were it not now possible to settle the question by means of carbon 14 age determinations.

Ages of 11,800–14,600 ± 1400 years were obtained for the hydrocarbons extracted from several sections of the Grande Isle core of Recent sediments. A composite carbonate sample from the entire core proved to be 12,300 ± 1200 years old, and the nonextractable organic matter, which comprises a major portion of the original organic content, had an average age of 9,200 ± 1000 years. This slightly younger age can be readily explained by the somewhat larger amounts of nonextractable organic matter present in the shallower sections of the core.

For control purposes, a sample of shale was extracted, and the resulting extract was separated by chromatography, using the same technique as was applied to the Recent sediment samples. The hydrocarbons thus obtained were "dead" by carbon 14 analysis, as might be expected, giving a net count, in cpm/g carbon, of 0.03 ± 0.08. In a similar manner, samples of cetane, produced by the hydrogenation of sperm oil, were analyzed before and after going through the same sequence of analytical steps. Net counts of 3.18 ± 0.10 and 3.10 ± 0.06 were recorded, which check the value of 3.14 ± 0.07 obtained for modern wood under the same conditions. All age determinations were carried out by J. Laurence Kulp, of the Lamont Geological Observatory of Columbia University.

The data demonstrate that the analytical procedure used on the Recent sediment samples does nothing to make the hydrocarbons appear either younger or older than they should. Hence it may be concluded that diffusion did not occur to any appreciable extent, and that the isolated hydrocarbons were either deposited with, or generated in, the sediments themselves.

It is interesting to speculate as to the source of these hydrocarbons. Shimkin *et al.* (*6*) have established the presence of polynuclear aromatic compounds in extracts from barnacles. ZoBell and coworkers (*5, 7*) found paraffins and naphthenes in extracts from laboratory cultures of marine bacteria. In our laboratories, hydrocarbons have been detected in concentrations of 45–58 ppm dry weight in oysters and bluefish. Until much more work is done to clarify the picture, it seems plausible to suggest that the petroleumlike mixture being formed in the present era is a composite of the hydrocarbon remains of many forms of marine life. It is a logical extension of this hypothesis to state that crude oils of varying composition might result from changes in the relative contributions of different forms of marine life.

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Dangers Confronting American Science

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The American Association of Scientific Workers, New York

THE STATUS OF SCIENCE

The changed status of science. During the past ten years science in the United States, through a series of outstanding developments, has won for itself a public acceptance and support that it has never known before. The main achievements have been the technological ones that contributed so notably toward winning the war, as well as the sequence of revolutionary medical discoveries in the fields of antibiotics and hormones. It seems natural that enthusiastic public and governmental support of science should have arisen from results as palpable as these. Nevertheless, many scientists believe that the form this support has taken is fundamentally unsound, that a dangerous situation has developed, and that analysis and remedial measures are urgently needed. Indeed, it was fairly apparent at the outset (and was pointed out by many at the close of the war) that science was not being supported for its own sake, nor for what it *could* do, but, in far too narrow and specific a way, only for those things that it had so spectacularly *done*. The resulting cumulative damage to science has now reached conspicuous dimensions, and it is the purpose of this article to outline and examine this situation.

Classically, science has had two distinct but harmonious goals: the discovery of the secrets of nature for humanitarian purposes—that is, for improving the

[1] The present report is the work of no single author: It represents the result of extended discussion by officers and many members of the Amercan Association of Scientific Workers over the past two years. Officers for 1951–52 were T. Rosebury, president, and a panel of vice presidents: S. S. Cohen, I. Fankuchen, W. F. Hewitt, R. Hodes, K. F. Mather, W. H. Pearlman, L. Pauling, E. L. Smith, and C. J. Witton. Melba Phillips was 1951–52 secretary.

material conditions of human life—and the acquisition of knowledge for its own sake. Both aims are largely denied under the new conditions for public support.

The greatest humanitarian opportunity ever offered to science—namely, the technological development of vast backward areas of the earth—has become manifest and realizable in our epoch. This aim, although formally accepted in President Truman's Point IV program, has received only the most paltry governmental support and is largely ignored. What has displaced it? A vast program of military research, which transforms the humanitarian aim of science into its opposite.

