 27, 1937.

relation between science and religion, and pious but more or less futile attempts were made to harmonize "Geology and Genesis" or "Evolution and Revelation." To the majority of modern scientists nothing is more dull and fruitless than such attempts to make science the handmaid of theology, nothing more futile than sectarian conflicts over theological dogmas and creeds and ceremonies. But there is an aspect of religion with which science is vitally concerned, namely ethics, and this has been well called "the religion of science."

Science, as we all know, is tested, verifiable organized knowledge; ethics is concerned with ideals, conduct and character. Any program looking to human welfare and betterment must include both science and ethics, and there would be great gain for the world if organized religion and organized science could cooperate more effectively in the promotion of practical ethics.

Among the generalizations of science which have been charged with the weakening of ethics, first place must be given to the theory of the natural evolution of man and of ethical systems. It is a fundamental postulate of modern science that man is a part of nature and that his body, mind and social relations have undergone evolution in the long history of the human species. This is not a mere hypothesis but an established fact, if anything is a fact. There is positive evidence that in long past times there were types of human and partly human beings that were much more brutish in body, mind and social relations than the general average of the present race. There is abundant evidence that ethics has undergone evolution no less than intelligence; it has developed from its beginnings in the primitive family group, to tribal, racial, national and international relations; from the ideals and practices of savagery to those of barbarism and civilization; from the iron rule of vengeance and retribution, "an eye for an eye, a tooth for a tooth," to the ideals of love and forgiveness and that highest conception of ethics embodied in the Golden Rule. But as in physical evolution there are retarded or retrogressive individuals and races, so also in the development of ethical ideals some people and periods are far behind others and all fall short of their highest ideals.

As is well known, the distinctive principle running through the whole of Darwin's philosophy of evolution is what he called natural selection. Having studied the notable effects of human selection in the production of new breeds of domestic animals and cultivated plants, he sought for some comparable process operating in nature without human guidance. This he found in the Malthusian principle of overproduction of populations, the elimination of the less fit and the preservation of favored races in the struggle for life. In general, he regarded the environment, whether organic or inorganic, as the principal eliminator of the unfit, although he assigned a certain rôle to the organism itself as selector and eliminator, especially in sexual selection, while in mental, moral and social evolution this auto-selection played even a larger part in his philosophy.

I shall not at this time discuss the present status of Darwinism further than to say that from practically every branch of modern biology it continues to receive confirmation and extension, so that in spite of severe attacks from many sources and assurances from some excited opponents that "Darwinism is dead," it is still very much alive.

It has been charged by many humanists that Darwinism is destructive of the highest ethical ideals. It is said to be the apotheosis of cruelty and selfishness, to recognize no values except survival, no ideals except success. In this struggle for existence the weak go under, the strong survive; and this is said to justify personal and class strife and wars of conquest. Militarists and dictators have seized upon this principle as justification of their philosophy that might makes right. Conflicts and wars are said to be both the means and measure of progress, and military training to be the highest type of discipline. By both militarists and humanists Darwinism has been considered as an eternal struggle, a vast battle of living things with one another and with their environment, a grim portrayal of

> Nature red in tooth and claw
> With ravine.

Bernard Shaw has said that if Darwinism were true only knaves and fools could bear to live.

This is, however, a fundamental misconception of natural selection. Darwin himself repudiated this extension of his principle to the struggle between races and nations of men. In a letter to Alfred Russell Wallace he wrote that "the struggle between races of men depends entirely on intellectual and moral qualities." Those who attempt to extend the principle of natural selection into the field of intellectual, social and moral qualities should remember that the standards of fitness are wholly different in these fields. Physically the fittest is the most viable and most capable of leaving offspring; intellectually the fittest is the most rational; socially the fittest is the most ethical. To attempt to measure intellectual or social fitness by standards of physical fitness is hopelessly to confuse the whole question, for human evolution has progressed in these three distinct paths. Man owes his unique position in nature to this three-fold evolution, and although the factors of physical, intellectual and social progress are always balanced one

against another, they are not mutually exclusive. All three may and do cooperate in such manner that each strengthens the other.

