It has been found both in Britain[46b] and the United States that after recent dosing with 'Mapharside' the excretion of arsenic in the urine is definitely increased by administration of *BAL*; after longer intervals from dosing with the arsenic compound, however, it is more difficult to pick up any extra differences due to the *BAL*, which are masked by the large daily variation in arsenic excretion usually present. This was well illustrated in the urines of the patients analysed by the Edinburgh group[45]. Enzyme experiments have shown that *BAL* will protect against the toxic effects of therapeutic arsenicals[38]. The compound of *BAL* and 'Mapharside' appears slightly more dissociable than that with lewisite and requires the presence of excess of *BAL* for its stabilization and reduction in toxicity to rats[47]. An important indication for treatment has been raised by Cameron, Burgess and Trenwith[48]. Animals with renal damage produced by injection of uranium acetate showed no difference in their response to large doses of *BAL*, whereas animals with livers damaged by carbon tetrachloride showed toxic signs. This suggests that hepatic damage is a contra-indication to the use of *BAL*.

Finally, arising out of an investigation on colour reactions, it was found that very stable and undissociable metal compounds were formed with dithiols[32,39]. This observation initiated tests of dithiols in other cases of metallic poisoning, an aspect of the work which is now being actively explored both in Britain[49] and in the United States.

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SCIENCE AND ETHICS

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THE development of methods and techniques for the release of atomic energy and the actual employment of the atomic bomb have demonstrated to the world at large, not only the immense and ever-expanding potentialities of science, but also the immediate power which lies in the hands of men of science. Hitherto the majority of those concerned with the fundamental sciences have not been directly concerned with the exercise of power but with the pursuit of knowledge. With the vast extent of their material power revealed, it now becomes both possible and imperative for them to discover the extent of their moral power and, taking their stand on ethical grounds, to indicate the full part which they are willing and able to play in human affairs and also the conditions under which they will in future agree to the conscription or hire of their minds. In order that

they may do this, two things would seem necessary. First, recognizing that their work and its needs ensure for them certain privileges and that these very privileges have hitherto compelled a certain detachment from human affairs, they must more generally accept that they have other important functions as leaders in world citizenship, functions which are to-day increased in their importance by virtue of their new achievements. Secondly, they must surely, in their local, their national and their international assemblies and in the course of their teaching, consider and affirm at the earliest possible date, and frequently thereafter, what they consider to be their particular duties and their rights.

The man of science has always been influenced by certain ethical ideals connected with the conduct of his science and his association with his fellows. Intellectual integrity and freedom, the absolute necessity for veracity and precision, the sharing of new knowledge, the obligation to publish important findings, the recognition of priority where priority is due—all these, together with his perfections of method, have made his discipline a thing apart, and the disciplines of some other professions seem poor by contrast. But he has not yet evolved a clear or comparable ethical code in respect of the relations of his science and his discoveries to the community and to the race.

We have an important precedent for the formulation and common observance of a more general ethical code by one profession. Medicine, a parent of the sciences, from the days of Hippocrates (whose famous *Oath*, together with the *Precepts*, *Decorum*, *Physician* and *Law*, defined the duties of the physician) has been constantly directed by a very binding and widely effective ethic relating not only to the conduct of its science and of its scientists and practitioners to one another, but also to the particular duties which medical men owe to man. Now it is obvious that the uses of medicine have been primarily and purposefully humane. Even so, the physician in all ages and in association with his particular powers has had plentiful opportunities for dubious or harmful actions of many kinds and for withholding or bartering useful knowledge for personal ends. It was these opportunities that made his ethical code necessary.

