SCIENCE

VOL. 101 FRIDAY, MARCH 9, 1945 No. 2619

Biology and Agriculture in the Postwar World: DR. ROBERT F. GRIGGS 235

Obituary:
Sumner A. Ives: DR. JOHN R. SAMPEY, JR. *Recent Deaths* 240

Scientific Events:
The Proposed Organization of Scientific Research in India; The Income of Professional Chemists; The Nutrition Foundation; St. Louis Conference on Gene Action in Micro-Organisms 240

Scientific Notes and News 242

Discussion:
Sir Isaac Newton and the Sensitive Radiometer: DR. C. G. ABBOT. *A 2,-3-Butanediol-Glycerol Fermentation:* DR. A. C. NEISH, A. C. BLACKWOOD and DR. G. A. LEDINGHAM. *Is Caste Differentiation in Ants a Function of the Rate of Egg Deposition?:* DR. STANLEY E. FLANDERS. *Staffing Science Departments after the War:* DR. HENRY E. SIGERIST. *Science Talent in American Youth:* DR. HAROLD A. EDGERTON and LIEUTENANT STEUART HENDERSON BRITT 244

Scientific Books:
The Production of Antibodies: DR. HANS NEURATH. *Mushrooms:* DR. FRED J. SEAVER. *Selected Experiments in Chemistry:* DR. HUBERT N. ALYEA 248

Reports:
The Southern Research Institute: DR. W. A. LAZIER 249

Special Articles:
Role of Fat in Incisor Depigmentation of Vitamin E-Deficient Rats: DR. HUMBERTO GRANADOS and DR. HENRIK DAM. *Urinary Excretion of Penicillin in Man after Oral Administration with Gastric Antacids:* JESSE CHARNEY, HARVEY E. ALBURN and FINN W. BERNHART. *Aerosol Application of Growth Regulators to Retard Abscission of Apple Fruits:* DR. H. B. TUKEY and DR. C. L. HAMNER. *Effect of Merthiolate (Lilly) on Certain Specific Precipitation Reactions:* DR. DAVID PRESSMAN and ALLAN L. GROSSBERG 250

Scientific Apparatus and Laboratory Methods:
A Strain Gage Recorder for Physiological Volume, Pressure and Deformation Measurements: DR. HARRY GRUNDFEST, PROFESSOR JAMES J. HAY and DR. SERGEI FEITELBERG. *A Modified Technique for Reading the Rapid Slide Agglutination of Leptospira:* HENRI P. MINETTE 255

Science News 10

SCIENCE: A Weekly Journal, since 1900 the official organ of the American Association for the Advancement of Science. Published by the American Association for the Advancement of Science every Friday at Lancaster, Pennsylvania.

Editors: JOSEPHINE OWEN CATTELL and JAQUES CATTELL.

Policy Committee: MALCOLM H. SOULE, ROGER ADAMS and WALTER R. MILES.

Advertising Manager: THEO. J. CHRISTENSEN.

Communications relative to articles offered for publication should be addressed to Editors of Science, 34 Gramercy Park, New York 3, N. Y.

Communications relative to advertising should be addressed to THEO. CHRISTENSEN, Advertising Manager, Smithsonian Institution Building, Washington 25, D. C.

Communications relative to membership in the Association and to all matters of business of the Association should be addressed to the Permanent Secretary, A.A.A.S., Smithsonian Institution Building, Washington 25, D. C.

Annual subscription, $6.00 Single copies, 15 cents

BIOLOGY AND AGRICULTURE IN THE POSTWAR WORLD[1]

By Dr. ROBERT F. GRIGGS
NATIONAL RESEARCH COUNCIL

BIOLOGISTS have not measured up either to their opportunities or to their responsibilities in contributions to the war effort. It is highly important for the public welfare and for the welfare of biologists that this situation be improved. There are many clear signs that the biological arts and sciences are going to assume a much more important role in public service than they ever have before. It is important that we biologists be able to perform this increased service that we should be rendering.

