nection, the possible significance of the physiological studies in the realm of photodynamics and their bearing on the nature of the chlorophyll mechanism,[19] but the opinion may be ventured that further attack, in which the water-soluble fluorescent pigments receive more extended and more critical study than they have as yet, will bring a rich victory.

Nor can one be aware of the discussions in the field of phototherapy, instancing, for example, the remarkable curative effect of light in rickets, without feeling that there exists some relation between this and the fluorescence of the blood pigment.

It may be added, also, that the taxonomist will find it to profit him to make use of the method for the finding and identification of the blue-greens. It is quite surprising with what ease one can find the organisms. For searching purposes alone, it is incomparable. Added to this is the fact that these organisms afford nuances of color which permit closely similar organisms to be separated and identified much more readily than when transmitted light alone is used. Furthermore, many of the grass-greens will be found to contain other fluorescent pigment than chlorophyll, and we are not compelled to await the outcome of the more tedious and time-consuming methods of the pure-culturist and biochemist, for the discovery of such organisms. We can now find the organisms by optical search, and, then, if it is desired, employ those methods with more direction. As I have already shown, too, there may be many organisms which do not contain fluorescent pigments, but which have not hitherto been regarded as members of the *Bacteriaceae* and perhaps which should not be so regarded, but which occupy a sort of intermediate position between these and the blue-greens. Other possibilities present themselves, but space prevents further discussion.

CITATIONS

Beck, W. A., Trans. Am. Micros. Soc., 42:108, Ap. 1923; *Boresch, K.*, Bioch. Z. 119:167, 1921; *Gaidukow, N.*, Abh. k. preuss. Akad. Wiss., 1902; *Gaidukow, N.*, Dunkelfeldbeleuchtung, Jena, 1910; *Gicklhorn, J.*, Sitzber. W. Akad. Wiss., 123: 1914; *Hagenbach*, Pogg. Ann. 1874; *Herlitzka, A.*, Koll. Z. 11:171, 1912; *Klebahn*, Jahrb. Wiss., Bot. 61:535, 1922; *Kohl, F. G.*, Ber. bot. Ges., 24:124, 1906; *Lloyd, F. E.*, Trans. R. S. C., III 17:129, 1923; *Nature*, 112:132, 1923; SCIENCE II 58:91, 229, 1923; *Locy, W. A.*, Trans. Am. Micros. Soc., 42:95; Ap. 1923; *Lommel, E.*, Pogg. Ann., 143:483, 1871; *Reinke, J.*, Ber. bot. Ges., 1:395, 1883; *Siedentopf and Szigmondy*, Drude's Ann. d. Physic. (4), 10:1–39, 1903; *Siedentopf, H.*, Z. f. Mikros., 24:382, 1907; *Simmler*, Pogg. Ann., 115:599, 1862; *Stern, K.*, Z. f. Bot., 13:193, 1921; *Teodoresco*, Rev. gen. bot., 32:145, 1920; *Timiriazeff, C.*, Proc. R. S. Lond., 72:424, 1904; *Tswett, M.*, Z. physical Chem., 36:450, 1901.

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[19] Discussions occur in Gicklhorn's 1914 paper and in Grafe's recent book, Chemie der Pflanzenzelle.

THE ECONOMIC VALUE OF GOVERNMENTAL SCIENTIFIC WORK[1]

THE subject that I have been asked to speak on is an interesting one to other persons than those who devote their lives to science. The economic value of the scientific work of the government is to some extent appreciated by the people of the country; I think, exactly to the extent that they come into contact with it and know about it. Perhaps, however, they do not realize that it is scientific work. There are various organizations of the government that perform services for the people, which services are based on scientific research—sometimes on very definite and exact knowledge, sometimes only on whatever state of knowledge has been reached after research has been pursued as far as it has gone, up to the present time. The people know the service they are getting. The western farmer knows something about the Bureau of Animal Industry that cures hog cholera, but it seems to me that the farmer does not think of it as scientific work; he thinks of it as a very valuable service which means dollars and cents to him. The southern cotton planter knows of the Bureau of Plant Industry and its progress in ridding him of the thing that threatens his welfare—the boll weevil. He may know that it is the result of scientific investigation, but he is more likely to think of it as a certain service that he needs on his plantation. Every shipper of meat in summer wants to know whether there is a hot wave coming that will require him to put more ice in his refrigerating cars. He depends on the Weather Bureau to give him that information. This is a service that is performed by the Weather Bureau and received by the people who hardly think of it as scientific work at all. Everybody knows that there is scientific work and that the government does it, but it is the idea of service that is most prominent in the minds of the people that receive it. The warnings that keep vessels in harbor when dangerous storms are coming are given out by the same bureau; warnings of frost that make fruit growers get their petroleum heaters out into the orchards. I shall not undertake to go through the various services performed by the Department of Agriculture, and I could not at all give a complete list of the services performed by the Bureau of Standards; I speak of certain things that are generally known. The farmers know certain scientific work of the Department of Agriculture and the manufacturers

