universal reply, which is a certain proof of victory for our ideal.

Amongst the scientific events of the year, prominent mention is due to the unveiling of the monument of our colleague Marey, one of those men to whom modern physiology owes so much. As M. Richet has said ("Inauguration du monument élevé à la memoire de Etienne Jules Marey, au Parc des Princes, à Boulogne-sur-Seine, le mercredi 3 Juin, 1914"; Paris: Gauthier-Villars), he is one of those who leave a work so firm, so fruitful, so perfect that every year adds to its renown. In fact, time takes no toll on a well-founded scientific work. The pages of Descartes on "la Géométrie analytique," of Harvey on "the contractions of the heart," of Lavoisier on "les combustions respiratoires," remain intact and intangible, like the Greek marble statues, the beauty of which remains unchanged after a lapse of twenty centuries. The idea conceived by Marey in his youth and realised by him in his work was the creation of methods permitting the direct and precise inscription of motion, either by graphical records, or by photographs taken at intervals so short as to appear continuous. A running man, a galloping horse, a flying bird, a beating heart, execute movements only a confused average of which can be seized by the eye. The photographs of Marey give an exact analysis of them; it is only necessary to realise the synthesis of the successive images by the aid of a method employed a long time ago in certain toys to obtain a kinematograph. This apparatus, possessing innumerable scientific applications, has then its origin in the work of Marey.

It presents the great philosophic interest of giving control of the time, which, until then, had been the one independent variable. Once a phenomenon is recorded it can be repeated in its successive phases, accelerating or retarding at will. Thus deceleration permits the study at leisure of the beats of the heart, the movements of a bird's wings, and acceleration shows in a few minutes the germination of a plant or the hatching of an egg. It is even possible to change the sign of the variable and reverse the order of events. Marey then was an inventor of genius, a man who extracted something from nothing; the improvement of a discovery is a small matter, the essential point is to make it.

This year French physicists have been actively occupied with the construction of a huge electromagnet, in which the intensity and dimensions of the field were to be much greater than those of the most powerful apparatus in current use. A magnet of this nature would permit of absolutely new researches on the magnetic properties of matter at different temperatures, on the constitution of crystals, on Zeeman's phenomenon, rotatory magnetic polarisation, and, in another order of work, on modifications of vital phenomena under the action of the magnetic field. The council of the Faculty of Science of Paris, struck with the importance of these researches, had reserved from the funds placed at its disposition by the liberality of M. Commercy for the advancement of science a sum of 50,000 francs, as a first contribution, although small, to the total expenditure required for the realisation of the scheme. Prince Bonaparte, who is always ready with active generosity to support great French scientific enterprises, has taken an active interest in this question. At his request an official committee, composed of the most competent members of our academy, was constituted, in order to study under what conditions France could be endowed with an instrument that should be unique in the world. This committee has held numerous meetings to discuss the various suggestions and hear the best-known specialists; its results have been published in a pamphlet which is a credit to our academy. Without quoting any names, the conclusions may be summarised thus: it is desirable that an important laboratory of magnetic research should be created; this laboratory should be placed under the patronage of the academy, and administered by the University of Paris; in this laboratory should be installed the most powerful electromagnets of the types chosen.

While we are thus dreaming of a gigantic magnet destined to enlarge the field of human knowledge, Germany, carried away by its dream of world-domination, prepared in secret enormous mortars in view of a sudden overwhelming attack on Belgian and French fortresses; when the time was thought favourable, war was declared against Russia and France, and Belgian neutrality was violated. Since the first days in August our academy has had but one thought, to assist the Government in the defence of the country and liberty.

At the meeting of August 3, the academy notified the Government that all its members who were not mobilised in the public service held themselves in readiness to aid in the national defence, each according to his speciality. After the meeting six large committees were constituted under the following denominations:—(1) Mechanics (including Aviation); (2) Wireless Telegraphy; (3) Radiography; (4) Chemistry (including Explosives); (5) Medicine, Surgery, Hygiene; (6) Food. All these committees have worked their hardest; the time has not come to speak of the reports which they have presented and the results they have obtained.

On August 10 the academy addressed to its correspondants in Belgium, M. Boulvin at Ghent, and M. Francotte at Brussels, the expression of its brotherly friendship and its profound admiration for the Belgian people and army. We solemnly renew to-day the expression of these sentiments, adding our indignant protest against the destruction of the treasures of art and science; the acts of violence on the liberty, life, and property of the non-combatants, committed deliberately in order to punish noble nations because they did not hesitate in their choice between the laws of honour, the respect for treaties, the love of independence, and the base suggestions of material interest or of fear.

MATHEMATICS IN ARTILLERY SCIENCE.

SIR GEORGE GREENHILL, president of the Mathematical Association, delivered an address upon "Mathematics in Artillery Science" at the annual meeting of the association on January 9. We have been unable to obtain a copy of the address from the officials of the association, though we think that one of the chief purposes of a scientific society should be to secure as wide a publicity as possible for its papers and addresses. Sir George Greenhill's remarks have, however, been summarised in the daily papers, and from the *Times* report the subjoined abstract has been derived. We may add that as Sir George was formerly professor of mathematics in the Artillery College, Woolwich, his opinions upon the position which science occupies in our technical training for modern warfare must be given careful consideration.

