its attention to the controversy at about the same time, and reported in like vein. Earlier still, the giants of the biological world, men like Charles Darwin and Thomas Huxley, had expressed their concern about the possibilities of cruelty in laboratories. All this led directly to the Act of 1876, which controls painful experiments on animals in Great Britain, and was supported by most scientists. Under this Act, which has been and still is faithfully observed, all severely painful experiments are carried out while the animal is completely under the influence of an anæsthetic ; if severe and enduring pain follows on recovery, life is destroyed forthwith. What more is wanted, if we are not to abandon the most fruitful method of medical research so far devised ?

Prof. Robert B. Lawson, writing about animals in pædiatric research, says ". . . one cannot escape feeling the intense debt due the research animal. The way in which each type of investigation requires a particular animal is particularly striking. Rats play a key role in one study—mice in another—and the dog in a third. Rarely can one take the place of the other. We are indebted to all research animals for the tremendous advances in medical science that have made this generation of children healthier, bigger, and with more promise, than ever before"[7]. In a recent symposium on the design of animal houses, the chairman, Dr. Parish, said, "It is a good thing that laboratory workers themselves wish to improve the living conditions of animals and thus repay the debt . . ." Indeed, the progress that has been made in recent years in the housing, feeding, care and management of laboratory animals is quite remarkable, and owes everything to the initiative of the scientists.

It is a symptom of the times to try to make scientists the scapegoats for that which disturbs the public conscience. They are not the high priests of a secret cult, dealing in matters not to be revealed to ordinary men and women ; neither are they mental acrobats and moral imbeciles. They are as good and as bad as the rest of the community, but no more indifferent to the sufferings of others than farmers or financiers.

If this tragic misunderstanding is to be got rid of, scientists must take time off to explain the mechanics and implications of their work and show that they respect the feelings, even the misgivings, of the humanitarians ; and the public must modify its "Scientists—I'd like to drown the lot" attitude. An example of what mutual goodwill can achieve is to be seen in Vancouver, British Columbia, where, by friendly agreement on both sides, the local Society for Prevention of Cruelty to Animals supplies to the medical school unwanted, unclaimed animals, which would otherwise be destroyed. In a nine-point agreement, the conditions in which this surrender of unclaimed strays operates are laid down, and the medical faculty has been only too happy to abide by them. As a result of the agreement, the medical school gets the animals it must have, it allows the S.P.C.A. to visit its animal quarters, and indeed looks to that enlightened organization for advice and help in maintaining the best possible conditions for its animals. An atmosphere of co-operation exists which is a help, and a credit, to both sides.

It is worth examining this arrangement more closely. The animals supplied to the medical school may only be used for non-recovery experiments, that is, they are anæsthetized before use, and never recover consciousness ; and they must be used within forty-eight hours of being handed over. All long-term experiments are done on animals obtained elsewhere.

Only dogs otherwise destined to be destroyed may be handed over, and these must not include any brought by their owners specifically for destruction, nor any bearing identification marks. The animals must be kept two days beyond the legal claiming holding period before being handed over. The S.P.C.A. inspectors may witness experiments and have access without appointment to records and to animal premises. No animal handed over by the S.P.C.A. ever suffers any pain at all ; it has a painless death under anæsthesia. At the same time, the S.P.C.A. can and does satisfy itself that all the animals used are well cared for. This shows how far mutual trust and co-operation can go.

There can be no objection on humanitarian grounds to any animals, including cats and dogs, being used for non-recovery experiments. If objections are raised, they must be based either on an aversion to animal experiments on principle, whether or not they are painful ; or on a profound mistrust of the scientist. The first alternative leads one into such a philosophical morass as few if any of us could escape from. I am inclined to think that the second alternative, mistrust of the scientist, is the real obstacle to co-operation. Sentiment comes into this question, and it is no use pretending we can keep sentiment out. It should not, however, be allowed to ride us. Scientists would prefer to obtain the animals essential to their work in ways which remove the danger of their being sold a stolen pup, and to have impartial people satisfy themselves about the propriety and humaneness of their work.

I would not like to leave the impression that to get scientists and humanitarians sitting around the conference table has, for the scientist, no more interest than to obtain more cats and dogs more easily. If that were one of the results, so much the better ; but the issue is much larger.

To-day we have a duty to pursue medical research by all legitimate methods, and one of those methods is the use of animals. We also have a duty to be considerate in our dealings with animals, and the two duties are not incompatible. Can we not, like the British Columbians, explore the no-man's-land of misunderstanding and discover instead the common ground of humanity ?

1 *Observer*, May 9, 1954.
2 M.R.C. Special Report No. 61 (1921).
3 *Brit. J. Exp. Path.*, **12**, 286 (1951).
4 *The Times*, Oct. 3, 1953.
5 "UFAW Handbook on the Care and Management of Laboratory Animals", p. 2 (1947).
6 Report of the British Association for the Advancement of Science, lxii (1870), and 144 (1871).
7 *N.S.M.R. Bull.* (U.S.A.), **8**, No. 3, 4 (Jan–Feb., 1954).

OBITUARIES

Dr. Herman A. Spoehr

By the death on June 21 of Dr. Herman A. Spoehr, at the age of sixty-nine, plant physiology has lost one of its best known and most distinguished research workers and exponents.