The perversion of goals. The largest single "scientific" budget in the world today is probably that of the Atomic Energy Commission: $1,200,000,000 (estimated) for 1951. Although detailed figures are not available, it appears that relatively little of this money and effort goes into the development of atomic energy for peacetime uses, whereas the overwhelming bulk goes toward the manufacture of bombs. Over 500 million dollars per year, in addition, are poured into other types of military research. An appreciable portion of these totals (figures again unavailable) is applied to the development of mass-bombing techniques and atomic, biological, and chemical weapons that by their very nature cannot discriminate between military and civilian targets. Thus science contributes to the destruction of the very life it has prolonged and the wealth it has created.

What about those fields in which the genuinely humanitarian aims of science have gained striking benefits from the new public interest? The most conspicuous of these is medical research. Even here there is much that is wrong. A survey article in the New York *Times* of May 13, 1951, which estimates the increase in research funds since 1941 at 400 per cent, summarizes the profound misgivings of the heads of the country's leading medical research institutions regarding the trend of current medical research. The chief complaint concerns the excessively narrow conditions under which research is granted. Donors demand, without delay, further sensational successes of the kind to which the nonscientific world has become accustomed. No allowance is made for the time-consuming, broadly exploratory work that underlay the earlier successes. Again science is the victim of an oversimplified image of itself in the public mind.

Consider now the state of "pure" science—i.e., the search for knowledge for its own sake. Again one must recognize an enormous increase in financial support, particularly in physics, with emphasis on nuclear and cosmic ray studies. That the motive for this support is basically military, and that the funds come largely from the military establishment, may seem in a narrow sense unobjectionable, since there is general agreement that the supporters (in particular, the Office of Naval Research) have a sophisticated understanding of the needs of basic research. What must be questioned is the value of concentration of scientific effort in a few fields. For the sake of brevity, we risk the following categorical statement: The free play of scientific interests, by seeking out paths of least resistance, tends to maximize the return for a given amount of effort. Although there are undoubtedly more subtle factors involved, we believe few scientists would disagree with the spirit of this remark. One must conclude, then, that the military control of expenditures, simply because it is narrowly motivated, will sooner or later reduce scientific productivity by inhibiting the free play of interests.

The new cult of "bigness" also weighs heavily. The availability of large sums of money, for which a show must be made, not infrequently leads to the construction of immense machines or the development of complicated techniques. It would be unrealistic to deny the great value of some of this work. But we do question the overemphasis on, and the preoccupation with, mammoth installations and elaborate techniques as ends in themselves, which absorb the energies of many investigators, and retard or block the development of more astute approaches. Witness the duplication (past the point of diminishing returns, in the opinion of many experts) of calculating machines, synchrotrons, and cyclotrons. It is perhaps a relevant commentary on this recent trend that the greatest strides in nuclear and cosmic ray physics since the war—namely, the development of photographic plate techniques and the discovery of the pi meson—were made in European laboratories that, by current American standards, were modestly equipped.

In fields where the rate of expenditure is too great in proportion to the number of research workers available, a particularly deadly form of damage results—derangement of the educational machinery needed to bring to maturity those who are still developing their research skills. Forces directly proportional to budgetary surpluses propel the beginner into positions that are advanced only as measured by their titles and emoluments, the duties of such "advanced" positions being in reality at the technician's level. The result is to cheat many younger scientists out of the training they require and deserve, and to adulterate the quality of future generations of research workers.

At the other end of the spectrum of scientific attainment is a similar phenomenon: There is so much to be supervised that established research workers are trapped in the sterility of administrative work while they are still in the productive stages of their careers. Not only does their own research suffer, but the welfare of students who should be learning from them is sacrificed.

Those branches of pure science that lack military appeal are as badly off financially as they ever were, but now they suffer from new ills. The best scientific brains are drawn away from them by greater monetary rewards in other fields. Project heads find it expedient to alter their programs in order to make them more attractive to those who disburse the funds. Many scientists find themselves engaged in uncongenial fields, or at best in fields they would not choose if their choice were truly free.

Such is the perversion of scientific goals that has already taken place. Side by side with this perversion goes impairment of the value of science to society. As the scientists' efficiency and satisfaction are undermined, so must the structure of all science be weakened.

But the perversion of goals is not the only damage. Other equally disturbing consequences are the attack on scientific freedom and the corruption of the attitudes of scientists themselves.