Six months ago artillery officers would have said there was no such thing as mathematics in artillery science; but that outlook was now ancient history, for at the present time we are engaged in what is, in fact, a mathematical war. Drawing upon his experience as a professor of artillery theory for in-

stances where science would prove itself useful on service, he explained how particulars of the enemy's guns could be deduced from fragments of the wall of a shell and photographic pictures. From a fragment they could determine whether a shell came from one of the 42-centimetre howitzers, the very existence of which still appeared in doubt. Dealing with the calculations for ascertaining how far men should stand from a gun to avoid the danger of permanent deafness, he said they need not fear to stand 12 yards behind the 42-centimetre howitzer; and so the story was discounted of the firing party taking cover 100 to 200 metres away when this howitzer was fired. An application of the theory of the conduction of heat would have reassured our men that life in the trenches would not be too cold, or would at least be warmer than in the frost above, provided only the floor could be drained dry under foot. It had also to be borne in mind that the trench gave better cover than a tent.

Five years ago he had an invitation to Berlin, to visit the Military Technical Academy there. It was a magnificent institution such as we could not afford, so our rulers assured us. Prof. Cranz showed how in his department no money was spared in recent equipment, including a bomb-proof range available for artillery fire and yet in the heart of a big city. There were plenty of outdoor artillery ranges also to visit, where instructive work was in progress. The Perry system of education was adopted in Berlin. After a lecture on wireless telegraphy, the class was set to work, as he saw, in making the antennæ which had played such an important part in the war. Sixty officers were under instruction at a time for a course of three years, and he was assured their zeal was admirable. It was considered such bad form not to give the best in return for the honour and glory of the Fatherland. But our Regular was apathetic by comparison. We must put our trust in the junior ranks to push old Apathy from his stool and carry us through this war.

It was a mournful contrast to revert to Woolwich. There they had been evicted and were told to found a new artillery college with the choice of a cellar under some stables or a kitchen and scullery and bare walls in a deserted hospital, there to organise victory and at no expense. With the courage of an Austrian general compelled to maintain his muzzle-loading musket a match for the Prussian needle-gun, the Military Director assured them that there was nothing superior to be found at Greenwich, in the Naval College there lodged in the old Palace. Such dismal, penurious surroundings had a disastrous effect on the *genius loci*, and they never really recovered from a downhearted spirit not calculated for victory. Our military science was under the rule of Thumb, the official genius. His fumbling method was considered a match for disciplined theory.

We saw already how the cost had been well laid out in this war of the Berlin Military Technical Academy, the German jumping off with a lead he was able to keep so far. The finished article of the academy was employed in the dissemination of true theory and in the scientific direction of warlike preparation as at Krupps. Assuming everything for the best for the Allies, and if we lived to go in again at Antwerp, an interesting match would be watched between our artillery science and the German, to see how long it would take us to get the other side out, compared with our own innings and the time we kept our wicket up. No long-range fire, he had been assured, was ever going to be of any use again, involving theoretical calculation. The word was "Gallop up close, to 400 yards, and let them have it."

The country was furious at the way our poor fellows were pounded mercilessly at the start by long-range accurate howitzer fire with no protection from our own side. King George's stirring appeal, "Wake up, England," was intercepted by our rulers, and it was England the Unready again when our Senior Lethargy bumped into the Titanic Energy of the German Empire.

SOME ASPECTS OF PROGRESS IN MODERN ZOOLOGY.[1]

IT is our privilege to live in a time of almost unexampled progress in natural science, a time distinguished alike by discoveries of the first magnitude and by far-reaching changes in method and in point of view. The advances of recent years have revolutionised our conceptions of the structure of matter, and have seriously raised the question of the transmutation of the chemical elements. They have continually extended the proofs of organic evolution, but have at the same time opened wide the door to a re-examination of its conditions, its causes, and its essential nature. Such has been the swiftness of these advances that some effort is still required to realise what remarkable new horizons of discovery they have brought into view. A few years ago the possibility of investigating by direct experiment the internal structure of atoms, or the topographical grouping of hereditary units in the germ-cells, would have seemed a wild dream. To-day these questions stand among the substantial realities of scientific inquiry. And lest we should lose our heads amid advances so sweeping, the principles that guide scientific research have been subjected as never before to critical examination. We have become more circumspect in our attitude towards natural "laws.' We have attained to a clearer view of our working hypotheses—of their uses and their limitations. With the best of intentions we do not always succeed in keeping them clear of metaphysics, but at least we have learned to try. We perceive more and more clearly that science does not deal with ultimate problems or with final solutions. In order to live science must move. She attempts no more than to win successive points of vantage which may serve, one after another, as stepping stones to further progress. When these have played their part they are often left behind as the general advance proceeds.

In respect to the practical applications of science we have almost ceased to wonder at incredible prodigies of achievement; yet in some directions they retain a hold on our imagination that daily familiarity cannot shake. Not in our time, at least, will the magnificent conquests of sanitary science and experimental medicine sink to the level of the commonplace. Science here renders her most direct and personal service to human welfare; and here in less direct ways she plays a part in the advance of our civilisation that would have been inconceivable to our fathers. Popular writers delight to portray the naturalist as a kind of reanimated antediluvian, wandering aimlessly in a modern world where he plays the part of a harmless visionary; but what master of romance would have had the ingenuity to put into the head of his mythical naturalist a dream that the construction of the Panama Canal would turn upon our acquaintance with the natural history of the mosquito, or that the health and happiness of nations—nay, their advance in science, letters, and the arts—might depend measurably on the cultivation of our intimacy with the family lives of house-flies, fleas, and creatures of still more dubious antecedents!

[1] Presidential address delivered to the American Association for the Advancement of Science, Philadelphia, December 28, 1914, by Prof. E. B. Wilson.