Herman A. Spoehr was born in Chicago on June 18, 1885, and was educated at the University of Chicago, where he took his bachelor's degree in 1906. After working for a time in the laboratories of Emil Fischer in Berlin and L. Maquenne in Paris, he returned to Chicago, where he worked with the well-known sugar chemist, J. U. Nef, and where he took the degree of Ph.D. in 1909. In the following year he joined the staff of the Carnegie Institution's Desert Laboratory in Tucson, Arizona, where he remained for ten years. During this period he published a number of papers which established his reputation as an original and critical investigator. Among his more important publications of this period may be mentioned those dealing with the mechanism of photosynthesis. At that time the theory that formaldehyde was an intermediate product in photosynthesis was very largely accepted. Spoehr, on repeating under properly controlled conditions the experiments which were supposed to provide the evidence for this theory, was unable to find the slightest indication of formaldehyde production, and Spoehr's work was no doubt largely responsible for the ultimate abandonment of that theory. Perhaps the most important of Spoehr's publications during his time at Tucson was his monograph "The Carbohydrate Economy of the Cacti", published by the Carnegie Institution in 1919.

In 1920 Spoehr moved to the Carnegie Institution's Coastal Laboratory at Carmel, California, followed in 1929 by a move to Stanford University, which in that year took over the housing of the Division (now the Department) of Plant Biology which had been created in the previous year with Dr. Spoehr as its first chairman. While at Carmel, among other publications, he produced two of particular importance. One of these, jointly with J. M. McGee, was "Studies in Plant Respiration and Photosynthesis", published by the Carnegie Institution in 1923, the other his well-known book on photosynthesis published in 1926.

For a short time in 1930–31 Dr. Spoehr was director of the Natural Sciences Division of the Rockefeller Foundation in New York; but in the latter year he returned to Stanford to resume the chairmanship of the Division of Plant Biology. He retired officially in 1950 but continued thereafter to work in the laboratory that he had directed for so long.

Throughout his life in the Division of Plant Biology Dr. Spoehr's main scientific interests continued to lie in photosynthesis and related matters. Particular mention may be made of his successfully bringing to maturity albino maize plants, while in later years he was much interested in the question of applying the results of research in photosynthesis to increasing the food supply of the world. This led to the idea of the culture of algae on a large scale for the use of food, and by 1947 the possibility of cultivating *Chlorella* on a large scale for this purpose was taken seriously and a preliminary analysis of the problems involved was prepared by Spoehr and H. A. Milner and published in the Carnegie Institution Year Book for 1948. Although preliminary work on the subject at Stanford Research Institution was ended in 1950, it has been continued elsewhere, and the recent (1953) Carnegie Institution Publication on "Algal Culture", edited by J. S. Burlew, indicates in no uncertain way that further investigation on the problem is proceeding vigorously.

During the Second World War the laboratory of which Dr. Spoehr had charge concentrated on the study of antibiotics from chlorophyll-containing organisms.

As well as by his direct contributions to plant physiological research and literature, Dr. Spoehr served the cause of science in other ways. He was a member of the board of directors of the Forest Genetics Research Foundation, a member of the scientific committee of the Board of Managers of the New York Botanical Garden, a trustee of the California Section of the American Chemical Society, a member of the executive board of the Save-the-Redwoods League and for a time chairman of the editorial board of Annual Reviews, Inc. He was a member of the American Philosophical Society, the American Academy of Arts and Sciences, an honorary member of the Linnean Society of London and the Deutsche botanischen Gesellschaft of Berlin. He was awarded the honorary degree of doctor of science of the University of Chicago and he received from the same University one of its Distinguished Alumni Awards in 1943.

Dr. Spoehr is survived by his widow, a son Dr. Alexander Spoehr, the anthropologist and director of the Bernice P. Bishop Museum in Honolulu, a daughter, his mother and a brother.

In preparing this notice of Dr. Spoehr I have been greatly helped by information provided by Dr. J. H. C. Smith and Dr. C. S. French, the present director of the Department of Plant Biology of the Carnegie Institution of Washington.

WALTER STILES

Dr. A. M. Turing, O.B.E., F.R.S.

ALAN TURING was born on June 23, 1912, and was educated at Sherborne and King's College, Cambridge. He was made a Fellow of King's in 1934; he submitted his fellowship dissertation—a version of the central limit theorem for the normal distribution—four months after being placed as Wrangler in the Mathematical Tripos. During his first years of research he worked on a number of subjects, including the theory of numbers and quantum mechanics, and started to build a machine for computing the Riemann ζ-function, cutting the gears for it himself. His interest in computing led him to consider just what sort of processes could be carried out by a machine: he described a 'universal' machine, which, when supplied with suitable instructions, would imitate the behaviour of any other; he was thus able to give a precise definition of 'computable', and to show that there are mathematical problems the solutions of which are not computable in this sense. The paper which contains these results is typical of Turing's methods: starting from first principles, and using concrete illustrations, he builds up a general and abstract argument. Many years later he used an elaboration of the same ideas to prove the unsolvability of the word problem in semi-groups with cancellation.

In 1936 he went to Princeton for two years; he worked on group theory and logic, receiving his Ph.D. for a dissertation on "Ordinal Logics". In this he showed that when transfinite induction is used in logic for proofs and definitions, it is not the ordinal up to which induction runs that has significance, but rather the particular way in which that ordinal is described.

He was awarded the O.B.E. for the work he did during the War, and after it he was invited by the National Physical Laboratory to direct the design of an electronic digital computor (which he christened "The Automatic Computing Engine"). Although the theoretical aspects of its design were his chief concern, he was also keenly interested in its electronics; and while the final construction was in progress