

Science in the New Century.

WHAT WILL BE ITS GREATEST ACHIEVEMENTS?

INTERVIEWS WITH SIR NORMAN LOCKYER, SIR W. H. PREECE, SIR J. WOLFE BARRY, SIR WILLIAM CROOKES, MR. J. W. SWAN, M. BERTHELOT (SECRETARY OF THE FRENCH ACADEMY OF SCIENCES), SIR HENRY ROSCOE, AND MR. THOMAS BRYANT (EX-PRESIDENT OF THE ROYAL COLLEGE OF SURGEONS).

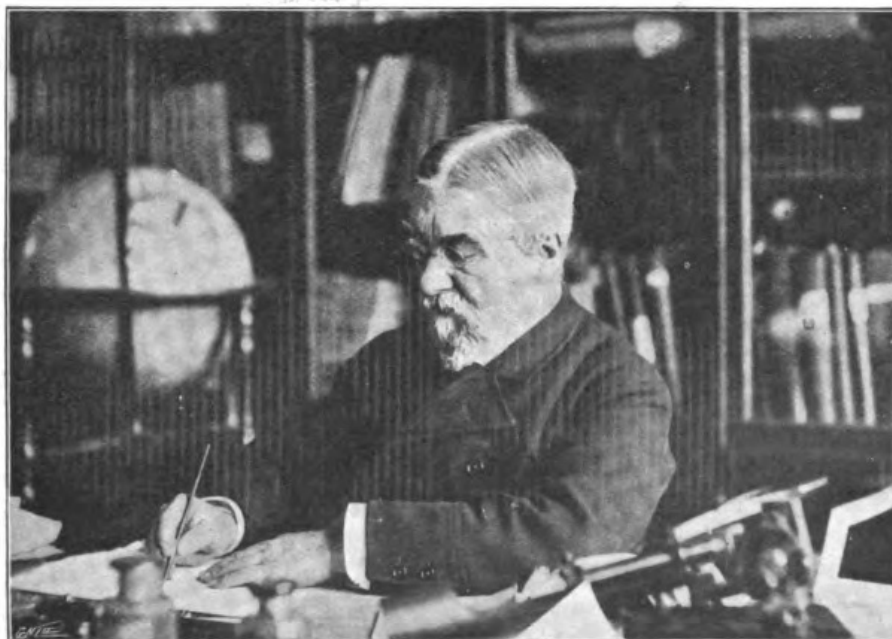
BY FREDERICK DOLMAN.

LT has been the century of Science writ largest. That much must be conceded by the historian, whatever he may have to say concerning the nineteenth century's many other claims. Railways and steamships, telegraphs and telephones, electric lighting and traction, the phonograph and the motor-car, Röntgen's rays and Marconi's messages. Can the century upon which we are just entering possibly have in store for the world any similar series of scientific achievements?

made my first call, had no difficulty in replying to my question as regards astronomy.

"We can count," he remarked, as he stood in front of the fire in his official room at South Kensington, "upon the new century witnessing several most important achievements in the sphere of astronomy. To the progress of the science the most valuable contribution will probably be made in America, which now has more observers and better instruments than either England or Germany.

"The first of these achievements will, I



From a

SIR NORMAN LOCKYER.

[Photograph

What are the "fairy tales of science" to which, having regard to this record of the marvellous, the new century may be reasonably expected to give the substance of fact? With such queries upon my lips I have been calling upon some of the most distinguished scientists of the day, the representatives of physics and chemistry, astronomy, electricity, mechanics, and medicine.

Sir Norman Lockyer, the director of the Solar Physics Observatory, upon whom I

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think, enable us by means of the spectra of sun-spots to forecast famines in India and droughts in Australia, as well as other important weather changes, a long time in advance. I have arrived at this conviction as the result of the work carried on in this observatory since its establishment twenty-five years ago. We shall be able to predict, not only the time, but also the area and extent, of drought and famine, thus rendering it possible to take timely precautions."

"This will certainly be an important

addition to the practical service which astronomy renders to mankind."