And this leads to the inquiry whether human or so-called artificial selection is not also natural. If we define "natural" as that which is regular and lawful, and not arbitrary and lawless, then human selection is also natural, and this must necessarily follow if man in his entirety is the product of natural evolution. Since Darwin's day the study of the behavior of lower organisms as well as that of human beings in all stages of development from the infant to the adult has shown that selective activity is everywhere present. One-celled plants and animals respond positively to some stimuli, negatively to others, and in general, though not invariably, this selectivity of response is beneficial. For example, they avoid extremes of heat or cold, they move or grow toward certain chemical substances and away from others, they take in as food certain substances and reject others. Even germ cells show some of these same properties, and in general it may be said that all living things manifest differential sensitivity and reactivity, and that by a process of trial and error and finally trial and success they generally manage to eliminate reactions that are not satisfactory and to persist in those that are. This is the Darwinian principle extended to the reactions of organisms in which the organism itself is eliminator and selector. Intelligence in animals and man is arrived at in this same way, by many trials and failures and finally trial and success, remembering of past failures and successes, elimination of the former and persistence in the latter. A cat that by trial and error has learned to open the door of a cage, as in Thorndike's experiments, or a horse that has learned in the same way to lift a latch and open a gate is intelligent with respect to that one situation; intelligence in human beings is acquired in the same way. Indeed, intelligence is the capacity of profiting by experience, while the ability to generalize experiences and to recognize fundamental resemblances in spite of superficial differences is what we call abstract thought or reasoning.

In his famous Romanes address at Oxford in 1892 on "Evolution and Ethics" Professor Huxley maintained that ethics consists in opposing the cosmic process of natural selection by intelligent human selection and in replacing the ruthless destruction of the weak and helpless with human sympathy and cooperation. He illustrated the superiority of human selection by pointing out the fact that a cultivated garden left to nature grows up to weeds and, therefore, that human intelligence can improve on the blind processes of nature in meeting human needs.

All this is undoubtedly true; we are continually improving on nature for our own purposes; all agriculture, industry, medicine, education are improvements on nature. The notion that nature is always perfect is certainly false, and the cry, "Back to nature," is more likely to be a call to regress than to progress. But it is a mistake to suppose that human intelligence and purpose, social sympathy, cooperation and ethics in general are not also parts of nature and the products of natural evolution. In Darwin's theory the environment eliminates the unfit organism, but in individual adaptations to new conditions the organism itself eliminates many useless or injurious responses. In such cases the organism rather than the environment is the eliminator or selector, either by the hit-or-miss process of "trial and error" or by the vastly more rapid and less wasteful method of remembered experience, that is, by intelligence. Thus intelligence can improve on the blind processes of nature, because it is not blind, although it also is natural. And thus intelligence has become a prime factor in evolution. Intelligence and social cooperation have become the most important means of further human progress.

Will and purpose are similarly natural phenomena growing out of the use of intelligence in finding satisfaction. Will is not an uncaused cause but rather the product of all those bodily and mental processes, such as appetites, emotions, memory and intelligence, which stimulate, regulate or inhibit behavior. Ability to thus control activity in response to remembered experience is what we call freedom from fixed, mechanistic action. Both intelligence and freedom vary greatly in different animals and in the same individual at different stages of development. They are relatively slight in human infants, but they rise to a maximum in normal adults. However, men are never perfectly intelligent nor absolutely free, but the more intelligent they are the freer they are.

All this is pertinent to a discussion of the natural history of ethics, for social ethics assumes the ability and the responsibility of individuals to regulate behavior in accordance with ideals and codes of conduct. It, therefore, demands freedom to choose between alternatives that are offered. Without such freedom there can be no responsibility, no duty, no ethics. It has long been the creed of certain rigidly mechanistic scientists that freedom, responsibility and duty are mere delusions and that human beings are automata, thinking, feeling and doing only those things which were predetermined by their heredity and environment over which they have no control. This fatalistic creed was in large part a deduction from the determinism of nature which was revealed in mathematics, astronomy, physics and chemistry and was then extended by certain physiologists to all vital phenomena, including human life and personality. Indeed some of these "hard determinists" went so far as to maintain that

