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EDUCATIONAL DARKNESS AND LUMINOUS RESEARCH[1]

By Dr. OSCAR RIDDLE

CARNEGIE INSTITUTION, STATION FOR EXPERIMENTAL EVOLUTION, COLD SPRING HARBOR, N. Y.

I

ALMOST any group of scholars would agree that during the past fifty to one hundred years research in the natural sciences has provided truth and principles which are capable of transforming earlier and popular views concerning nature and man. Yet, despite the surpassing fruitfulness of this era of research, it may well be that if or when later generations of man should care to form an estimate of our present generation, they will marvel less at this brilliant research than at the depths of our present educational darkness—less at the intellectual achievements of an amazing century of science that has disclosed the basic facts of man's own nature and man's place in nature, than at our present educational programs which essentially fail to give the new truth and principles to this generation. It is in the field of biology—the life-sciences—that this failure is so flagrant and conspicuous; and it is the truth and principles of this same group of sciences that could otherwise contribute so greatly to the mental and physical well-being of the present generation of mankind. These remarks will therefore deal with certain aspects of this flagrant failure of our educational program to comprehend and teach life-science.

In the course of this discussion it may become apparent that the same familiarity with life-science which is required for modern intellectual life, for good citizenship, for progressive agriculture and husbandry, for better health and for preservation against many diseases, will automatically supply that better knowledge which this audience well knows is needed also to save many thousands of lives from cancer.

II

To every one it is evident that only the primary and secondary schools of a nation have opportunity

[1] Luncheon address before the Cancer Forum, Philadelphia, November 30, 1937.

to train the great mass of its people in life-science or in any other subject. These schools form the only broad path to the education of a people. That point is self-evident, but let us briefly examine the recorded comment of a few intellectual leaders who have considered the actual performance of these schools as measured against a background of what is both needed and attainable.

Four years ago Professor Dewey, philosopher and educator, stated as follows:

> We have broken with the intellectual traditions of the past and the mass of men have not had the nature of the change interpreted to them. . . . The field of education is immense and it has hardly been touched by the application of science. There are, indeed, courses in science installed in high schools and colleges. . . . But the scientific attitude, the will to use scientific method and the equipment necessary to put the will into effect, is still, speaking for the mass of people, inchoate and unformed. The obligations incumbent upon science can not be met until its representatives cease to be contented with having a multiplicity of courses in various sciences represented in the schools, and devote even more energy than was spent in getting a place for science in the curriculum to seeing to it that the sciences which are taught are themselves more concerned about creating a certain mental attitude than they are about purveying a fixed body of information, or about preparing a small number of persons for the further specialized pursuit of some particular science.
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> There is, moreover, a virgin field practically untouched by the influence of science. Elementary education is still a place for acquiring skills and passively absorbing facts. It is generally now admitted that the most fundamental attitudes are formed in childhood, many of them in the early years. The greatest indictment that can be brought against present civilization, in its intellectual phase, is that so little attention is given to instilling, as a part of organic habit, trust in intelligence and eager interest in its active manifestation . . . (and) to the formation of the inquiring mind that explores and tests.

From President Hutchins, trained in law and administration, we quote the following:

> However diversified the curriculum below the junior year of college may be, the core must be a good general education. We know that such a thing does not exist to-day. What we find instead is a series of short unrelated courses comprising a smattering of miscellaneous facts, which leaves the student uneducated and, except perhaps in the spasmodic exercises of memory, untrained.

The writer Joad has well said:

> One of the most disquieting facts about modern civilization is the failure of our social wisdom to keep pace with our material power. Science has equipped us with powers fit for the gods, and we bring to their use the mentality of babes and schoolboys.

A few days ago Dr. F. R. Moulton, the mathematician and astronomer, said: "If science is to be made to realize its possibilities in the advance of civilization, then it must become an essential part of the intellectual life of the average man, for in the long run the masses determine the rate of progress." On the same day Professor Hooton, the anthropologist, stated: "I believe that the application of biological science to man is the single means of salvation of our species."

Finally, we recall some words of Charles W. Eliot, a chemist, who was long president of Harvard and America's great educational leader. "The human race has more and greater benefits to expect from the successful cultivation of the sciences which deal with living things than from all the other sciences put together."

