SCIENCE

VOL. 89 FRIDAY, FEBRUARY 24, 1939 No. 2304

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, RELIGION AND SOCIAL ETHICS[1]

By Sir RICHARD GREGORY, BART.

RETIRING EDITOR OF NATURE

MANY reasons have been put forward to account for the origin of religion, but it can not be said that any of them have solved the problem. Ancestor worship, ghost propitiation, worship of the soul, belief in spiritual beings, reverence for tribal leaders, have all been suggested as originating causes of religious sentiment. Primitive man had no religion except such as was embodied in a system of social virtues. Men possessing these virtues to a high degree, and using them to make the tribe powerful or conditions of life more pleasant, would be esteemed as benefactors or heroes not only during life but after death, and this veneration would develop into ancestor worship and later into soul worship.

[1] Concluding part of the fifth Elihu Root Lecture of the Carnegie Institution of Washington, given on December 8, 1938. The substance was included in a lecture before a general session of the American Association for the Advancement of Science, Richmond, Virginia, December 29, 1938.

If it is assumed that the divine purpose of the existence and evolution of life upon the earth is that man should work out his own salvation, it is difficult to understand what the ultimate gain will be when the earth will no longer be in a condition to maintain life as we conceive of it. All that science can say as to the future of the earth, or of any other planet or system in the astronomical universe, is expressed in the words of the hymn, "Our little systems have their day: they have their day and cease to be." We may contemplate the progressive development of man and society to any stage that may satisfy our ideals, but, so far as we now know, the whole phantasmagoria will eventually be dissolved, and the death of mankind will be the final penalty for achieving the highest type of humanity conceived by the human mind. This thought should not, however, be subversive of effort and aspiration on the part of humanity as a whole, any more than the

individual should neglect noble motive and conduct because he himself has to pass away whether his influence has been for good or evil. Though science is unable to provide any positive evidence for survival of personality after death, it must acknowledge that belief in such survival is a powerful ethical factor in human development. It is just as permissible, therefore, to assume that another world awaits habitation by an exalted type of humanity after this earth has come to an end, as it is to believe in the eternal existence of individuality.

Whatever convictions may be held as to the future of man or humanity, the standard of goodness is decided by the community. The man who lives a moral life merely because he wishes to save his own soul is little better than an expectant hedonist; for his motive is personal profit. He may be saved from punishment hereafter by being negatively evil, but his life will be of no benefit to the human race unless he is positively good. What existence awaits us when we are called away we can not say, but we find stimulus and high endeavor in the hope that each thread of life is intended to contribute to the web designed by its Creator. Though science may not be able to contribute much to the ultimate problems of spiritual beliefs, it does teach that every action carries with it a consequence—not in another world, but in this—to be felt either by ourselves or by others in our own time or the generations to come.

Evidence of the progressive development of forms of life in the past and of changes still going on is so convincing that it may almost be regarded as a law of nature. In so far, therefore, as evolution signifies an orderly succession of organic growth, few would venture to deny the fact; but how and why such changes are brought about has not yet been established beyond discussion. Whether organic evolution has proceeded by gradual development of small variations of structure and habits, or by the sudden appearance of new forms, is a question for naturalists to decide among themselves in their search for natural causes. The court of observational science is concerned only with evidence which throws light upon such causes, without assuming the existence of supernatural design or intervention. Whether behind the natural causes producing evolution there is a transcendental principle or architect is not the concern of naturalists but of other philosophers. Their position is that even if the facts of organic evolution can not be explained by existing knowledge, they will be explicable when more is known about natural causes and consequences, without introducing a *deus ex machina* to conceal our ignorance and suppress the pursuit of objective evidence.

We have passed the stage when, in order to afford support for Christian belief in general, and the Mosaic account of creation in particular, it was only necessary to find naturalistic or rationalistic explanations of miraculous and other elements in biblical records. Such attempts to fit all new knowledge into a system of thought having no claims to scientific accuracy or intention served no useful purpose to the Bible or to science, and to-day would satisfy neither historical students nor naturalists. A much sounder basis can be found by applying evolutionary principles to religious thought and by studying sacred books as stages in the story of man's progressive discovery in theology. It is only by disregarding history that the idea of a fixed and final theology becomes possible. In science, there are no final interpretations or unchangeable hypotheses; and if the same principle were recognized in theology, religion would share some of the vitality of the natural sciences. Evolution can be regarded by the theologian as merely the means of creation; and the conception of gradual development is not incompatible with Christian theology. It is through the acceptance of the idea of evolution in the spirit as well as in the body of man that the partition which formerly separated religion and science is being dissolved.

