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NAVAL RESEARCH[1]

WHEN the war ended ten years ago there was a universal feeling throughout the civilized world that there must not be another war. I am sure that such feeling still persists among intelligent, thinking people. There is, though, a group who think that the way to prevent future wars is for our country to set an example to the world by disarming, and who, I believe, would desire to have each individual in the country sign a pledge not to take part in a future war. This group is, in the main, made up of patriotic citizens who are actuated by an honest desire to have affairs between nations settled without resorting to war. They have not, however, in my opinion, sufficiently studied history, nor have they properly taken into account human nature and national hysteria.

There is another group who just as earnestly desire peace, but who believe that the best guarantee for peace is an efficient, prepared navy for enforcing national policies and protecting national ideals.

Our navy plays the same part in international affairs, in being the force behind our international policies and our interpretations of international law, as do the national enforcement agencies and local police in making effective national and local laws.

We have gradually adopted or developed certain policies which we believe express our American ideals. Among others, these include the Monroe Doctrine, the open door to the world's markets, the freedom of the sea and the freedom of the Panama Canal. The Monroe Doctrine has been considered so vital for the peace and security of this country that we have always refused to consider it a subject of arbitration in any international court. President Roosevelt stated a fact in saying, "The Monroe Doctrine is as strong as the United States Navy, and no stronger."

The causes of war are many; among others may be mentioned the pressure of increasing populations and national desires for obtaining greater resources as represented by natural or artificial wealth. Any steps the pacifists can take which will tend to harness the above forces will be welcomed by every one; but, as long as these forces remain uncontrolled, the possibility of war must be recognized. It is easy to scrap navies and disband armies, but it is not so easy to control the causes of war.

[1] Read before Section M, American Association for the Advancement of Science, New York, December, 1928.

We have a rich, prosperous nation; we are dedicated to liberty for the individual; we believe in the square deal, and it is necessary for us to guard our heritages and to be prepared to defend them if required. There is much confusion of thought at present on the subject of world peace and a means to obtain it, and some feeling that our presentation of the Kellogg Treaty for abolishment of war is inconsistent with our efforts to strengthen our navy up to a parity with that of any other nation. As a matter of fact, these two steps are both designed to insure world peace, and they complement each other. Let us, then, see our navy first as an agent to prevent war, and second as our first line of defense in case war becomes an actuality.

I have presented this preamble to give the background and lead up to the part the scientist must play. Our navy, in order to carry out its mission, must be efficient and modern. It is my desire to present to the scientists of this country the part they must of necessity play, in providing the country with the best first line of defense obtainable, and in helping to guard our national heritages.

Though the desire of the naval officer and the entire navy is strong for peace, the navy must leave no stone unturned in its plans for effective preparedness. The people of the country decide when a war is to be, and the navy must be prepared whenever that decision is made.

There is a romantic spirit in all men, and it is particularly developed in the research worker. Down through the ages the romance of the sea and the navy has appealed to the adventurous spirit of man, and the navy can well profit by fostering comradeship with the inquisitive civilian.

There are problems to be solved and new devices and methods to be perfected whose major purpose is the improvement of the fleet's effectiveness in war. There are other researches and developments which will incidentally increase the effectiveness of wartime efforts but which also will have far-reaching effects in advancing peace-time civilization.

No matter how diligent we may be in peace time in perfecting methods, means and apparatus to serve most effectively in war, an actual war will present new situations and new problems. To meet such problems and situations, we require all sorts of specialists, each supreme in his own field, all of them navy-wise as to conditions to be met, and all trained in coordination, to realize the common goal.

We learned during the World War that the scientist and the research man had to be utilized to the utmost. The type of mine used in the North Sea barrage, the use of gas, the development of listening and other submarine detection devices, new means of communication and sound ranging, to mention only a few of the important developments, were all brought out under the competitive stress of conflict. All of these developments would have been more effective if they had been available and we had been prepared to use them immediately on our entry into the war.

The directive coordination of naval research should be conducted both in peace and in war by the professional naval officer. This involves no particular difficulty, provided the research workers and the naval officer have learned to speak each other's language and have a general understanding of each other's technique. This mutual understanding and appreciation must be developed by personal contacts and by working together on common problems. It takes time to develop the cooperative and coordinated spirit between these two groups, and it should be accomplished during peace time.

In addition to developing an organization of research workers, trained to think in naval terms and to work with naval officers, who will be available to solve such problems as may arise during a war, it is desirable that men in the university and industrial laboratories be utilized to help solve naval problems now, in peace time.

In fact, the best way to develop nuclei of naval-minded research men is assigning, to groups or individuals, certain problems in which the navy is interested and establishing working arrangements between the civilian and the naval officer.