For the first time in history food is being used as an instrument in national and international policy. Food policy as it is now being formulated by the Interim Commission of Food and Agriculture set up by the Hot Springs Conference of the United Nations is the best device yet brought forward for preventing future wars.

How far the recommendations of the Interim Commission will be put into practice it is not now possible to say. But I believe it certain that some sort of food policy will be adopted by the civilized nations. Some policy will in fact have to be adopted. Food production in the United States has increased much more than in the first World War. It is up about one third over 1939. It has increased even more in Britain. There is good reason to suppose that further increases rather than recessions will occur. We shall have food surpluses—if we are to consider them surpluses—much greater than during the depression. In the face of the situation that is surely coming only two courses are possible: (1) we may either restrict production and put surplus producers on some sort of a

[1] Invitation paper before a joint session of Section G and the Botanical Society of America in Cleveland, September 13, 1944 (somewhat revised).

dole, or (2) we may dispose of the surplus at low prices. There are many millions of people who never get enough to eat who need all the food that can be produced. How can the food be got to them? To do so we need to make only one simple decision which is analogous to a decision made by our forefathers here in America.

In the old days only the well-to-do could afford an education. Our forefathers decided that it was necessary for the public good that every child go to school. If now we similarly decide that it is in the public interest that everybody have enough to eat, food will be provided for all.

As I pass to the more personal problems of our group, I point out that the servicing of any food policy whatever is going to call for great enlargements in the biological and agricultural sciences.

Now at the threshold of the postwar world, we must ask ourselves what kinds of professional services will be rendered by the group which we loosely call biologists. Clearly enough we have not done very much in the war. The most striking feature of the whole war effort from the point of view of biologists is the fact that we were not enabled to render anything like the services which were needed and which we were anxious to give toward the war effort. Why was this so?

The essence of professional service is that it should provide what clients need—not necessarily what they want. Clients are acutely conscious that they need help, but they seldom have any clear conception of what they need from any of the professions. That is one's primary reason for calling a doctor. All that is required of a patient is that awareness of need prompt him to consult a doctor. A competent physician will do the rest.

Here is the first of our problems. We must educate the public, of which the Army is part, to realize what it needs from us. The Army had need of a vast amount of service from our sciences, but it wanted very little.

That is always the way with the Army, or, for that matter, with any organization. More than a year before the "bazooka" appeared in North Africa a friend told me that his organization was developing a portable weapon carried by two men which would do the damage of a cannon which had to be mounted on an automobile truck. But, said he, "The Army will have none of it." We all know the outcome. When the Army was finally convinced and took it up they were inordinately proud of it. Perfecting the weapon required perhaps less work than "selling" it to the Army. Educating the Army to its own need is a major part of war service.

We scientists do not generally appreciate that this is a perfectly expectable characteristic of human nature. You will recall the well-known occasion when George Westinghouse tried to sell air brakes to Vanderbilt, and the railroad magnate dismissed him with the remark that he "had no time to bother with damn fools." We who number so many teachers among us ought to know that education is a slow, difficult process which requires an expert staff, a systematic curriculum and careful organization throughout.

Why should we expect it to be different with the War Department? The thing to rejoice in and marvel at is not that new weapons were invented but that O.S.R.D. had the set-up and the funds to carry its ideas clear through to the battlefield.

Many important improvements in warfare were offered by the plant and animal sciences, but our groups did not have the organization to carry through or even to get the funds necessary to carry through.

I am reliably informed that $500,000 was spent for development work on a fungus project which could have been done by mycologists for $20,000, but the government agency in charge did not know where to turn for assistance. If one were to try to allocate blame for this waste he would have to charge it not to the government, but to the patriotic mycologists who though anxious to help did not know that a professional organization was necessary to render effective assistance. If there had been a competent war committee in mycology, alert and able to give the time required to establish the necessary contacts and confidence in the competence of their "profession" the mycologists would, as they should, have made a tremendous contribution to the war and would have secured a recognition of the importance of their science, which is still a long way off.

It is interesting to observe that the plant pathologists, who deal with fungi as do the mycologists, but in a more limited way, could not handle the problem in question. They were in fact not aware of it until it was well on its way toward solution.