In recent years, there has been much discussion of the ethical or social consequences of the application of mechanical and other scientific discoveries to industry. In the early days of the industrial revolution in England, there was little of the scientific spirit in industry. The discoveries of science were used with as much indifference to science as to humanity. The inventions of the eighteenth and early nineteenth centuries came from the workshop rather than from the scientific laboratory. Machines were devised and operations developed largely by trial and error methods, and academic research had few points of contact with industrial practice. The characteristic of the present age is the utilization in industry of principles, properties and products revealed by scientific research, whether carried on solely in the pursuit of knowledge or with a practical purpose in mind.

It is sometimes suggested that progressive science and invention are responsible for the troubled condition of the world at the present time, owing largely to overproduction. It would be just as reasonable to blame the Almighty for good harvests, or for providing in some parts of the world all the means of existence for primitive man without the need for labor. The fault is not with those who create gifts for men's comfort and enjoyment, but with the social system which prevents their easy distribution and use. A century ago, most of the machines and engineering works which now make up a large part of our industrial life, and which are supposed to have led to unemployment, did not exist, yet there was then wide-spread unemployment and poverty. The population of Great Britain was

then only sixteen millions, yet there were two millions in workhouses or receiving outdoor relief. The terrible conditions of those days were bitterly described by Carlyle in "Past and Present." He wrote:

> We have more riches than any Nation ever had before; we have less good of them than any Nation ever had before. Our successful industry is hitherto unsuccessful; a strange success if we stop here! In the midst of plethoric plenty, the people perish; with gold walls and full barns no man feels safe or satisfied. Workers, master workers, underworkers, all men, come to pause; stand fixed, and cannot go farther.

In the "hungry forties" the mechanization of transport and industry was but in its early stages, and if the description of Carlyle is a correct one it is apparent that there is little justification for trying to lay the blame for the unemployment of to-day at the feet of the mechanical inventors. When Carlyle wrote, men still traveled by stagecoach and sailing ships, and a multitude of things were done by manual labor which to-day are done by machinery. When first introduced, new machines, it is true, do tend to displace labor in one direction, only, however, to stimulate it in another, and in the end greater wealth is created. The problem to-day, as it was a century ago, is to adapt the social and economic systems to the new conditions brought about by advances of science and invention. For a people to be made wretched in proportion to the increase of means of producing plenty shows that there is something radically wrong in industrial or social economics.

It is of course natural that labor, with its memory of bitter struggles against long hours and low wages, should stress much more acutely the problem of distribution of the products of its toil than that of the factors of industrial progress. The artisan has had good reason for regarding every labor-saving device as a wage-saving device; and it is almost a mockery to suggest to men who find themselves unwanted through the introduction of particular machinery that the ultimate effect will be increased employment. The thought, however sound it may be in industrial economics, affords poor satisfaction for present needs. Men thus displaced through no fault of their own may rightly claim, on the ground of humanity alone, that the community which is eventually to benefit by the saving in costs of production should accept a measure of responsibility for the maintenance of those whose means of existence are suddenly taken from them.

In the history of early civilizations, a condition of stagnation and of internal dissention has usually preceded their decline and extinction. The end has come through conquest by military forces of a superior type or by the invasion of hordes of barbarians whose only motive was plunder. It used to be suggested that modern civilization would be saved from this fate by the powers with which science has provided civilized peoples to protect themselves against overwhelming numbers having only primitive weapons. Few people thought that the yellow and dark races would ever be able to dispute the supremacy of the white races, even though equipped with modern weapons, but that view could scarcely be held to-day. The perils which threaten modern civilization are not, however, so much from the greater numbers of peoples who may eventually possess powerful appliances of war as from the very peoples who have themselves perfected such weapons. Efficient barbarity made no distinction in the Great War between the destruction of masterpieces of architecture and ammunition dumps; and, since then, aerial bombing of any center of life or of beauty seems to be accepted as a means of offensive action by nations which claim to be civilized. Instead of science having to save modern civilization from being overwhelmed by barbarous hordes, it seems to have provided the means of self-destruction. Man has advanced so little in spiritual evolution that he is just as much a barbarian in his use of aerial bombs and poison gas as he was when his weapons were only clubs and arrows.