You are thus given some evidence that present failure of our secondary schools to educate in satisfactory degree is recognized by many of those who are competent to pass judgment. Also, the high value of the life-sciences as a *means* of education, and the unique importance to human welfare of wide-spread familiarity with the principles of life-science, are things now accepted by some competent judges who are themselves not biologists.

III

Later in this statement we shall indicate that in this country instruction in life-science has deteriorated rather than advanced during the past third of a century—that is, instruction has regressed during the precise period when research has brought us the most of clarifying knowledge concerning ourselves and the living world. Before elaborating that point, however, I ask several minutes for placing before you some samples of the truths and principles of life-science which our schools could teach most of our educable children if life-science were given a continuous four-year place in the curriculum of our secondary schools. With that done, you yourselves are further asked to judge whether these samples are or are not well adapted "to kindle power and understanding in immature minds"; whether likely or unlikely to give "familiarity with the scientific method, and the will to use the scientific method"; whether they fail either to indicate or to clarify our "break with the intellectual traditions of the past"; and whether they can serve "to form the inquiring mind that explores and tests"; whether indeed, they are not essential for good citizenship and for anything that may to-day be rightly considered a decent education.

A good course of study in life-science would begin with the earth as a burning fragment of the sun. And its early chapters would deal with the physical results of the cooling of this fragment. In the super-heated gases of the new-born earth only a *few* chemical com-

pounds could possibly exist and present knowledge of the sun gives the clue to their identity. With progressive cooling of the little sun which became the earth more and more chemical compounds *must* form, and important parts of that story are at hand. When cooling progressed to a stage at which water could exist in the liquid state an inevitable and almost limitless series of new compounds *must* have begun to form. Many of these compounds are identifiable; and they are found to include some quite simple *organic* compounds which had to enter into the first living matter and which still continue to sustain it. Obviously, some simple facts from astronomy, physics, chemistry and geology have a share in the subject-matter of life-science.

Next, the findings of paleontology would place minute and lowest forms of life as the first to appear on the earth; and that science would supply still other superb chapters of the history of life. Later and adequate biological consideration of selected types of living things, from virus and bacteria to man, would provide the background against which the principle of continuity, and of change dependent upon *natural law,* may be seen to reach from sun to man.

The early part of such a course of study would seem capable of giving our youth an *orientation toward nature* which corresponds with what modern research has disclosed. The latter and much more time-consuming phase of this effort at education would relate to *the nature of living things and of man himself* and so prepare him to live comprehendingly among other men. Of some of these many and specific things concerning man and the living world I wish now to speak.

Life-science can present the basic facts concerning the great principle of organic evolution. The gradual origin by descent with modification of complex life, including man himself, and the kinship of all living things, are blended in this preeminent principle. The outlines of the rules and laws of that progress may and should become the common denominator of all thought about life. In the center of this great stream of life we discover the principle of progress deep within ourselves; and, as a crowning fact, we observe that of nearly two million living species it is mankind that has been lifted most—and mankind that is now the moving point—on the wave of life.

Life-science presents the broad and humanly momentous principles of inheritance: How and why the offspring find repeated in themselves the characteristics of their ancestors; knowledge and understanding of differences or variation among offspring; the utilization of these principles in the improvement of races of animals and plants upon which human existence depends; and finally, the full realization that on the basis of their heredity no two human beings, excepting identical twins, are exactly equal. So significant are these well-established principles, that we ask: For how long and to what extent dare communities, and their ever more complicated social and legal regulations, disregard the basic fact of the biological *in*equalities of men?

Life-science now presents the inspiring facts of the plasticity or modifiability of the growing organism, even though initial hereditary inequalities can never be wholly or permanently erased. In much the same way, and using some of the same tools, by which life-science has obtained control over many diseases it has now made substantial beginnings in controlling the growth and attainments of plants, animals and of man himself. Best of all, these and hundreds of kindred things are things always repeatable under the prescribed conditions—they are in no way at the caprice of magic or of wishful thinking. What a world of wealth and inspiration is this to the unspoiled youth—the future citizen—who thus learns of man's fast-growing power over even his own destiny!

Life-science—thanks to laboratory triumphs for almost each one of the last twenty years—now presents a handful of vitamins with which any youth may cure certain diseases; and better still with these he can assure himself freedom from these diseases. This simply statable knowledge is needed by all, and all of it is particularly useful to the young.