Yet the plant pathologists, together with the entomologists, had a very able war committee on crop protection which did one of the best war jobs in the whole field of the life sciences. Their committee, cooperating intimately with WPB, worked out a system of allocations and substitutions which provided an adequate supply of fungicides and insecticides through the period when all copper was sequestered for war uses. As an illustration of the amount of persistent education that was necessary to bring that about it is interesting to recall that on the first interview WPB replied, "Oh, yes, we recognize that you must have insecticides and we will give you all the blue vitriol you need. But of course every ounce of copper will be used in weapons"—blissfully ignorant that blue vitriol is sulphate of copper.

A good illustration of "what it takes" to serve the War Department, or for that matter any part of the

public, is furnished by the Ethnogeographic Board. That board, headed by Duncan Strong, undertook to furnish the War and Navy Departments with all available information from travelers and from the literature about the geography, the peoples and the conditions in countries of interest to the military. It proceeded both to gather together all possible resources and aggressively to contact all officers in the Armed Forces responsible for furnishing this type of information to the field commanders. It won great acceptance and high appreciation from the Services, as it deserved to do. But it required a good many thousand dollars just to make available to the Army what was more or less common knowledge to the sciences concerned.

The devotees of the biological and agricultural sciences may, I believe, usefully consider the education of the public which has been carried out by the medical profession during the last generation. When I was a boy nobody thought of calling a doctor until he was bedfast. The result was that in many cases the doctor was not called until it was too late.

By a long and carefully planned course in public education the physicians have shown us that it is thoroughly advantageous for us to seek help from them at the first sign of trouble. This has been of even greater advantage to physicians than to patients. The change in the situation of the medical profession is very great, and very important for us to consider.

First and most important is that fact that the public is being maintained in far better health than was possible under the old régime. That is to say, the foundation of all the prosperity of the medical profession lies in the fact that it is rendering better service than it ever did before. Second, under this growing appreciation of our general need of medical attention, the number of physicians has doubled and quadrupled, and their average incomes likewise have doubled and quadrupled.

Clearly the job of the biological and agricultural sciences is similarly to educate the public as to what it needs in the way of service in our fields.

What biological services, now, does the public need? Very much as the old-time doctor could not have foreseen the services which his successors would render, so we in our sciences have no very clear vision of what we ought to be doing for the public. That, I think, is our greatest weakness, and every one of us ought to set his mind to work figuring out those ways in which in his specialty he could contribute most to the public welfare.

I shall content myself with only one illustration of what I mean—drawn from my own science, ecology. The ecology—the total ecology—of pastures and ranges is a matter which has been given comparatively little attention. It has been computed that in some of the western ranges the rodents consume more forage than do the grazing livestock. The insects may take as much as the rodents and domestic animals combined.

All the complex interrelations of forage plants, rodents, insects, predatory animals and domesticated livestock in pastures and ranges call for detailed and expert attention by large groups of specialists. At present there are no such people. We have plant ecologists who will study succession of vegetation on the pasture, and we have animal ecologists who will discuss the relations of the various animals present—but we have no adequate and comprehensive knowledge of the total ecology of pastures.

Moreover, all our knowledge of pasture ecology is general or, at least, it is expressed in generalizations. What is needed is very specific service on specific ranges at specific times.

Suppose for the sake of illustrating the point that our present knowledge of pasture ecology were an adequate foundation for management of pasture lands. We would be merely in the stage of progress where research could begin to be useful. In medicine the utilization of a research begins only after its publication when it is taken up and put into practice by physicians. But in ecology we drop a subject when we have successfully completed and published the pioneer research.

We ecologists naively hope that farmers and ranchmen will apply the findings of ecological research to their own lands. But no one would expect that laymen could go far in the application of the results of medical research to their own ailments.