To-day we realize that all the other sciences are literally the physicians of man's future, that they could in time prevent or cure a thousands ills, but that they too have plentiful opportunities for harm. Is it too much to ask of the scientific fraternity in all countries that they should unite now in recognition of the absolute necessity for a declared ethical code and that they should proceed to its formulation ? A provisional charter of rights and duties, outlined and circulated, let us say, by the Council of the Royal Society in Great Britain, and modified and agreed by the academies of science of other nations, discussed in all the learned societies and with students, and finally made public, would not only be received as a historical event of unique importance, but also would go far to restore a declining faith in the intelligence and prospects of man. It might, furthermore, do much to arrest the present deterioration in international sympathies and help both to neutralize the hostile suspicions of statesmen and to retard the schemes of the now dependent general staffs. For the declaration of such an ethical policy (however difficult it might be to implement at first) could mark the beginning of a rule of reason and would, in essence, constitute a powerful plea for non-co-operation with industries and governments in all war-like and anti-social preparations and equally an insistence on their fuller co-operation in scientifically proved measures for human betterment. The engineer, the technician and the public have, perhaps, a right to look for leadership to the accepted leaders of thought in matters of such moment. Morality and social service concern us all, and, whenever possible, should be related to our more special tasks.

Let us return, for illustration, to the ethics of the physician. Medical men are ordinary men with ordinary human frailties. We know that there are occasional back-sliders among them and that, when their fault is grave, they become subject to strong disciplinary action at the hands of the profession's own tribunals. But we know also that, by and large, medical men have maintained high standards through the centuries and that their individual and corporate morality ensures for them the trust and respect of the community. They do not engage in profit from the sale of medicines ; they seek no material reward from their discoveries ; they care for the sick and wounded enemy in war-time ; they have the good of the individual, the community and the race in mind whatever their branch of the profession may be. Accepting, as they do, the principle which was condensed in the Hippocratic injunction "to help, or at least to do no harm", it is difficult to believe that any responsible group of physicians or pathologists could be found in any country to subscribe to bacterial warfare, even if they were able to discover an effective method without repercussions, and even if the strongest pressure were brought to bear upon them by a government and its military leaders.

Ethically speaking, is there anything to choose between an organized cholera epidemic and an atomic bomb ? With the Second World War behind us and a general agreement that a Third World War, employing atomic weapons, would be the end of our civilization, what case—whether ethical or practical —can the physicists put forward for any new co-operation directed specifically towards the development of these weapons ? International agreements and controls may accomplish much ; but they are not enough. The fullest possible opportunity and expression must also be given to moral decisions, and these should be based on finite knowledge as well as ideal thinking.

What has been said has reference to the present and the future. It implies no criticism of the remarkable contributions of our men of science to the victorious prosecution of the War. It may be assumed that the military decision to drop the two bombs on two densely populated cities, instead of on an unpopulated 'demonstration' area of Japanese territory, was not the choice of the men of science and may well have been opposed by them. But now that they know the potency of the new material agencies and how their discoveries may be utilized, can they do otherwise than decline to be further associated with militarist preparations ? Anxious as they must be "to help, or at least to do no harm", should not their future direction of applied atomic research be exclusively towards the development of its beneficent and productive uses ? And, is there any body of men more likely than they are to reach international agreement on a decision of this nature ?

Ethical ideals and policy should not, however, be considered only in relation to possible future wars. The scientific worker's mind may be conscripted through economic necessity or otherwise hired, not

only for secret *ad hoc* undertakings under government, but also for the ends of private profit and sometimes for purposes which he cannot, in his heart, approve. If his liberty and his right to communicate or publish are restricted by an employer, he must deny a part of his already accepted ethical code. If he is party to the production of over-costly materials which should benefit the whole community, he must deny the humanist morality now required of him.

So powerful, however, is the position of men of science to-day and so considerably has their prognostic ability increased, that they could become, in some measure, the conscience as well as the technical advisors of the State. In the face of a concerted declaration of rights, the exploitation of those younger men of science who cannot find a place in academic work and whose skills could, under just conditions, be usefully employed, would be made at once more difficult and eventually impossible.

In a more positive sense, right actions in a social regard could be more frequently sponsored by the authoritative pronouncements of important scientific groups. Social responsibility should to-day extend to the effective instruction of the community and of central, local or colonial governments whenever policies touching the public weal are in question and especially when full scientific support for a particular beneficent policy is forthcoming. Here, for example, medical science could already make a larger contribution. Nutritional physiology had for some time established the basic human requirements, and yet it took a world war to ensure for the working people of Great Britain an equitable distribution of necessary foods. We still accept in England an annual death-roll of between one and two thousand children from bovine tuberculosis and much other sickness and disability due to contaminated milk. The occasional protests and individual writings of physicians and hygienists have been educationally insufficient to counter ill-informed opinion and to secure necessary legislation for the universal pasteurization of milk for human use.