the whole course of human history was predetermined in the original constitution of the universe, that nations had risen and fallen, cultures and civilizations had come and gone and that the present state of the world and its future destiny were all determined by inexorable laws. However, many biologists who investigated the behavior of animals refused to regard them as mere automata, and students of human behavior generally held that there must be some flaw or break in this logical chain that bound man helpless on the wheel of fate, some fallacy in the logic that denied all freedom and responsibility to man, some monstrous error in the conclusion that saints and sinners, philanthropists and fiends were mere pawns or puppets in a game in which they were moved by forces over which they had no control.

As a way of escape mathematicians and physicists, who were most impressed by the determinism of inanimate nature, were generally inclined to adopt some form of Cartesian dualism, which would endow living beings and especially man with an immaterial principle or soul which was not subject to this rigid determinism. But on the other hand, students of life phenomena in general could find no sufficient evidence for such dualism, and hence arose the strange anomaly of physiologists and psychologists being more rigid determinists, so far as life and man are concerned, than students of the physical sciences.

Several scientists recently have expressed the view that Heisenberg's principle of indeterminacy in the sub-atomic field can somehow be converted into the novelty, creativity and freedom manifested by living things. But, so far as I am aware, no one has shown how this can be done, since the principle of indeterminacy does not apply to molecules or masses of matter, and living things are always composed of complex aggregations of these. Furthermore, biologists generally do not admit any fundamental indeterminacy in the behavior of living beings. Novelty, creativity and freedom, wherever their origin has been traced, are found to be caused by new combinations of old factors or processes, whether these be atoms, molecules, genes, chromosomes, cells, organs, functions or even sensations, memories and ideas. By such new combinations of old elements there emerge all the new properties of chemical compounds, and by new combinations of genes and chromosomes and environmental stimuli all the novelties of heredity and development arise. There is good evidence that even psychical properties, such as intelligence, will and consciousness, emerge in the process of development because of specific combinations of physical and psychical factors. This is, indeed, the whole philosophy of evolution, namely, that the entire universe, including man and all his faculties and activities, are the results of transformation rather than of new-formation, of emergence rather than of creation *de novo*.

Freedom does not mean uncaused activity; "the will is not a little deity encapsuled in the brain," but instead it is the sum of all those physical and psychical processes, including especially reflexes, conditionings and remembered experiences, which act as stimuli in initiating or directing behavior. The will is not undetermined, uncaused, absolutely free, but is the result of the organization and experience of the organism, and in turn it is a factor in determining behavior. Therefore, we do not need to import from sub-atomic physics the uncertain principle of uncertainty in order to explain free will. The fact that man can control to a certain extent his own acts as well as phenomena outside himself requires neither a little daemon in the electron nor a big one in the man.

Just one hundred years ago the English poet, William Wordsworth, wrote:

> Man now presides
> In power where once he trembled in his weakness;
> Science advances with gigantic strides,
> But are we aught enriched in love and meekness?

These lines are much more significant to-day than when they were penned. The strides of science have never before been so gigantic as during the past century. So far as our knowledge of and control over natural forces and processes are concerned we live in a new world that could not have been forecast by scientists and could scarcely have been imagined by poets and seers of one hundred years ago. Within the last century we have passed from the "horse and buggy stage" to the locomotive, the automobile and the airplane era; from slow mails to the telegraph and telephone and radio, from education and music and art for the favored few to a time when these are available to untold millions. Applied scientific knowledge has made amazing advances in all the means of living; in the abundance and variety of food and clothing; in comfort, convenience and sanitation in housing; in relative freedom from degrading drudgery and a corresponding increase in leisure and opportunity for the pursuit of happiness. At the same time medical science has to a great extent removed the fear of "the pestilence that walketh in darkness"; no more do whole cities flee in panic from the black death, or yellow fever, or white plague; no more do civilized people live in dread of smallpox or typhoid fever or diphtheria; the average length of life has been greatly increased; physical pain has been reduced and comforts have been multiplied.