Life-science can give acquaintance with our own bodies, with the functions of our various organs, with the natural and artificial enemies of these organs, and with the conditions essential for health. Having interest in and familiarity with our own bodies and minds each individual would thereafter become the quite special and unique protector of his health and well-being in situations that attend all the days of his life. It is not negligible that this knowledge would curtail the quacks. Of much importance too is the circumstance that, if all our secondary school graduates obtained the thorough grounding in all aspects of life-science contemplated here, the public press of the country might soon become a real adjunct to the continuing education of our people in science beyond their days in school. That service will develop only if and when interest and understanding develop in the public that buys and reads the daily newspaper.

Life-science provides the natural and best opportunity of introducing those facts concerning reproduction and sex which are necessary for youth at or before the high-school age. We all know that many parents do not supply this expedient information and that the personal welfare of many is adversely affected by a protracted ignorance of this somewhat difficult and delicate subject.

Life-science presents the ever-present and pervasive

fact of the struggle for existence with the consequent elimination of the unfit. The young citizen will learn that in our civilized communities the harsher aspects of that struggle are not present; that the individual no longer depends on his perfect bodily fitness, on the acuity of his senses, on the alertness of his mind, to survive and reproduce. He will know that this must have profound effects upon the future of man. He will find much food for fruitful thought in the dilemma that, unless we develop and use a quite possible and far-reaching control over human reproduction and development, our high civilization will itself lead to the deterioration of the race; and that this retrogression—already in evidence—renders the individual correspondingly more and more dependent upon the community for his welfare. He will thus become familiar with basic facts against which he may judge proposed laws dealing with social change.

Life-science attends and discloses the halting steps of primitive man. That man required many thousands of years for learning to make a most simple tool—a flint for aid in obtaining food and in subduing wild animals; and for hundreds of thousands of years thereafter that paleolithic man seems to have made little or no further progress, and probably his successors built their first city only during the last 15,000 or 20,000 years. That long drab epoch of human futility provides a full and brutal demonstration of binding limitations of raw untutored man. And no citizen who is unaware of the lame march of early man and the lifting power of a few tools and discoveries has even begun to comprehend either the human species or the social and political forms under which modern men may hope to live together.

Life-science can present the drama of life as this was performed in a very restricted zone—quite near to the very surface of our small planet. Even bacteria disappear in the upper reaches of the atmosphere, and other life extends downward only to the limits set by the ocean depths. At no earlier time in the earth's history has this been different. Fossil remains of living things are found in coal and rock strata now some thousands of feet beneath the soil on which we walk, but it is clear that these veins were land surfaces or ocean floors when they trapped the dead bodies of organisms. If, in an Arabian Night's excursion, we might look at the present living world from afar—say, from the 24,000 miles which is one tenth of the distance to the moon—we could rightly sense the narrow pinions of life. Then, on the great sphere which would nearly fill our view to east or west, we should see all life imprisoned in a thin film—a living skin—tightly fitted to the very surface of the earth. As we now know it, the entire story of life sticks to the place where there is liquid water, with earthly salts dissolved in it; where gaseous oxygen, carbon dioxide and nitrogen abound; and where surfaces can absorb sunlight for a continuous flow of free energy. Life thus presents itself as the most circumscribed and contingent thing in a world of things; and it seems to be the newest thing in the universe.

Life-science can emphasize the newness of intimate knowledge of ourselves. Nearly all the definite and worth-while that we know about our own bodies has been learned within the time of men now alive. Most that we know about the care of our bodies and nearly everything that we know about fighting disease successfully has been learned in that same time or in an even shorter period. The whole range of diseases based on bacteria and viruses are things new to this period. The science of nutrition is new. The science of anthropology is new. The real science of psychology is new. So it is with practically all other aspects of this subject. In the life-sciences the new evidence has come that life itself was evolved from the non-living; that one living species is slowly transmuted into others; and that all life phenomena, from the division of a bacterium to the consciousness of man, have evolved under natural law. As a result of these extensions of knowledge the intellectual life of some men of the present generation is a variety hitherto unshared with any former generation of man. It is, and has been, the great educational opportunity of to-day and yesterday to bring this intellectual climate to the many who come for education to our secondary schools. And who will doubt that future beehive aggregations of men may be wrecked if the ever-multiplied rules and laws under which they are forced to live are based upon variegated tradition instead of upon a common body of knowledge?

We have taken some pains to say that there is no lack of a body of knowledge especially adapted to real education at the high-school level; and that, fortunately, this same body of knowledge provides a firm basis for a comprehending citizenship.