"Yes, and may give a fresh fillip to astronomical work in the new century. So long as scientific research is merely speculative Government and people generally care very little about it. The theories on which Marconi worked, for instance, had little interest for anybody until it was shown that by wireless telegraphy you would be able to establish regular communication between lighthouses and the coast, etc. When we first devoted attention to sun-spots people only laughed at us, but it will be quite different when the subject is shown to have practical value. The Indian authorities are already taking keen interest in the connection which has now been shown to exist between variations in the heat of the sun's surface and the amount of rainfall in subsequent years."

In the room I had a glimpse of the methods by which astronomy is preparing to confer in the new century this fresh boon upon the human race. Sir Norman showed me some of the diagrams whereby were measured in lines spots on the sun as recorded by the camera in India, Mauritius, and other distant observatories, the photographs being taken every day and regularly forwarded to South Kensington. On an adjoining table, too, were Blue-books giving the most elaborate statistics as to Indian rainfall during the greater part of the nineteenth century. In these statistics I noticed a frequent gap of several years.

"This occurred," Sir Norman explained, "in many of the more northern stations as a consequence of the Indian Mutiny. It has added considerably to the difficulty of my task."

Sir Norman then spoke of three other important achievements in astronomy, to

which he looked forward in the twentieth century—first, the chemical classification of the stars; second, the completion of a photographic chart of the heavens; and third, the substitution of photography entirely for the observation of individuals in recording "transits" of the stars. I asked him what practical bearing these achievements might be expected to have.

"No man can say. You may take it as a general rule, however, that it is the seemingly useless in science which ultimately turns out to be the most useful. As I have said, speculation as to sun-spots was laughed at for a long time. From such a subject as the chemistry of the stars greater discoveries may be reasonably expected than from electricity, say, simply because it is almost virgin soil, whereas the speculative possibilities of electricity have probably been exhausted."



SIR WILLIAM PREECE.

From a Photo. by George Newnes, Ltd.

Sir W. H. Preece, who shares with Signor Marconi the honour of the invention of wireless telegraphy, received me in his rooms at Queen Anne's Gate, which are filled with most interesting souvenirs of his long and distinguished career as an electrical engineer.

"What is to be the greatest achievement in my own sphere of science during the coming century? Well, in science as in many other things, it is the unexpected

which always happens. I have no doubt in my own mind that, in the twentieth, science will eclipse its record of the nineteenth century: that the people of 2000 A.D. will smile at our achievements as we smile at those of 1800. But in what way this will be so—who can tell?"

"But in electrical engineering, as well as in other things, do not coming events cast their shadows before?"

"No, not as a rule. We had no previous premonitions, for example, of the telegraph,

the telephone, or the phonograph. We all ridiculed the telephone when it was first announced to the world. I went over to New York in 1877 with the intention of exposing the fraud, but Graham Bell, the inventor, convinced me after five minutes' conversation, because he made it clear that he had alighted upon an absolutely new idea. Wireless telegraphy was, perhaps, an exception; I worked at it since 1882, and it was, of course, forecasted long before Marconi perfected his system. But we have now done as much with wireless telegraphy as is likely to be done. It will be most useful for marine and military purposes, but for ordinary, everyday communication there is no reason why we should expect to dispense with the wire and the cable. Here is a paper on 'Wireless Telephony,' which you may like to look through—I have been working at the subject for some time past."

This paper, which was contributed by Sir William Preece to the last meeting of the British Association, gives one the impression that as a means of communication between ships at sea or between islands and the mainland wireless telephony will be as generally useful in the next century as wireless telegraphy. But at the same time he would not admit that either he or Marconi possessed the clue to messages through space over an indefinite distance, as some of us had rashly imagined. In the same spirit he incidentally referred to the possibility of the twentieth century man flying through the air.

"Having regard to what has happened in this century I should not like to say that anything was impossible. But if we are to have a real flying machine it must be based on some entirely new principle, at present altogether beyond our conception. In our present knowledge, having regard to all the efforts and experiments that have been made in this direction, we can have no such hope.

"I suppose that in the way of scientific inquiry most work is now being done by Lord Kelvin and others respecting the constitution of the atmosphere. But it is impossible to say what sort of practical results, if any, will follow these labours. As a rule, the speculative scientist follows the practical, he does not precede him. It was thus with steam, for instance—the properties of steam were not fully examined until after Watt and Stephenson had done their work. The Röntgen rays, as the invention of a speculative man, forms quite an exception, and in that case the invention was quite an accident.