The full responsibilities of the science teacher to his students also call for thoughtful revision. The late Prof. J. S. Haldane, in his Gifford Lectures (1928), concluded an argument concerning the fundamental character of psychological or humanistic knowledge with the following sentence: "It follows that the basis of a sound education must be humanistic, and that even the teaching of abstract sciences such as mathematics or physics should, through the history of these sciences or in other ways, be connected with human interest".

Seventeen years later an alliance of science and humanism in the teaching of our schools and universities has become more than ever necessary.

Ethical ideas and practice, phenomena peculiar to human societies, will in due course be themselves subjected to more intimate and scientific study, as we have been lately reminded by Julian Huxley in his Romanes Lecture (1943), by Waddington and others. But in the meantime we have evidence on certain major issues which compels us to assume right of judgment. Moral thinking and teaching are not a prerogative of the philosopher and the theologian. Nor can they thrive in dissociation from other specific intellectual activities. Fundamental physical studies and humanistic studies can no longer proceed safely in complete separation. The Good, as well as the True, has become a necessary objective of all science.

OBITUARIES

Prof. N. I. Vavilov, For.Mem.R.S.

NEWS has recently been received of the death in the Soviet Union of Nikolai Ivanovich Vavilov. The circumstances are not precisely known, but the time was after December 1941 and the place probably Saratov.

Vavilov was born in 1885 and was the son of a textile manufacturer. His sister was a medical woman and died of typhus during the First World War. His brother is a physicist and is now president of the U.S.S.R. Academy of Sciences. He had two sons.

In 1913 and 1914 Vavilov worked with Bateson at the newly established John Innes Horticultural Institution. There he published a paper revealing one of the main lines his thought was to follow: "Immunity to Fungous Diseases as a Physiological Test in Genetics and Systematics exemplified in Cereals" (*J. Genet*, **4**, 49–65). His idea was Darwinian, but its development was genetic in the modern sense. Its novelty depended on his taking the practical problem of host and disease as seen by the pathologist, and turning it upside down.

Vavilov returned to Moscow in August 1914, not without mishap. His valuable experimental materials were lost with the S.S. *Runo*, which struck a mine on the voyage home. During the War, he began the second of the important lines of his life's work—namely, exploration for cultivated plants. He visited Persia and the surrounding countries in 1916, principally in search of the cereals, the systematic relationships of which he had already examined experimentally.

In 1917 he went as professor of agriculture, botany and genetics to Saratov. Here he wrote the paper which provides the third line in the origin of the new methods combining systematics and genetics which he was to adopt, "The Law of Homologous Series in Variation" (*J. Genet.*, **12**, 47–89). Finally, in 1921, he was picked by Lenin for a post of unexampled opportunity. He found himself, at the age of thirty-six, president of the Lenin Academy of Agricultural Sciences and director of the Institute of Applied Botany.

Inspired by his own enthusiasm, and by Lenin's determined policy, Vavilov set up more than four hundred research institutes and experimental stations in the course of a few years. Several of these had as many as two hundred research workers, and the total number of their staffs in 1934 amounted to 20,000. His journal, the *Bulletin of Applied Botany, Genetics and Plant Breeding*, with its comprehensive surveys and its numerous supplements, became a leading international organ of publication in its field.

In these days it was a remarkable sight to see Vavilov at work in what he now called the Institute of Plant Industry, the palace which he had converted to his use. Here he would be, in his shirt sleeves, sprawled over a map of the Soviet Union covering the floor of his office, busy distributing and arranging his staff and stations. No less remarkable was the experience of flying with him from one to another and watching his vigorous, confident and cheerful handling of the machinery he had created and of the people who were working it. Wherever he went he took sunshine and courage. Nicolas III (as he playfully called himself in contrast to the statue across the road) certainly got things done.

In spite of these vast administrative duties,