These are only a few of the marvelous advances of science, most of them within the memory of old persons still living. No similar progress can be found

within any other century of human history. "But are we aught enriched in love and meekness?" With man's increased control over the forces of nature there has not gone increased control over human nature. Man's conquest over outer nature has outrun his conquest over his own spirit, and consequently the gifts of science, which might be unmixed blessings if properly used, become new dangers when used for evil purposes. Science is organized knowledge, and knowledge in itself is neither good nor bad but only true or false. That which gives social and moral value to science is the purpose for which men use it. If it is used for selfish advantage it may weaken or destroy social cooperation. If used for greater and more terrible wars it may end in the destruction of civilization itself.

Neither in human nature nor in social relations has progress kept pace with science. This is not the fault of science but rather of man and of society. The great advances in the applications of science have often been used for selfish purposes rather than for social welfare. Scientific progress in medicine and sanitation is far in advance of its social utilization, but not in advance of its urgent need. Rational and peaceful means of solving class conflicts and of preventing wars would be vastly less costly and more effective than strikes and armaments. Scientific control of population and the necessaries of civilized life would be more humane and progressive than to leave these to the law of the jungle. The fact is that social progress has moved so much slower than science that one might say that scientific progress is matched against social stagnation. Many thoughtful persons are asking: "Will science, which has so largely made our modern civilization, end in destroying it? Has it not placed powers in the hands of ignorant and selfish men which may wreck the whole progress of the race?"

It is a fact that improvements in human nature are not keeping pace with increasing knowledge of and control over outer nature. By means of language, writing, printing, the radio and all the means of communication and conservation of knowledge each human generation transmits its acquirements to succeeding ones. Thus present-day science, culture and civilization represent the accumulated experience and knowledge of all the past, each succeeding generation standing, as it were, on the shoulders of preceding ones. Every individual, on the other hand, begins life where all his ancestors began, namely, in the valley of the germ cells; he then climbs to the summit of maturity and goes down into the valley of death. But society, gifted with continuous life, passes on with giant strides from mountain top to mountain top. And so it happens that science and civilization in general outrun individual heredity, for the learning and acquirements of each generation are not transmitted to succeeding ones through the germ cells (except in the case of Professor McDougall's trained rats) but only through social contacts. For this reason increasing knowledge and power have greatly outrun improvements in inherent human nature, so that man is still, in the language of Raymond Fosdick, "the old savage in the new civilization."

It is impossible to halt the march of science except by destroying the spirit of intellectual and political freedom. No scientific moratorium by international agreement is possible, even if it were desirable, and any nation that undertook to halt the progress of science would be doomed to the fate of Ethiopia and China. Is there any way of escape from this perilous situation, in which knowledge and power have outrun ethics? Can world-wide ethics keep up with world-wide science? Can science itself do anything to close this widening gap between lagging human nature and the increasing responsibilities of civilization?

Eugenics has been proposed as a possible and necessary solution of this problem. Undoubtedly great improvement in human heredity could be effected, if the principles of good breeding which are used with such notable results in the improvement of domesticated animals and cultivated plants were to be used in the breeding of men. There is no doubt among students of heredity that by means of a system of selective breeding a healthier, longer-lived, more intelligent type could be developed and the prevalence of emotional instability and neuroses could be decreased. But the difficulties in the way of such a eugenical program are enormous where the human stock is so mixed, as it is in almost all races of men, and where the rules of good breeding would have to be self-administered or imposed by authorities that are influenced by social, racial or ethical prejudices. Even if these obstacles could be overcome and this program wisely and persistently followed it would take thousands of years to bring about any marked improvement in the masses of mankind, and in the present crisis of civilization we need a more quick-acting remedy, if it can be found.

