SCIENCE

VOL. 88 FRIDAY, JULY 8, 1938 No. 2271

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal
Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

THE CHEMIST AS DEFENDER OF HIS FATHERLAND[1]

By Professor MARSTON TAYLOR BOGERT

COLUMBIA UNIVERSITY

AT the beginning of man's history upon this planet, the struggle against his environmental enemies did not differ radically from that of other mammalia of that era, nor had he much more control over the forces of his universe. As a reasoning creature, however, he soon learned from experience, and this fund of experience, passed on from generation to generation and steadily augmented, has given him an ever-increasing knowledge of the laws which govern our little world and how they can be made to execute his will.

As science advances, warfare changes. Methods of fighting inconceivable to our ancestors occupy the center of the stage to-day, and future wars will see still other methods employed of which we do not as yet even dream. One by one, man's fighting weapons have been rendered obsolete by the appearance of new and more potent ones, or ineffective through the development of an adequate defense. The bow and arrow displaced the war club and grew into the cross-bow; but the archers were put out of business by the introduction of body armor, which lost its value in turn through the discovery of gunpowder and firearms. The contest between artillery and above-ground fortifications was decided definitely in favor of the former in the early days of the world war, and men sought refuge in trenches and dugouts, there to be asphyxiated by the toxic gases later employed, until protection was supplied by gas masks and dugout blankets. In the year 1862, in my own country, the navy boasted of its wooden fighting ships. No one dreamed of ironclads; but in that same year the *Merrimac* destroyed the Union Fleet in Hampton Roads, and wooden war vessels gave place to the steel battleship, which has itself become the prey of the submarine and of the airplane. The operation of both land and sea forces is now subject to domination by the military forces in the air, whether the planes are discharging huge aerial tor-

[1] Translation of an address in Italian, delivered on May 20, 1938, before the Tenth International Congress of Chemistry, Rome, Italy, by the Chairman of the Section on Chemistry and Defense.

pedoes, toxic gases and incendiary bombs, or only smoke screens.

The outstanding developments of the world war and since have been the military airplane, the submarine, the combat tank and chemical warfare.

What the future holds, no one can predict. Although in some of the major bombardments towards the close of the world war, 80 per cent. of all the shells thrown over by the Central Powers contained toxic chemicals, so-called chemical warfare is still in its infancy. The discovery by any nation of some new and deadly gas which would penetrate the masks of all other nations, but not their own, would give the discoverers an enormous advantage, at least initially, or until efficient protection could be provided. Naturally, the distribution of such material is not limited to its use in artillery shells, since it may be conveyed to the enemy in any kind of container from aerial torpedo down to the trench cylinders which release it for a drift gas or toxic smoke attack. Further, it may be employed in naval or air engagements, as well as on land, and by airplane deposited in any part of an enemy's country.

The only new casualty producers introduced into warfare in the last six hundred years have been the explosives and toxics of the chemist, and to-day the greatest possibilities for other revolutionary discoveries still appear to be in the field of chemistry.

Colonel Prentiss, author of "Chemicals in War," is of the opinion that, "While chemical combat immensely complicates modern war, it is susceptible to complete an adequate defense, and protection against it is essentially a matter of scientific skill. The chemical war of the future will, therefore, be primarily a contest between the scientific abilities of the combatants, *i.e.*, a contest of brains not brawn. This simple fact alone holds out the greatest hope for the future of civilization, for the destiny of man is safest in the hands of the most intelligent."

If we can judge by published reports, toxic chemicals have been used but little, if at all, in the wars in Spain and China. The airplane has been a much more potent weapon. In fact, the airplane is to-day not only one of the most effective arms of the military service, but also the greatest menace to civilian populations and non-combatants. Defense against such attacks is therefore of prime importance. But the possible use at any time of toxic chemicals should not be overlooked, nor should vigilance be relaxed, to assure complete protection against this type of warfare also. To do otherwise would be suicidal.

It seems scarcely likely that disease germs will be used to any extent in war, because of the impossibility of controlling the spread of pestilence or of restricting it to an enemy country. It should not be forgotten that in the year 1347 the Black Death was brought from the Crimea to Genoa by an Italian advocate, Gabriel de Mussis by name, and within the short space of twenty-four months, twenty-five million people had fallen victims to that dread plague. Those who would start a yellow fever epidemic in tropical countries by the introduction of the Stegomyia mosquitoes will do well to keep this in mind.

The use of insect pests in war is also improbable, for similar reasons. For, while it is true that such pests immobilize a certain number of men who might otherwise be at the front, their invasion of other countries can not be prevented.

The chemist's answer to all this is that eternal vigilance is the price of safety. This means not only military preparedness, but still more it demands scientific preparedness, for the wars of the future are going to be decided more and more in the laboratories and research institutions of science, and less and less merely by the movement of armies or fleets. The military argument based primarily upon numerical, or even tactical, superiority of armies and fleets, is valid only when the opposing forces are similarly equipped with both offensive and defensive weapons, an assumption which may be at wide variance with the facts. Against an enemy adequately provided with air and chemical warfare services, what chance would an army stand if not similarly equipped? Ethiopia and China can answer that question for you.