Against this background of achievements of recent illuminating research we may nevertheless witness a deterioration rather than an advance in secondary school instruction in biological or life-science during the past thirty or thirty-five years. Even in that earlier period life-science grudgingly held a very subordinate place in the secondary schools of the United States; but my own examination of this question leads to the conclusion that less biology per high-school pupil is taught to-day than was taught a third of a century ago. I have earlier and elsewhere presented some of the evidence for this conclusion, and can cite no more than a trace of such evidence here. The purpose of this address is to prompt this group of interested citizens to awareness that one to three genera-

tions of luminous research are now in eclipse; that laboratory conquests bringing life and light to man are now submerged in an educational darkness that is shameful and unworthy of our day; and that heavy obligation and duty rests upon us all to identify and oppose those forces which now prevent an oncoming generation from possessing this rich inheritance.

In commuting to my laboratory each day I pass through a typical Long Island town whose public high school enrolls about six hundred pupils. This school has forty-three teachers, and of these *two* are teachers of science! That is, two of these forty-three teach whatever is taught of chemistry, physics, astronomy, earth science and life-science. Two of the forty-three teach whatever is taught about the human body and mind, its care, defenses and diseases; whatever is taught about the living plants and animals from which we sprang, from which we must ever be sustained and with which man must always remain in balance; whatever is taught in their six-year high-school period about the earth, air, water and sunlight that built life and man; whatever is taught of the sciences which are the sustaining parents of the technologies—engineering, medicine, forestry, agriculture, husbandry and the rest; yes, upon these two of the forty-three rests whatever is taught about those physical, chemical and biological laws and forces—outside and inside of man—that supply mankind with its just hope for grandeur and power and happiness, and with its rational estimate of the limitations of man and of the origin and destiny of man.

Less than 5 per cent. of the effort of these forty-three guides in secondary education is given to these many supreme things. At this moment about one sixth of the pupils of this school are giving about one fifth of their school effort to "general science," and sometime late this winter or next spring this course being studied by one sixth of the pupils will become concerned with bits of elementary biology. Meanwhile, and at this moment, only thirty-five pupils in this school are in fact given opportunity to devote a fragment of their time to the study of biology as an elective subject.

But the degree of intellectual sterility and the prevalence of abortive educational practice in our secondary schools become still more emphatic when it is found that in most such schools the biology that is taught must first be emasculated either by veiling or by excluding the principle of evolution—which is the core and center of biological thought. Though this preeminent principle pervades the whole of life-science and constitutes its most superb intellectual achievements, both teacher and text-book are often or usually forced by prevailing prejudice to place only a pale ghost of our science in the student's hands. During the past seventeen years five states (if we include Utah) have passed laws which prohibit the teaching of evolution in their public schools. The sentiment which wrote these laws is widely prevalent everywhere; and we would be both blind and asleep if we failed to recognize that this sentiment receives its chief support from the traditional religion of this and earlier days. There is to-day no country under the sun where the prevailing religion—be it Buddhist, Mohammedan, Shinto, Pagan, Christian or Hebrew—does not resist the compelling facts, and clear implications of the facts, that modern research has disclosed concerning the origin of life and man under natural law. If the best of life-science is to become a possession of our people, thinking men and women must free our schools from that paralyzing restraint and see to it that the course of our civilization is guided by knowledge rather than by tradition and the dead hands of the past.

Perhaps you who live in and near Philadelphia imagine that the bit of life-science taught in your schools is *real* biology, and that here the heavy hands of tradition have not restricted the teaching of the evolution principle—the central principle of our science. The following quotation from the *Philadelphia Evening Bulletin* of August 13, 1937, and not corrected in immediately following issues of that newspaper, indicates that the biology taught here in Philadelphia is of the bloodless and ghostly type so commonly taught elsewhere in the high schools of this country. The principal of one of your most honored high schools is there quoted as saying:

> The old theory of evolutionists as to whether man is descended from the monkey has been over these many years. Such teaching is discredited and is not representative of science and so will not be found in our text-books.
>
> The public schools teach biology. In this study, the difference of the species is indicated.
>
> The difficulty in teaching science often has been that it has been approached with an irreligious attitude. There is no such attitude among the public school teachers of Philadelphia.
>
> This old controversy is a recurrent thing among laymen but in science it has been generally discredited and is not representative of science.