Fortunately there are other and more rapidly acting remedies for this disharmony between biological and social progress. Heredity determines only the capacities and potentialities of any organism, the realization of those potentialities depends upon development, which is greatly influenced by environment, hormones, health or disease, use or disuse, conditioned reflexes or habits. In every individual there are many capacities that remain undeveloped because of lack of suitable stimuli to call them forth. Since these inherited potentialities may be social or anti-social, good or bad, it is the aim of enlightened society to develop the former and to suppress the latter. In the heredity of every human being there are many possible personali-

ties; which one of these becomes actual depends upon developmental stimuli. Each of us might have been much better or much worse characters than we are if the conditions of our development had been different. Endocrinologists and students of nutrition are already preventing or overcoming many of the deficiencies or defects that arise in the course of development. Medicine and sanitation have notably reduced the occurrence, spread and mortality of epidemics and there is every reason to expect that the causes and cures of the most serious diseases that now afflict mankind will be discovered, that sickness and suffering will be greatly reduced and that the average length of life will be still further increased. In all these respects science is contributing greatly to human welfare and to practical ethics.

But of all the possible means of rapidly improving social conditions, ethical education is probably the most promising. Education, based upon a knowledge of the principles of development and aimed at the cultivation of better relations among all classes, races and nations is the chief hope of social progress. The most enduring effect of education is habit formation. Good education consists in large part in the formation of good habits of body, mind and morals. Heredity is original or first nature; habits are second nature, and for character formation and social value they are almost if not quite as important as heredity itself. Ethical habits especially, are dependent on education, and in all normal human beings it is possible to cultivate habits of unselfishness rather than selfishness, of sympathy rather than enmity, of cooperation rather than antagonism. To trust entirely to heredity to improve men or society is to forget that heredity furnishes capacities for evil as well as for good, and to disregard the universal experience of mankind that human nature may be improved by humane nurture.

On these grounds certain humanists have proposed that art, literature, history and political and moral philosophy should replace science in the educational program, since, as they assert, science neglects or destroys the real values of life, inasmuch as it is said to be materialistic, non-ethical and lacking in high ideals. The president of the University of Chicago has recently called science a failure in the educational process and has urged a return to philosophy as the only sure road to sound discipline and true culture. Those who have never experienced the discipline and inspiration of scientific studies fear that science will destroy our civilization, and they call upon educators to repent and to return to the good old subjects of classical learning. Without discussing the specific value of different subjects in the educational program it may be remarked that it was not science that caused the decay of former civilizations nor was it in the power of classical art, literature and philosophy to save those civilizations. The fact is well attested that science has given us grander and more inspiring conceptions of the universe, of the order of nature, of the wonderful progress through past evolution and of the enormous possibilities of future progress than were ever dreamed of in prescientific times. And as an educational discipline there are no other studies that distinguish so sharply truth from error, evidence from opinion, reason from emotion; none that teach a greater reverence for truth nor inspire more laborious and persistent search for it. Great is philosophy, for it is the synthesis of all knowledge, but if it is true philosophy it must be built upon science, which is tested knowledge.

> To the solid ground
> Of nature trusts the mind that builds for aye.

Education, then, which looks to the highest development of the physical, intellectual and moral capacities of men is the chief hope of human progress. Even any possible program of improvement of inherited human nature must rest upon education concerning the principles of heredity and the methods of applying them to the breeding of men. Without waiting for the slow improvement of human nature through eugenics great progress can be made toward the "good society" by the better development of the capacities we already possess. All the advances from savagery to the highest civilization have been made without any corresponding improvement in heredity. Within a few generations, through the inculcation of better social habits or fashions, there have been many improvements in human relations. The torture and execution of heretics, whether theological or political, had all but disappeared from the earth until the recent revival of intolerance under dictatorships; belief in witchcraft and demoniacal possession and methods of exorcising devils by fire or torture no longer exist; human slavery as a legal institution has been abandoned everywhere; in this country the duel is no longer regarded as the necessary way of defending one's honor. These and a hundred other improvements in social relations have come about through education and enlightened public opinion. May we not hope that class, racial and national conflicts and wars may be outmoded in the same way?