The decline of scientific freedom. Freedom of thought and of communication has always been considered essential to science. Yet it is taken for granted that the scientist, as a valuable but untrustworthy piece of property, must have his speech constrained and his freedom of movement restricted. Every scientist employed by the government, whether on secret military work or not, is screened genealogically and politically. Educators in public institutions are rapidly coming under the same kind of surveillance. Although scientists are by no means the only victims of this repression, they do bear the brunt of the attack because of the tendency to see in a scientist a "potential atom spy." Students must be "cleared" to qualify for publicly supported fellowships, even in nonsecret work. This whole subject has been adequately surveyed elsewhere, notably by Walter Gellhorn in *Security, Loyalty and Science.* A brief summary of the educational aspect appeared in the New York *Times* of May 10, 1951, under the headline "College Freedoms Being Stifled by Students' Fear of Red Label." The opening sentence of this article is worth quoting: "A subtle, creeping paralysis of freedom of thought and speech is attacking college campuses in many parts of the country, limiting both students and faculty in the area traditionally reserved for the free exploration of knowledge and truth." Another report in the New York *Times* on May 25, 1952, headlined "Textbook Censors Alarm Educators," discusses with concern the increasingly widespread success of self-appointed "patriotic" groups in intimidating educators and librarians in the choice of textbooks. There has even been a "book-burning" incident in Sapulpa, Oklahoma.

Restrictions on scientific intercourse, both domestic and international, further infringe on the freedom of the scientist and limit the advance of science itself. The frank, corrective interchange of ideas, which uncovers the mistakes and misconceptions of individual or group thinking, is seriously hampered. The large amount of secret research acts as a deterrent to open and independent work in some fields, because workers fear duplication of effort and even the imposition of restrictions if they stray into sensitive areas. Some important borderline regions are thus left uncultivated. Even work within military projects suffers from the lack of communication between and among them.

Passports for American scientists are sometimes delayed, denied, or restricted. Foreign scientists have been denied entry visas, or are required to take oaths concerning their beliefs and opinions. Unwilling to subject themselves to the indignities that might result from an effort to enter this country, many of them refuse even to make the attempt (see *Newsletter* of the Federation of American Scientists, Jan. 16, 1952; *The Nation,* March 1, 1952).

A disturbing development, in this context, is the admission of Nazi scientists to this country to participate in military research projects. The most notorious example is that of Walter P. Schreiber (SCIENCE, **114**, 537 [1951]), but other Nazi medical specialists, as well as numerous rocket scientists, are known to be working in the United States.

The decay of morale. The damage that has been done to the morale of professional men is incalculable. The notion that science is primarily for war is accepted by some mature and presumably responsible scientists, who urge their colleagues to work in immediate military projects in order to justify their existence. An increasing number of younger workers have done no professional research under other than secret conditions. It is not surprising that many of them have become infected with the idea that secrecy is a natural condition of science.

These attitudes form part of a more widespread trend. The Cold War is invoked to justify an evident corruption of ethical standards. An example in the domain of medical ethics is the "Guest Editorial" in the *Journal of the American Medical Association* (November 1950) by J. Edgar Hoover, head of the Federal Bureau of Investigation. It urges physicians to report to the FBI "any information [regarding presumably subversive activities or thoughts] which might come into their possession." No exemption is proposed, by Hoover or the *Journal,* for the confidence of patients. Physicians (and psychiatrists) are apparently expected to reconcile such disclosures with the Hippocratic injunction.

In more general terms, it would seem that many members of professional groups now accept and even justify attitudes that they would have found repugnant ten years ago. The erosion of intellectual and ethical standards has already gone far. In Western Europe there has been a much greater tenacity in holding to the traditions of science than here in America. This may be attributable to the longer-established and more secure position of science there, or to the comparative absence of anti-Red hysteria, or both; but it exists in the face of a presumed threat of war much closer, physically, than ours. It demonstrates that surrender is not necessary.

WHAT NEEDS TO BE DONE

Conditions for progress in science. We believe that it is the responsibility of scientists, as citizens and as beneficiaries of the humanistic traditions of our culture, to guard and uphold the standards by which they live. We do not think it possible to maintain anything of value while yielding these standards, since they are themselves among the ultimate values. Specifically, we believe that there are certain conditions for the advancement of science that permit no compromise. Among them may be mentioned:

1. Scientific work must be in the public domain, freely published, taught, and criticized.
2. Scientists must not be hedged about with restrictions on personal freedom.
3. Science must be supported as a public responsibility for the public welfare, whether immediate or ultimate, and not for primarily military ends.