[1] Address made at the dinner of the American Geophysical Union at its annual meeting.

know of certain of the services rendered by the Bureau of Standards. I wish everybody knew more, and I think one reason why everybody does not know more of the value of scientific work—well, perhaps it is because some of the scientists do not express themselves so that an ordinary man can understand them.

I have read, or attempted to read, scientific articles that I have no doubt were thoroughly intelligible to other scientists engaged in the same specialty (at least, I hope so) but not intelligible to an outsider who has only an interest in science as one of the fields in which the human intellect is at work. It is 300 years since Francis Bacon said with, I suppose, the egotism of youth, "I have chosen all learning to be my province." No man can do that now. But, after all, the all-round man is a fairly good sort of man to do the work of the world even in our own generation. No man can be a specialist in everything, but the man that does not know anything outside of his own specialty lives a very limited existence. He narrows himself and his own usefulness. General information is desirable, even though it falls short of the exact knowledge of the specialist.

If you want larger appropriations from Congress, tell us what you are doing in a way that will enable us to understand it. I think I speak for a good many members of Congress when I say that there is not only a willingness, but a desire, to go just as far along that line as public sentiment will permit. You can not appropriate all the money that is asked for all the purposes for which it is asked in these days. A study of appropriations has been made, and made very carefully, by Dr. Rosa, who guarded his statement so that it ought not to have been misunderstood, but yet it has been misunderstood and misused. When he went through the appropriations made by Congress from the United States Treasury for a period of years he estimated that in 1920 about 92 per cent. of the appropriations were for present or past wars. In that, of course, he included all payments of interest on the national debt, all pensions and compensations, all provisions for the World War veterans through the Veterans' Bureau as well as all appropriations for the War Department and the Navy Department except the non-military work, particularly the non-military work of the War Department in rivers and harbors. I think this percentage was 92½; about 6½ for general government purposes, leaving 1 per cent. for scientific work and education. This 1 per cent. was about $57,000,000 that year, out of a total of five billion six hundred and some million dollars.

Well, what was the United States Government organized for? To provide for the national defense especially, and, in things not reserved to the states, to promote the general welfare. The 13 states could take care of themselves pretty well except in the matter of national defense, and the principal thing that the United States Government was organized for was to defend the states against foreign enemies. Education was not thought of as a national activity, nor was the development of scientific knowledge.

Nevertheless, in that year in which $57,000,000 were appropriated by the government for all these services based upon science, and for education, the states and municipalities appropriated $1,039,000,000 for education. So it is not exactly fair to say that the representatives of the people of the United States spend 92 per cent. of the revenues raised by taxation for war, past and present and future, and 1 per cent. for scientific research and education. Nevertheless, while the duty of education, and even the promotion of scientific research, is not one of the chief purposes of the United States Government, it is one of the things that we can do and are permitted to do. The Constitution provides that Congress may levy taxes for three purposes only. Congress has power to levy taxes to pay the debts, to provide for the national defense, and to provide for the general welfare of the United States. The general welfare clause has been overworked. There are no restrictions on the right of Congress to pay the debts, but there are restrictions on the right to appropriate money to provide for the national defense. We can appropriate for the Navy for as far into the future as policy may seem to require, but for the army for only two years at a time. As a matter of fact, it is ordinarily for only one year. Appropriations for the general welfare also are restricted to certain matters enumerated in the Constitution. I confess I do not know exactly where to find the enumeration that covers scientific research, but the interpretation of the general welfare clause has been greatly extended in recent years. We do appropriate some money for scientific purposes and I hope we will appropriate more for these purposes in time to come; not only scientific work that results immediately in services of which I have given examples in some of the branches of the Government, but scientific work that seems now to have little prospect of economic value; pure research work. I think we ought to see far enough into the future to know that any such work will probably have an economic value in time to come. It is not very many years ago that we heard of the discovery by a German physicist of peculiar stresses in the ether to which the name Hertzian waves was given. Nobody thought then that this discovery would be of great economic value in the future, but now in almost every home that can afford it there is a radio receiving set catching messages which come by these same stresses. It never pays to lose a chance to learn anything that can be learned about the physical universe. It will have a

value when we have learned other things that fit with it and make it complete.