Sensations, emotions and instincts are the principal driving forces in our lives as well as in those of animals. Primitive instincts, or what we properly call the "Old Adam," may cause persons, classes and nations to disregard reason and to give way to an orgy of passion. Lawyers for the defense sometimes call this a "brain storm," but it might more truly be called a "brainless or endocrine storm," for it is the sort of

behavior which one sees in decerebrate cats or in animals in which the lower centers of the emotions and reflexes are very active but are imperfectly controlled by the higher centers of intelligence and reason. One of Europe's dictators says, "We think with our blood," which is a pretty sure way "to see red." Another dubious test of truth is "to feel it in the bones," which is generally indicative of ossified thought. It is especially man's superior brain that makes him the paragon of animals. It was intelligence and not brute force that enabled primitive men to overcome great beasts of prey, and it is intelligence joined with ethical ideals that alone can guarantee future progress. Emotional behavior is highly infectious; a dog fight sets all the dogs in the neighborhood into a frenzy; an excited chimpanzee will set a whole colony of apes raging; and we know only too well how the mob spirit may spread through a peaceful community, or war psychology sweep through an entire nation. The only safety for society and advancing civilization is in learning to control these animal passions by intelligence and reason.

Throughout the period of recorded human history there has been a notable growth of freedom not only from the rigors of nature but also from the tyrannies of men. Freedom from slavery of the body, mind and spirit has been bought at a great price through long centuries of conflict and martyrdom, and one of the amazing revelations of the past few years is the compliant way in which millions of people in Europe have surrendered all freedom not only in government but also in speech, press, thought and conscience on the orders of dictators. Even in certain sciences, freedom of teaching and research has been restricted or prohibited, in spite of the fact that the advancement of science rests upon freedom to seek and test and proclaim the truth. Dictators seek to control men's thoughts as well as their bodies and so they attempt to dictate science, education and religion. But dictated education is usually propaganda, dictated history is often mythology, dictated science is pseudo-science. Free thought, free speech and free criticism are the life of science, yet at present these freedoms are stifled in certain great nations "with a cruelty more intense than anything western civilization has known in four hundred years."

In spite of a few notable exceptions it must be confessed that scientists did not win the freedom which they have generally enjoyed, and they have not been conspicuous in defending this freedom when it has been threatened. Perhaps they have lacked that confidence in absolute truth and that emotional exaltation that have led martyrs and heroes to welcome persecution and death in defense of their faith. To-day as in former times it is the religious leaders who are most courageous in resisting tyranny. It was not science but religion and ethics that led Socrates to say to his accusers, "I will obey the god, rather than you." It was not science but religious conviction that led Milton to utter his noble defense of intellectual liberty, "Who ever knew truth put to the worst in a free and open encounter? For who knows not that truth is strong, next to the Almighty?" It was not science but religious patriotism that taught, "Resistance to tyrants is obedience to God." The spirit of science does not cultivate such heroism in the maintenance of freedom. The scientist realizes that his knowledge is relative and not absolute, he conceives it possible that he may be mistaken, and he is willing to wait in confidence that ultimately truth will prevail. Therefore, he has little inclination to suffer and die for his faith, but is willing to wait for the increase and diffusion of knowledge. But he knows better than others that the increase and diffusion of knowledge depend entirely upon freedom to search, experiment, criticize, proclaim. Without these freedoms there can be no science.

Science should be the supreme guardian of intellectual freedom, but in this world crisis only a few scientists have fought for intellectual freedom, and organized science in the countries most affected has done little or nothing to oppose tyranny. Science has flourished under a freedom which it has not created and it is sad to see that to-day, as in former centuries, it is left largely to religious bodies to defend freedom of thought and conscience, while great scientific organizations stand mute. I am proud of the fact that our own Association for the Advancement of Science adopted at its Boston meeting in 1933 a ringing Declaration of Intellectual Freedom.

The proposal was recently made in England that the British Association for the Advancement of Science and the American Association unite to draft "a Magna Charta, a Declaration of Independence, proclaiming that freedom of research and of exchange of knowledge is essential, that science seeks the common good of all mankind and that 'national science' is a contradiction in terms." I am glad to report that these two great Associations for the Advancement of Science have for the past year or two been engaged in bringing about more intimate relations in the common tasks that confront all science.

We who are the inheritors of the tradition of liberty of thought, speech and press and who believe that freedom and responsibility are essential to all progress should use our utmost influence to see that intellectual freedom shall not perish from the earth. Such freedom has been essential for the advance of science, and the time has come when scientists and scientific organizations should stand for freedom.