Scientists must bear some of the blame for the present-day negation of these conditions. If, in the public mind, there is a widespread tendency to identify science with destruction and atomic scientists with spies, it is in part because scientists have so largely forgotten their duty, as educators, to the public. In England, France, and Germany, there sprang up in the nineteenth century a tradition of the scientist's obligation to interpret his philosophy and his results to the nonscientific public to which, in the broadest sense, he owed his support. At the present time, Albert Einstein is an outstanding exemplar of this tradition, which was notably supported in the past by Faraday, Pasteur, Huxley, and Poincaré, among others. Most American scientists have retreated so far into the remote reaches of specialization that they have largely forgotten their obligation to the public. It is not altogether the fault of the man in the street if he is relatively unaware of the traditionally humanitarian role of science and of conditions necessary for maintaining it.

Formal scientific education in the schools has also failed in this respect. Overspecialization, preoccupation with the minutiae of separated disciplines, results in students failing to see the forest for the trees. The view tends to be lost that science as a whole is a living, growing body of knowledge, the product of men who live while they work at it, men whose sensitive responsiveness to subtle phenomena is nourished by cooperative interchange in an atmosphere of scientific freedom and can only be blunted by the imposition of officially prescribed standards.

In order to give a complete picture, however, we wish to point out recent progress in the area of scientific teaching and popularization. There has certainly been an increase in public interest in the methods and workings of science, as distinguished from its more sensational achievements. At least one magazine, *The Scientific American,* has been founded (or refounded) since the war, that reports on the current achievements of science intelligently and skillfully. The trend toward "General Education" programs in the colleges represents an effort to teach science in a meaningful and integrated way. Such things as these, apart from their more obvious aims, are great assets in the cause of the freedom of science.

The political context. If these were normal times, it would be hard to conceive of scientists accepting, without individual and collective protest, the conditions we have described. Indeed, immediately after World War II, many did band together for a brief period and succeeded in arousing effective public sentiment against the military control of atomic energy. Unfortunately, although most American scientists are probably still aware of the danger, both the effort and its effectiveness have dwindled. Acquiescence and apathy seem to prevail.

It was, of course, the Cold War that killed the movement of protest. Even if science as we have known it in the past is also a casualty, there is no lack of arguments put forth in favor of its expendability. According to the basic argument, we must choose between two alternatives: world victory by the Soviet Union, which would mean the end of democracy with all its spiritual and intellectual achievements, science included; or an all-out effort, even total war if necessary, in which no sacrifice is to be reckoned too great. It is asserted that the suspension of democratic freedoms that must accompany this effort is only a temporary one. When victory is won, everything will be virtually as it was before. Would anyone acquiesce if he did not have this hope?

Even if no one can prove the truth of its assumptions, or guarantee the fulfilment of its promises, this argument is a powerful one. Since no one can predict the future, no choice of action in the face of alternatives can be made otherwise than on the basis of belief. We do not pretend that our own views, which differ from these, are free from this unavoidable imperfection. The impossibility of arriving at ultimate truth should not, however, preclude a rational comparison and evaluation of conflicting arguments. Let us first, before proposing our own solution, consider the alternatives stated above.

Are the freedoms that have been lost already, or are now in danger, really as easily recoverable as has been assumed? There is too much at stake for this question to be treated casually. Putting aside the possibility of a sudden surrender of the Communists throughout the world, which no one any longer considers a serious possibility, only two eventualities remain: an indefinite prolongation of the present state of tension, or total war. We do not believe that scientific freedom—or any freedom, for that matter—has the ghost of a chance of surviving in either case.

Consider the dangers of a long period of tension. It is not cynical to suggest that hope must be within reach to be sustaining. Human memories are not indefinitely long, and habit is as strong as any influence in human behavior. Ideals cannot be far removed from immediacy as governors of daily life without losing their power. Even the comparatively brief detour of science into destruction during World War II (which we believe was undoubtedly necessary) may have helped pave the way for the surrender of scientific standards that took place so soon after its close.

We must again emphasize that there has been not only a suspension of the positive aims of science, but a substitution of negative ones. How long, in this atmosphere, can we educate the young and impressionable—who would have to take over this crusade if we do not win it in our own lifetime—to an appreciation of the constructive value of science, with nothing but a hypothetical future, and a past that survives only in books, to hold up as examples?