Now, as I said a little while ago, I wish every man engaged in scientific work could tell the story of what he is doing in such a way as to show to ordinarily intelligent men its possible relation to other things than his own immediate specialty, and its possible useful application, and I feel sure that we could get a backing in public sentiment which would show itself in the action of Congress by an increase of appropriations for that kind of work, to the very great advantage of our civilization. It is not the easiest thing in the world to convey a new idea to any mind. I suppose it is true, really, that no man can take in an absolutely new idea. The psychologists tell us of apperception, the coalescence of a new idea with the old state of mind which receives it—the assimilation of a new idea by the group of ideas already in possession. A place must be found in the framework of one's thinking where the new knowledge will fit, or perhaps the new knowledge must be distorted and considerably modified before it can possibly be taken in. I recall the story of a negro boy in Africa who became, I think, a clergyman afterward in his native country. In his stripling days he had been one of the bearers in the caravan of David Livingstone. Livingstone was a man who sat with his servants around the camp fire and talked with them not merely of religion, though he was a missionary, but of anything that would interest them and furnish common ground between his mind and theirs. This negro boy had learned to have great respect for and confidence in the white man, but, as he told the story years afterward, his confidence was seriously shaken when Mr. Livingstone tried to get him and the other black men around the camp fire to believe that in England they had tea kettles that could pull wagons. It was not until many years afterward, while himself riding in a railway car, that he suddenly recalled with amusement the result of his attempt to find a place for the locomotive in the group of ideas already in his mind. Perhaps you may find men in Congress, and elsewhere as well, who can come no closer to what you are trying to tell them about your specialty than that negro boy did to the unfamiliar truth that Livingstone was trying to convey to him. But try it; it can be done; it has been done.

I think I may be pardoned if I say that I have a sixteen year old boy who, about two years ago, came across a scientific book that aroused his interest, and I think that book is going to influence his choice of a profession in life. A few years before some one had given him a toy set known as a chemo-craft set. It contained a few chemicals and a little pamphlet describing some experiments that were spectacular and would attract the attention of a boy. His interest, aroused in that way, continued. About two years ago he saw on my desk a book called "Creative Chemistry" which he could read and understand. Science needs a press agent, and in Washington you have him. I believe that boy is going to be influenced all his life and his tastes will be developed along the lines of the book written by Dr. Slosson.

That is an example of what I have been trying to say. It is necessary to make your work understandable to the man who is not a specialist in your line, but who has some intelligence. You can not express everything with perfect accuracy without using technical language, but most men can not carry away a thoroughly accurate impression even if a matter is minutely and accurately explained; so sometimes a teacher has to content himself with giving an approximate idea of the truth. Let us speak the English of the streets, and give the ordinary man a chance to understand what we are doing.

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SCIENTIFIC EVENTS

BRITISH EXPEDITION TO EAST AFRICA

ACCORDING to an article in *London Times* during the years that part of East Africa was under the jurisdiction of the Germans a large number of specimens of a gigantic dinosaur were raised and transported to Berlin. For the past four or five years the trustees of the British Museum have had under consideration the proposal to send a small expedition to East Africa, with the view of exploring the fossil remains that occur there, especially these large dinosaurs, as it would be of the greatest interest to correlate them with similar remains which have been known for many years from the Jurassic rocks of Wyoming.

Sufficient funds have now been got together to enable a start to be made, and early last autumn the trustees secured the services of Mr. W. E. Cutler, of the University of Manitoba, to lead the expedition. He sailed from Marseilles on February 28.

Mr. Cutler has for many years had an unrivaled experience of collecting for the British Museum and other museums large dinosaurian and similar fossils in North America, and is therefore conversant with the methods of extracting the specimens from the matrix and packing them in such a way as to withstand the strains and stresses of the journey to the museum.

Since it was desirable that Mr. Cutler should have in the party at least one white assistant, the trustees arranged for Mr. L. S. B. Leakey, of St. John's College, Cambridge, to accompany him. He was born in Kenya Colony, and his home is still there, his father being a clergyman near Nairobi. His knowledge of