Such prostitution of the rich gifts with which modern science has endowed the human race must be condemned by all who see, in the general feelings of civilized people to-day, incipient stages in the development of characteristics which distinguish man from other living creatures. The law of the jungle is that of the battle to the strong, and the race to the swift. It recognizes no right to live except by might; destroys the weak; has no sympathy with suffering, and no sense of the highest human values. In the struggle for existence, man has survived because his physical structure and intelligence have enabled him, individually and in communities, to master the things which would destroy him. His social instincts have at the same time been extended from the family to the tribe, the nation and the empire, and will reach their highest and best when they embrace the world.

The virtues which should be prized most to-day, if civilization is to mean the evolution of social ethics to a noble plane, are regard for spiritual values, love of truth and beauty, righteousness, care for the suffering, sympathy with the oppressed and belief in the brotherhood of man. These are the principles of the Sermon on the Mount; and they must be accepted by all who believe in progressive human development. And nation or people which separates itself from the rest of the world in the name of race or religion, and cultivates ideals of conquest by force in order to assert its claims, is not assisting human evolution but retarding it.

Science has made the world one through the facilities of communications and transport now available; and it recognizes no political or racial boundaries in its fields of knowledge. Among modern social and intellectual forces, science alone speaks in a tongue which meets with universal understanding. The conception of science as a social factor intimately linked up with human history and human destiny gives a new meaning not only to scientific research but also to the position of citizens who are engaged in it.

Both rightly and wrongly, science has been blamed for much of the wastage of life which has been brought about by the rapid applications of scientific knowledge to purposes of peace and of war. Men of science are, however, citizens as well as scientific workers; and they are beginning to realize their special responsibilities for making sure that the fruits of scientific knowledge are used for human welfare. They can no longer remain indifferent to the social consequences of discovery and invention, or be silent while they are blamed for increasing powers of production of food supplies, providing means of superseding manual labor by machines and discovering substances which can be used for destructive purposes. It would be a betrayal of the scientific movement if scientific workers failed to play an active part in solving the social problems which their contributions to natural knowledge have created.

The view that the sole function of science is the discovery and study of natural facts and principles without regard to the social implications of the knowledge gained can no longer be maintained. It is being widely realized that science can not be divorced from ethics or rightly absolve itself from human responsibilities in the application of its discoveries to destructive purposes in war or economic disturbances in times of peace. Men of science can no longer stand aside from the social and political questions involved in the structure which has been built up from the materials provided by them, and which their discoveries may be used to destroy. It is their duty to assist in the establishment of a rational and harmonious social order out of the welter of human conflict into which the world has been thrown through the release of uncontrolled sources of industrial production and of lethal weapons.

Science can only continue to render its fullest service to the community as the relations between the general scientific worker and the general citizen are harmonized and the purposes and methods of science are widely understood. In the establishment of such a sympathy, a nobler type of citizenship becomes possible, adequate to defend us against the dangers to which civilization is exposed and to build a social order worthy of the limitless powers which the advance of science has placed in the hands of man. It is in the light of service to these high ideals that science, without which we can not live, and religion, without which most people see no meaning in life, can find a field in which both can work together for the highest human destiny.

CONCERNING ECOLOGICAL PRINCIPLES[1]

By Professor W. C. ALLEE and Dr. THOMAS PARK
UNIVERSITY OF CHICAGO

THE statement is frequently made that ecology deals mainly with facts which are organized around relatively few principles. Usually this is given as a reproach by non-ecologists, sometimes if not with pride, at least with resignation, by ecologists. If such a condition exists, it seems to us to be a cause for regret. For a number of years we have been interested in thinking over this problem and in collecting distinctly ecological principles from the literature as well as in amassing evidence dealing with more specific problems. The present paper is presented as a report of progress in the hope of provoking discussion which may make future ecological work more effective.

In making this study we are not conscious of having contributed anything new, even though we find the results at least mildly stimulating. It is not our concern at present to deal with the history, with the personalities associated with the different principles or with the date of their discovery. This means that we are not particularly interested in the percentage of these principles which have grown out of modern, self-conscious ecology. Our only care has been to select and make some preliminary attempts at classification of those principles that deal in the main with interrelations between an organism, or one or more groups of organisms, and its or their environment.

It would be relatively easy to become entangled in a discussion of terminology in connection with the consideration of ecological principles. We wish to avoid this as far as possible and shall at times use only one of a number of common terms associated with a given idea. Our selection in such cases will be based on our personal usage rather than on a fully reasoned consideration of the merits of possible alternative terms. Our whole emphasis for the moment is on ecological ideas which we think have merit, rather than on ter-

[1] We are indebted to Alfred E. Emerson and to Karl P. Schmidt for reading a preliminary draft of this manuscript and for making pertinent suggestions.