Thus, in this Philadelphia high school one notes no hesitation in plumping both the baby and the bath out of the educational window. One can only wonder how a biology that has thus been robbed of its viscera and brain may be expected to sustain intellectual effort—and educate. Perhaps we should also wonder whether those engaged in secondary education of this type seriously expect—from any or all subjects they teach—to "form the inquiring mind that explores and

tests" which Professor Dewey has noted as the valid aim of public education.

We thus approach a second restrictive influence on the teaching of life-science to our people. There is wide-spread failure of educators and public-school administrators to recognize and to utilize the great intellectual achievements of this scientific age. Even the most favored type of training for leadership in public education seems in recent decades to have slipped away from substantial backgrounds of knowledge into protracted tests and dissertations on methods of teaching. Educators with an outlook thus narrowed and distorted must be held largely responsible for a growing number of state laws and regulations which now often practically limit teaching licenses in high-school subjects to those who are surfeited with drill and doctrine on *how* to teach, but who are largely bankrupt in the subject-matter which must be taught.

During the past eighteen months I have been a member of a committee which is actively investigating the many things which affect the teaching of biology in our schools. From this source and from others there is no lack of evidence that laws and state board requirements of the type just indicated adversely affect the teaching of all science subjects in our high schools. It could be said with fair safety and certainty that in some states the promotion of such laws and regulations by our educational leadership is now preventing most of their prospective teachers of biology from obtaining an acceptable training in biological science. Here, then, is a second aspect of harmful restraint in public education upon which an aroused interest of thinking citizens is greatly needed.

IV

In conclusion, let us recall that in these and coming days the principle of democracy is itself under destructive pressure. Shall the public that decides the fate of our democracy conceive nature and man as research discloses them, or as uninformed and essentially ignorant masses can variously imagine them? In some laboratories of the world—chiefly in Europe and America—the researches of much less than a century have shown that such things as mosquitoes, flies and lice may and do carry pain, disease and death—and poverty—to human beings. Enlightened thought and practice in some parts of the world now strive to exterminate such carriers of pain, poverty and death, and thus to advance civilization on a basis of reality; but only two years ago last June Mahatma Gandhi—who alone largely controls the destiny of one eighth of mankind—seems to have said: "We have no right to take the lives of mosquitoes, flies, lice, rats or fleas. They have as much right to live as we." The Gandhis are everywhere—they are your neighbors and mine—and they thrive and propagate in a dim educational twilight from which the thought-transforming light of new knowledge is essentially excluded. To-day nations and peoples have a choice: on the one hand, between the host of unrealities, poverties and diseases rooted in meditations, crystal-gazing and traditional ignorance; on the other hand, through full and earnest public education their destiny can accord with the realities already disclosed by much and luminous research.

RESEARCH AT MELLON INSTITUTE DURING 1937-38

By Dr. W. A. HAMOR

MELLON INSTITUTE, PITTSBURGH, PENNSYLVANIA

THE scientific work of Mellon Institute during the fiscal year, March 1, 1937, to March 1, 1938, is described in the annual report of the director, Dr. E. R. Weidlein, to the board of trustees, which has just been published. During this period the institute's investigations in pure science were expanded, especially in the fields of biology and medicine, and the research programs of the industrial fellowships were also widened. Throughout the year $1,062,830 was expended by the institution in conducting pure and applied science research.

Hydroxyethylapocupreine, a contribution of the institute's department of research in pure chemistry, has aroused great interest as a possibly useful drug in the treatment of pneumonia, and hence has been given broad collaborative study by the chemical, pharmacological and medical staffs connected with the problem of pneumonia therapy. Drs. C. L. Butler and B. L. Souther and Misses Mary Hostler and Mary Clapp were active in the preparation work; and in order to facilitate further the production of the drug for more extensive clinical trial, semi-plant scale operations were undertaken by E. R. Mease. Medical work on hydroxyethylapocupreine also advanced during the year through the study of additional clinical pneumonia and pneumococcic empyema cases and through the testing of new experimental drugs prepared in the institute (Drs. W. W. G. Maclachlan, J. M. Johnston, H. H. Permar, M. M. Bracken and G. E. Crum; Professor W. T. Dawson). Supplemental clinical studies on children are being carried on by Drs. Maud Menten and R. R. Macdonald. Research on alkyl, hydroxy-