"But for all that," concluded Sir William, "I am confident that science will excel itself in the coming century. Even in this century we have seen much more achievement in the second than in the first half. And you must remember that with the spread of scientific education on every hand the number of workers applying themselves to all sorts of problems is rapidly multiplying."

"Forty years ago, when I first entered the profession," said Sir John Wolfe Barry, the engineer of the Tower Bridge, in his room at Delahay Street, Westminster, "it was said to me that engineering had practically no future—the railways, canals, docks, and other important undertakings which the world required were nearly all carried out. Yet since then engineers have never been so busy. The Suez Canal has been finished, also the Manchester Ship Canal; several great railways and docks have been constructed, many big schemes of water supply carried out. So I have no doubt it will be in the next century—engineering will have as large a share in the progress of the twentieth as it has had in the nineteenth century, although it is difficult to indicate exactly what its greatest achievements will be."



SIR JOHN WOLFE BARRY.

From a Photo. by Lambert & Weston & Son, Folkestone.

"Some people are looking to engineers, are they not, to utilize the energy not only of the great waterfalls, but also of the tides of the sea?"

"Yes, but at present there is no definite prospect of this idea being realized. Not only would the engineering works required to store the energy of the tides be very expensive, but the supply of this energy would necessarily be very irregular and uncertain. It is for similar reasons that wind-power has been disused, a windmill being costly in proportion to the amount of energy obtained from it, and the energy itself being irregular and uncertain. Of course, in regard to either wind or tide, an engineer may arise with some new plan overcoming these objections, and in this sense there is scope for one of the greatest achievements on the part of engineering in the new century. Our attention in this country has been turned to the tides because we lack any great waterfall; but, on the other hand, in some parts of the country we get a large amount of rain. If the rain which falls near Ben Nevis, for instance, were stored it would furnish an enormous amount of hydraulic pressure. This could be done on well-tried engineering principles, and seems to me much the more hopeful way of dealing with the problem which is likely to be created by the increasing cost of coal.

"Another most important problem which will have to be solved in the new century is that of street traffic in London and our other large cities. In this connection I was much interested in the moving platform at the Paris Exhibition, and I see no reason why the idea should not be largely adopted. Constructed underneath or overhead, such platforms along main thoroughfares would have many obvious advantages over other methods of locomotion—there would be no

waiting on the part of passengers, and absolutely no danger of accidents. The platforms might be municipal and free to the public."

"You have taken great interest in this question of street traffic, Sir John?"

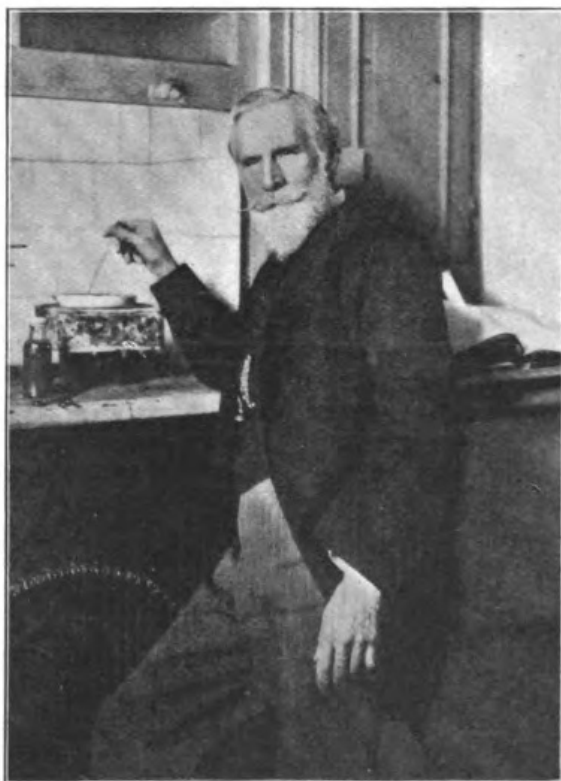
"Yes; as you may remember, I have advocated before the Society of Arts the reconstruction of important London thoroughfares on a large scale and in accordance with a systematic plan. Subways and underground railways do not entirely solve the question—you have got to provide for an enormously increased and ever-increasing traffic in the streets themselves. I am also of opinion that the conflict of traffic, both passenger and vehicles, at certain points—such as Piccadilly and Ludgate Circus—should be remedied by new thoroughfares, either overhead or underground."