There is no possibility that all men can be made alike

in personality, nor any reason why all races and nations should hold the same political and social ideals. But there are grounds for hoping that they may come to cherish the same ethical concepts, for the needs and satisfactions, the instincts and emotions of all men are essentially similar. Upon this fact rather than upon uniform opinions, the hope of universal ethics rests. Science is everywhere the same in aims and methods, and this fact greatly strengthens the hope that in a world bound together by science into one neighborhood there may come to be common ideals regarding fundamental ethics.

The greatest problems that confront the human race are how to promote social cooperation; how to increase loyalty to truth, how to promote justice, and a spirit of brotherhood; how to expand ethics until it embraces all mankind. These are problems for science as well as for government, education and religion. Each of these agencies has its own proper functions to perform. Instead of working at cross purposes these greatest instruments of civilization should and must cooperate if any satisfactory solution is to be found. Scientists will unanimously agree that the spirit and aims and methods of science must be followed by all these agencies if any permanent progress is to be achieved; they will unanimously agree that science should cooperate to the fullest extent with government and education, but unfortunately there is no such unanimity of opinion when it comes to cooperation with religion. The memory of the many conflicts between science and theology in the past and the knowledge of the existing antagonism of many religious bodies to science has generated a reciprocal antagonism on the part of many scientists to all religion. If the humanitarian aims of both science and religion could be viewed in the spirit of sweet reasonableness it would be seen that the differences between them are not such as to prevent fruitful cooperation in promoting human welfare.

Science as well as religion consists of both faith and works, principles and practice, ideals and their realization. The faith, ideals and ethics of science constitute a form of natural religion. Scientists generally would agree, I think, that the faith and ideals of science include the following: (1) Belief in the universality of that system of law and order known as nature. (2) Confidence that nature is intelligible and that by searching our knowledge of it may be increased. (3) Recognition of the fact that knowledge is relative, not absolute, and that only gradually do we arrive at truth concerning nature. (4) Realization that there is no way to avoid temporary error, since in unexplored fields we learn largely by trial and error. (5) The necessity of freedom, openmindedness and sincerity in seeking truth. (6) Confidence that truth is mighty and will prevail and that even unwelcome truth is better than cherished error. (7) Realization that truth can not be established by compulsion nor error permanently overcome by force. (8) Belief that the long course of evolution which has led to man and society, intelligence and ethics, is not finished, and that man can now take an intelligent part in his future progress. In these articles the faith of science does not differ essentially from that of enlightened religions.

The ethics of science regards the search for truth as one of the highest duties of man; it regards noble human character as the finest product of evolution; it considers the service of all mankind as the universal good; it teaches that both human nature and humane nurture may be improved, that reason may replace unreason, cooperation supplement competition and the progress of the human race through future ages be promoted by intelligence and good will.

In its practical aspects the ethics of science includes everything that concerns human welfare and social relations; it includes eugenics and all possible means of improving human heredity through the discovery and application of the principles of genetics; it is concerned with the population problem and the best means of attaining and maintaining an optimum population; it includes all those agencies which make for improved health and development, such as experimental biology and medicine, endocrinology, nutrition and child study; it includes the many scientific aspects of economics, politics and government; it is concerned especially with education of a kind that establishes habits of rational thinking, generous feeling and courageous doing. In spite of notable advances of our knowledge of these subjects we still know too little about human nature and the causes of social disorders. The extension of the methods of experimental science into this field is bound to be one of the major advances of the future. The ills of society, like the diseases of the body, have natural causes and they can be cured only by controlling those causes.

It is often charged that science is worldly, materialistic and lacking in high ideals. No doubt this is true of some scientists as it is also of some adherents of religion, but this is no just condemnation of either science or religion. Scientists as well as religionists have all the frailties of human nature and both fall short of their highest ideals. It has always been true and will continue to be true that knowledge outruns practice and that ideals are better than performance. Shakespeare said: "If to do were as easy as to know what were good to do, chapels had been churches and poor men's cottages princes' palaces." Or in the language of Mark Twain, "To be good is noble, but to tell others to be good is noble and no trouble." This

is the age-long problem with which religion and ethics have struggled, namely, how can men be induced to live up to the best they know? How can they be brought to substitute the spirit of service for selfishness, love for hate, reason for unreason? The long efforts of past centuries show that there is no rapid solution of this great problem. But in the cooperation of science, education and religion there is hope for the future.