One can readily name half a dozen other types of practicing ecologists whose service to the public would be decidedly worthwhile. Every ocean-going fishing vessel should carry an ecologist thoroughly grounded in oceanography. As it is now, the captain has to be ecologist as well as navigator and executive. Similar specialists in game management are needed in every considerable game-producing area. Consulting specialists in the control of soil erosion are needed in many areas fully as much as physicians to maintain the very existence of man on those lands. Billions of dollars would be saved annually by the services of a competent corps of farm management specialists available to individual farmers. Our present extension system provides only a minute fraction of the services needed, that is to say, of the services which would return to the landowner substantially more than it would cost to provide them.

It is important to realize that our professions would grow and prosper irrespective of whether such services were provided on a fee basis, as are physicians and lawyers, or from public funds, as are county

agents. There are advantages and disadvantages of each type of compensation for the consultants. The relative merits of these systems do not enter into our present concern. The important consideration for us now is that the public welfare would be vastly promoted by the development of ecological services of the type mentioned.

One type of such practicing ecologist is already in existence though in a small and comparatively inadequate way—the forester advising those types of forest management that will bring the largest returns in the long run. What ecologists need to do is to take organized thought toward the development of similar avenues of service in other branches of the science.

Ecology is merely an example. Every other biological and agricultural science has similar calls for service and every one ought to have an energetic promotion committee to bring to realization its opportunities—no, rather, its duties—to serve the public.

In the biological sciences we have no considerable body of men comparable to the practitioners of law and medicine, and among practitioners I include in this sense the lawyers and physicians who are supported by public funds as well as those who set their own fees. It is we, in fact, who deserve the familiar jibe leveled at a proverbial Mexican Army. At present we are all trying to be generals!

We complain that whereas medical research is generously supported, research in the biological sciences receives only niggardly stipends. It is often said that the difference is due to the directness of application of medical research to human welfare. This can not be the real reason, for much research in the biological sciences brings as direct benefactions to its recipients as the services of a physician. Hybrid corn, enabling a man to produce 30 per cent. more with the same effort than he could with the old varieties, certainly confers as direct a benefit as the physician who by his advice might perhaps be able to keep the farmer well, actively producing and out of the poorhouse for, let us say, 30 per cent. more years than his father. But the services which plant and animal breeding can render to agriculture and through agriculture to all of us have yet to be imagined by most people.

I believe that the better support of medical research is due more to the fact that there is a large body of physicians able to understand technical researches and to interpret them to the public than to any other reason. Certainly the American people will support biological researches as soon as they are convinced of what these will do for human welfare. The best way to gain support for research in the biological sciences is to develop a large body of intelligent and influential practitioners who would demand that some one solve the problems they met in their daily service.

An unsympathetic but, I fear, discerning critic has charged that while the chemists, physicists, geologists and other scientists have gone to work in the service of mankind, the biologists are still children picking flowers and catching butterflies!

Psychology, the latest science to join the group practicing directly for the public, has achieved that degree of service only during our generation. I would call your attention to the twin facts that the public now finds very useful, psychological procedures of which it was entirely ignorant a few years ago, and that psychologists at the same time have become more numerous, better paid, more useful and, may I add, they have developed vastly greater self-respect than they had a generation ago. Moreover, the pure science of psychology has made such progress in these decades as could not have been imagined by our fathers.

The problem before us, then, is to create more jobs in the biological sciences by enlarging their services to the public welfare. This is not a thing which can be done in a day but requires continuous effort and calls for a never-ending program of public education.

Our scientific societies ought to undertake it. Consider how long the physicians have been engaged in this sort of activity, and how it continues to pay dividends both to the public in the way of longer and better living and to physicians in opportunities for more service.

The primary need of our sciences is for permanent organizations of skilled people to carry on this work of public education. I believe that biological and agricultural scientists could make no better investment than to supply the funds for such organization.

People tell me that the income of biologists is too small to permit them to assume the expense of effective organization. I reply that just because they are underpaid, biological scientists need all the more to undertake this work. It is the one thing which they can not afford to skimp.