Certain desirable naval developments have direct application to the merchant marine and other outside activities. The navy has, in the past, led in many developments which have had wide usage, and the navy should continue a progressive policy of developing new methods and apparatus which may have general use, as well as serve special naval purposes. To enumerate but a few: there are new and more economical methods of propulsion to be developed for all classes of craft; there are innumerable problems to be solved in aviation; there are means to be developed for safe navigation in foggy weather, both at sea and in the air; there are many new metal alloys to be discovered, especially non-corrosive alloys to meet naval conditions, and there are many improvements to be made in communications.

Now, if we will accept the desirability of bringing the civilian research man into contact with the navy, we can investigate the best means of providing a skeleton organization for peace-time use with the idea of expanding it to meet war demands.

We might well start by listing the various special branches of science which might be involved in our problems. This will be a fairly large list, for we will find after a little reflection that nearly every scientific

specialty bears some relationship to the navy's varied problems. Then it is suggested that the National Research Council be requested to help select three or four representative men in each specialty who can be appointed with appropriate rank in a naval research reserve. It is proposed to have these reserve officers become acquainted with the navy by inviting them to make short cruises with various units of the fleet. It might also be found desirable to call some of them, at times, to active duty at the Naval Research Laboratory at Bellevue.

It would probably work out that in certain localities there would be a number of research reserve officers who could be brought together as a local body with contact with some local naval activity and that special naval problems could be assigned to such a local group.

The central office of the research organization in the department should maintain contacts with the local groups or individuals, and encourage reports covering scientific developments that might be of interest in any way to the navy. The classifying, correlating and applying of the information received would require considerable talent in the central office, but the results would well justify all the efforts expended.

We have been discussing a senior class of research men, but assistants will also be required who might well be inducted into this reserve during their post-graduate period, and as they become more experienced in their later civilian work be advanced to the senior class.

It is believed that the navy would materially benefit by establishing a certain number of navy research fellowships at representative technical schools. It would be proposed to have the research students holding these fellowships carry out their researches on problems assigned by the navy. It would be desirable to establish these naval fellowships at universities where senior research reserve officers are attached. The student research man would then be able to carry out his assigned work under the guidance and direction of one or more experienced research men who would also be directly interested in the naval problem. The navy would thus obtain important data and information, and at the same time would be providing for the training of research men and providing these men with some idea of navy atmosphere. These research students, after completing their fellowship and obtaining their doctor's degree, would be commissioned in the research reserve.

Individual naval officers, or a naval activity, could profitably be assigned to keep in touch with each university or school where one or more fellowships were maintained so as to afford direct personal naval contact with the work undertaken.

It is possible that the navy might find it desirable to assign, at times, naval officers to university laboratories to work, either independently or in conjunction with members of a research reserve, on special problems. All the large industrial companies have learned by experience that every cent they have spent on research has been returned to them many times over in improvement to their product. It is certain that every cent the navy may spend in fostering this proposed naval research reserve will be the most profitable expenditure made in its efforts to be ready for emergencies.

I am presenting this as an individual naval officer's views. The subject seems to me to be of great importance, and I feel that some such plan as outlined should be actively developed at once. This will require the active support of scientific societies and organizations, as well as that of naval officers.

C. S. McDOWELL

U. S. NAVY

SOME NEW FUNDAMENTALS IN PLANT BIOLOGY, AGRICULTURE AND THE FOOD PROBLEM

THE discovery that plants obey a logarithmic law of increase under the action of growth factors was announced by Eilhard Alfred Mitscherlich (Koenigsberg) in 1909. During the twenty years that have now intervened numerous investigators have tested this law both by laboratory experiments and by extensive field experiment and observation in various quarters of the globe. The earlier doubts and criticisms have been swept aside by an immense mass and variety of confirmatory data, and although the voice of skepticism has not been wholly silenced, it may be stated that the opposition has become practically negligible.[1]

It is not too much to characterize the work of Mitscherlich as by far the most important contribution that has been made to agricultural science since Liebig discovered the rôle played by mineral plant

[1] The historical development of the Mitscherlich laws of plant growth is traced mainly in the files of the *Landwirtschaftliche-Jahrbuecher*, the *Landwirtschaftliche-Versuchsstationen* and the *Zeitschrift fuer Pflanzenernaehrung und Duengung*. Readers desiring a condensed view of these laws and their experimental foundations may consult Mitscherlich's "Die Bestimmung des Duengerbedurfnisses des Bodens" (Paul Parey, Berlin). The same logarthmic law of growth was independently discovered by Spillman several years after Mitscherlich. Spillman's book "The Law of Diminishing Returns" (World Book Co., Yonkers, N. Y.) also contains a fair—although now somewhat obsolete—summary of the earlier stages of the development of these laws and the controversies they aroused. A short monograph dealing with the present-day scientific, social and economic implications of Mitscherlich's epochal discovery is in preparation by the writer.