Leadership in science is the only dependable safeguard. The time has already gone by when research in science was merely the price of progress. It is now, and has been for some time, the price of both industrial and national existence.

The nation which disregards and neglects this, no matter how extensive and varied its natural resources, or how great its population, is certainly headed for early decline and ultimate subjugation by more scientific and therefore more progressive and more powerful nations. Could there be a better illustration of this than China, asleep for centuries, and now too late awakening to find herself hopelessly outclassed, by a nation whose land area and population are but a fraction of her own, but whose people sooner recognized clearly the significance of science and have devoted themselves to its development with such energy and ability that their leading investigators are well known by scientists in all lands. Of how much defensive value to-day is the Great Wall of China?

David used his head as well as his sling against Goliath. In the Second Punic War, Hannibal's elephants struck terror to all hearts until some Italian with a head suggested the use of arrows carrying tips of flaming tar, with the result that a wild stampede of elephants ensued. In the struggle of brain versus brawn, or science versus ignorance, the final result is

never long in doubt. Napoleon Bonaparte is credited with having said: "There are but two great forces in the world, the sword and the brain and, in the long run, the sword is always beaten by the brain."

Inferiority in population and in endowment of natural resources may be more than counterbalanced by progress in science and in industrial organization and efficiency. As man's scientific knowledge grows, his power becomes less and less dependent upon mere number of population or upon a complete supply of natural resources. In the present troubled condition of the world, that chemist serves his country best who helps it most to self-sufficiency. For "Self-dependent power can time defy, as rocks resist the billows and the sky."

The role of the chemist in the battle to overcome the lack of important raw materials, food, textile fibers, fuels and essential chemicals, has been pointed out repeatedly, with characteristic clarity and power, by Italy's great chemical leader, the distinguished president of this congress and of the International Union, Exc. Prof. Dr. Nicola Parravano.

In the defense of a nation, it is of the utmost importance that every man should be placed where he can render the maximum service. Trained chemists, therefore, should not be permitted to go to the front, if they are more urgently needed behind the lines. It is also imperative that they should be in constant and close contact with other defense forces, whether those forces be military, medical or industrial.

Man's mastery over the physical forces which rule his universe is increasing and expanding so rapidly in all directions that it is entirely appropriate to ask if we are breeding humans who can be safely entrusted with these vast powers.

Daily it becomes more apparent that there are but two paths open to the dwellers upon this planet, depending upon the use they make of this accumulated knowledge. One leads to inevitable ultimate extinction of the race by misuse of these powers. In fact, the opinion has been expressed also by others that science, unless directed into proper channels, may bring about its own obliteration. The other path leads to the development of a race of supermen, superior physically and mentally to any the world has yet seen, and to such a development the biochemist will be an outstanding contributor.

The future of a country and its defense depend not alone upon its birthrate, but also upon the kind of stock it is breeding. It should be a matter of grave concern, therefore, to every nation to make sure that the salaries and living conditions of its intellectuals—its professors and scientific investigators, for example—are not such as to render it difficult or impossible for them to afford the luxury of having children. The real test of a successful life is not how large an estate is amassed, nor how many decorations and other distinctions are won, but how many useful children and grandchildren are left behind you, and how much you did during your lifetime to help protect, teach and train the children of others. It is the human problem which is paramount. The most important crop still remains men and women. We have been so absorbed in making more and better automobiles, airplanes and the host of things which minister to our prosperity or pleasure that we have overlooked completely the far greater need for more and better humans. Things and knowledge are much less important than the nature of the individuals who are to use them, and it is far less difficult to protect ourselves against things than against thoughts.

It is entirely praiseworthy to seek for "the more abundant life," but it does not appear to be understood, except by those well versed in history, that no people can achieve and retain greatness unless they worship sacrifice rather than ease, and crave service rather than support in idleness. As Roger W. Babson so clearly puts it, "progress comes only through truth, security comes only through courage, and freedom comes only through sacrifice."

Scientists are potent factors in maintaining the integrity and progress of a nation, and within that group none have more important roles to play than the chemists. But the chemist must not forget that, in addition to his strictly professional duties, there are other obligations which devolve upon him as a citizen, and to which he can not be recreant. He is a truly great defender of his fatherland who, as expert chemist and loyal citizen, gives to her the best that is in him, in times of peace as well as in war.

RECENT CONTRIBUTIONS TO THE THEORY OF PROTOPLASMIC STRUCTURE[1]

By Professor WILLIAM SEIFRIZ
UNIVERSITY OF PENNSYLVANIA

AN invitation from Sigma Xi is particularly welcome to a worker on protoplasm, for there is no field of research which so perfectly illustrates the need of cooperation as that on which I am to speak this evening.

Theories of protoplasmic structure fall into three categories—solution, emulsion and gel.

Such a grouping is a modern one, but it includes

[1] Lecture delivered on February 28, 1938, at a general meeting of Sigma Xi at Rutgers University.