I will admit, however, that permanent effective organizations are more than some of our scientific specialties could undertake, and the obvious answer is for related fields to combine for this purpose. We have among us illustrations of the beginnings of such combinations of societies. One is the Federation of American Societies for Experimental Biology. A second is the Inter-Association Council of Societies Concerned with Animal Disease and Production. Other areas in which combination is obviously called for are in the fields of plant disease and plant protection in which the plant pathologists and entomologists could well develop their common services to the ad-

vantages of themselves and the public. Another is the various societies concerned with the other manifold applications of ecology to the public service, which are suggested in the illustration given above.

Now, as I talk, I suspect that a large number of my audience are feeling that I am not talking about them or even that I am not talking about biology as they know it, since I have spoken only of applications. The majority of you—of biologists in general—are teachers, as I am myself. We are devotees of pure science and we commonly look down on applied science. And that is the way I also was brought up. But we are acutely conscious of the fact that there is no adequate outlet for the students we produce. This, under present circumstances, is inevitable except in special cases.

Can you imagine the majority of lawyers, physicians or engineers being teachers?

The function of the teacher in those fields is merely to train the recruits necessary to keep the professions up to strength. It is perfectly clear that the biological sciences can never grow and prosper until they develop services to the public comparable to the other professions. And when this is done the numbers who will be required for teaching will increase to proportions little dreamed of to-day. Even for the men, therefore, who love pure science and desire to devote themselves to it, opportunities will greatly increase when we develop our services to the public. Think what has happened in psychology.

The fact that so high a proportion of the devotees of the biological sciences are teachers is merely another way of saying that we have not arrived at the status of professionals.

There is no such thing as a profession of biology. Within the Division of Biology and Agriculture of the National Research Council there are, indeed, already two well-developed professions. Each has a well-marked esprit de corps. Each maintains the type of professional organization which I advocated above, and each renders valuable services directly to the public: namely, the foresters and the veterinarians.

Any thoughtful consideration in the light of fact makes it clear that there can not be any one profession of biology, that professional development in our field must come in the various segments of biology.

There is clearly room for a profession of bacteriology, of ecology, of farm management, etc.

This brings me to the question which I suspect the sponsors of this program expected me primarily to consider: namely, What can be done toward the consolidation of biology and agriculture?

All analysis makes it clear that progress must be made primarily by those different groups among us which will ultimately develop into professions. For twenty years attempts have been made to build all biologists together into some sort of a single unity. As you know very well, they have not achieved any notable degree of success despite much effort by devoted men in that cause.

The reasons for the failure are clear enough. In essence, there is not now the foundation necessary on which to build such a federation of all the biological sciences. That is not to say that there is not need for and a place for common action of all our biological groups.

I find that the National Research Council can be of use, separately, to foresters, veterinarians, agronomists, bacteriologists, soil scientists and so forth, but it has to serve these different groups alternately. Their interests, their techniques and their objectives are too diverse to permit them to work together in common assembly.

We could not set up any single War Committee in Biology and Agriculture. There was plenty of good-will and no jealousy to interfere. But every problem that came up was concrete and called for consideration by experts in one segment of our field only. For instance, dairymen could not help much with the development and allocation of insecticides any more than plant pathologists could help with strictly mycological problems or foresters with problems in nutrition or bacteriologists with the shortage of animal feed.

If I may revert to an analogy used on a previous occasion,[2] I fear that we, who have been concerned with cultivating the growing plant to which we may liken the tree of the biological sciences have made the error, commonly fallen into by inexperienced gardeners, of looking only at the top of the tree we are seeking to nurture without paying sufficient attention to the roots. In short, our biological sciences are not as yet well enough rooted in service to the public to support the type of organized federation which we would all like to see.

Any serious examination of the roots of the biological tree will, moreover, reveal, I believe, that it is not growing from one tap root but has, rather, a branching root system spreading in many directions. Our present concern should be to strengthen each of these various roots, particularly those which show signs of vigorous potentiality and those which are reaching into large areas of unoccupied ground. If this is done, and not before, I suspect the top of the tree will blossom forth in a Federation of all the Life Sciences that would be surprisingly satisfactory to those who recognize the essential unity of all living things.

[2] SCIENCE, 96: 2503, 545–551, December 18, 1942, Vol. 96, No. 2503, pp. 545–551.