Suppose, on the other hand, that total war is the outcome. The experience of World War II and of the Korean War has shown the idea of quick and easy victory to be an illusion. With Western Europe devitalized by World War II, the vast human resources and geographical spaces of Russia and much of Asia actively against us, and the atom bomb available to both sides, civilization, and science along with it, would inevitably be the chief casualty. One cannot easily conceive of any other outcome.

If these were the only alternatives, then for one who believes Communism to be an ultimate and unmitigable evil there would be little hope indeed. But we assert the existence of another alternative, which transcends these; one which is positive, holds out immediate hope, and utilizes the strengths and not the weaknesses of the democratic philosophy. Discussion on this question has been closed prematurely. It must be revived before the degeneration of science and democratic freedom is allowed to progress any further. This is the alternative of peace.

Toward a solution. The advocacy of peace can be, with some, a matter of words. Everyone is in favor of peace. This is not enough. War can be prevented only through an active, positive policy for peace.

It is here that we can utilize the constructive values of science and the wealth we have gained from it. We are told that we must fight for freedom. Yet the problem facing the vast majority of the people of the world today is not the danger of losing political freedom, since they have not had it. The struggle in the Far East, the unrest in Africa, stem from the demand for a different kind of freedom—freedom from hunger, want, and disease. These people seek to gain the material benefits of modern scientific civilization: health, literacy, adequate food and shelter. They need help, and will accept it whenever it is offered, whether in the form of President Truman's Point IV, or (preferably) through the largely unsupported United Nations program for the development of backward countries. War would indeed thwart their hopes for a better life; they, like us, have a big stake in its prevention. But if we offer them no positive alternative, then, hardened as they are by famine and natural catastrophe, they will not be deterred from a revolutionary course by fear of war or atomic bombs.

We propose that this situation be accepted as an opportunity, not as a threat. The weakness of present national policy is vividly illustrated by the defensiveness that sees every independent movement of peoples anywhere in the world as a danger to us. With all our technological advancement, our country is today probably the most frightened and insecure in the world.

To meet this situation we do not suggest a panacea like unilateral disarmament, scientific or otherwise. We propose a change in point of view, a willingness to use diplomacy as a means to agreement and not as a weapon for the aggravation of hatreds. We shall not attempt to blueprint our policy at this point. An excellent presentation of a positive alternative to present American foreign policy is contained in the pamphlet *Steps to Peace—A Quaker View of U. S. Foreign Policy.*[2]

A scientist will hardly dismiss a problem in advance as insoluble. To solve the problem of the peaceful coexistence of disparate political systems would at any time be a worthy human endeavor. It becomes a matter of absolute necessity when war threatens complete destruction. We are frankly urging scientists to utilize their political power in this cause.

[2] Obtainable from the American Friends Service Committee, 20 S. 12th St., Philadelphia 7, Pa.

News and Notes

AAPG Los Angeles Meeting

The joint meeting of the American Association of Petroleum Geologists, the Society of Economic Paleontologists and Mineralogists, and the Society of Exploration Geophysicists at Los Angeles, March 24–27, established a new record for attendance, with a registration of 3277 geologists, geophysicists, and wives.

AAPG President Frank A. Morgan addressed the meeting on the subject of "Oil Finding," stating that "there is no force which contributes more to the science of geology and to the technology of petroleum and natural gas than the business of oil finding," and adding that, "incidentally I like the term *oil finding* better than the term *oil exploration,* as we do find oil and we are going to continue to find it. We cannot afford not to." President Morgan presented the AAPG President's Award to Raymond Siever, of the Illinois State Geological Survey, for his paper entitled "The Mississippian-Pennsylvanian Unconformity in Southern Illinois," published in the AAPG *Bulletin* for March 1951. This award is made annually to the author, under the age of 35, of an outstanding paper published in the *Bulletin.*

The Sidney Powers Memorial Award, the highest honor conferred in the field of petroleum geology, was given to K. C. Heald, Gulf Oil Corporation, in recognition of his outstanding career as an exploration geologist and leader in the petroleum industry. Dr. Heald was presented to the association by Max W. Ball, who described him as "scientist and promoter of science, executive and business administrator, leader and developer of men."

A special feature of this four-day technical session was the Symposium on Fractured Reservoirs, led by