The American Association for the Advancement of Science is proud of its eighteen thousand members; the new edition of "American Men of Science" will contain nearly thirty thousand names. But the Christian churches of the United States number among their members about fifty-five millions. In so far as these churches represent the spirit of their founder they are concerned especially with the cultivation of ethics. That so little has been accomplished and so much remains to be done is due in part to refractory material, poor methods and the necessity of repeating this work in every generation. These religious bodies are enormous organizations with great potentialities for good. Why should not science and religion be allies rather than enemies in this process of domesticating and civilizing the wild beast in man?

The ethics of great scientists is essentially similar to that taught by great religious leaders. A scientist not friendly to organized religion has said that the Decalogue of Moses might be accepted as the Decalogue of Science if the word "Truth" were substituted for the word "God." Ivan Pavlov, the great Russian physiologist, left an ethical bequest to the scientific youth of his country, which reads like the warnings of the ancient prophets. Over the tomb of Pasteur in the Pasteur Institute in Paris are inscribed these words of his: "Happy is he who carries a God within him, an ideal of beauty to which he is obedient, an ideal of art, an ideal of science, an ideal of the fatherland, an ideal of the virtues of the Gospel." John Tyndall, no friend of the church, pronounced this eulogy of Michael Faraday, one of the greatest experimental scientists who ever lived; "The fairest traits of a character, sketched by Paul, found in him perfect illustration. For he was 'blameless, vigilant, sober, of good behavior, apt to teach, not given to filthy lucre.' I lay my poor garland on the grave of this Just and faithful Knight of God."

As scientists we are inheritors of a noble ethical tradition; we are the successors of men who loved truth and justice and their fellow-men more than fame or fortune or life itself. The profession of the scientist, like that of the educator or religious teacher, is essentially altruistic and should never be prostituted to unethical purposes. To us the inestimable privilege is given to add to the store of knowledge, to seek truth not only for truth's sake but also for humanity's sake, and to have a part in the greatest work of all time, namely, the further progress of the human race through the advancement of both science and ethics.

OBITUARY

THOMAS NELSON DALE

T. NELSON DALE, a retired member of the U. S. Geological Survey, died at his home in Pittsfield, Massachusetts, on November 16, nine days short of his ninety-second year.

Several years in Williston Seminary, courses in mathematics and mineralogy at Cambridge University, England, petrography under Professor J. Wolf at Harvard University, field trips under the leadership of Dr. Carl Zittel, of the University of Munich, to Norway, Sweden, France, Germany and Switzerland, and a stratigraphic and paleontological research problem in the Val de Ledro in the Tyrolese Alps, comprised the systematic part of Mr. Dale's early training. The accuracy of this first geological research, praised by Dr. Zittel, of the University of Munich, and Dr. A. Bittner, of the Austrian Geological Survey, characterized all his later structural and petrographic papers written while he was associated with the U. S. Geological Survey, which service started in 1880 and terminated in 1920. This work was mainly concerned with the Taconic and Green Mountain structural problems, which involved some twelve thousand miles of walking and as much of driving in the most rugged section of western New England. The areal mapping and the structural sections have been found to be, on the whole, extremely accurate and thorough within the area studied. The latter phase of his work with the U. S. Geological Survey was concerned with the investigation of the granite, marble and slate industries of New England and the United States, the results of which work, published in the Survey bulletins, have long been considered standard references among quarry people as well as colleges and universities.

Aside from teaching at Vassar and Williams for short periods, at the latter institution for nine years, he had interests of a religious and philosophical nature, which were manifested in several publications. He was a member of the Geological Society of America, a corresponding member of the Austrian Geological Society and a life member of the French Geological Society.

CORRESPONDENT