Sir John also referred to an Irish Channel tunnel as a possible engineering achievement of the new century, but would not commit himself to a favourable opinion, as there was not yet sufficient *data* as to the geology of the bed of the Channel. In respect to the English Channel tunnel, on the other hand, full information had been obtained and engineering difficulties dis-

counted. This tunnel might certainly be an achievement of the new century if it were thought commercially and politically advisable—and as to that the eminent engineer evidently had his doubts.

Sir William Crookes, with whom I had a short conversation in his working-room—half laboratory and half study—at his residence in Kensington Park Gardens, declared at the outset that such a forecast as I proposed to him must necessarily be limited in scope to the application of existing ideas.

"I was reading recently," he remarked, "Mr. H. G. Wells's *When the Sleeper*



SIR WILLIAM CROOKES.

From a Photo. by George Newnes, Ltd.

Awakens,' and I found that every one of the things imagined by the author to have taken place was merely a further extension of something which we have already. I have no doubt, in my own mind, for example, that the next century will see a great multiplication of 'twopenny tubes.' We shall have every house in London connected with every other house by telephone. The phonograph will be in common use. I don't feel certain that London will be covered with glass, although, in my opinion, our cities would be much more comfortable if one could go out and about regardless of rain, cold, and fog. But all this, you will say, represents no fresh achievement on the part of science. Well, I might add the flying machine, which is almost sure to be perfected some time next century. Aerial navigation is now, I believe, only a matter of money. If only Governments would devote big sums to its solution the problem would soon be solved."

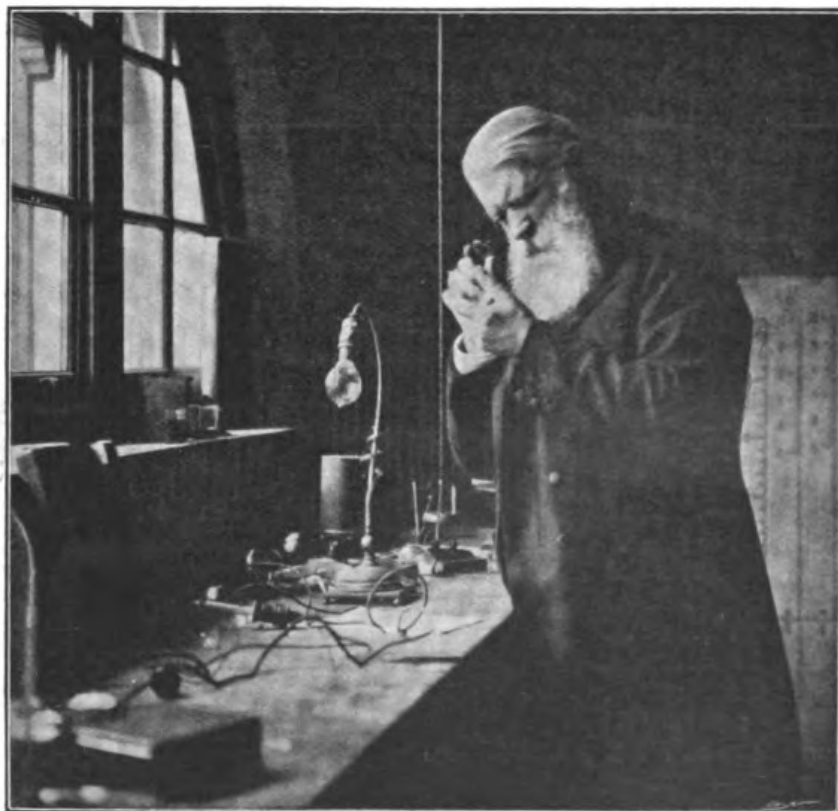
This view, readers will note, is in direct opposition to that which another eminent chemist — Sir William Preece — expressed to me. Sir William Crookes had seemingly been much more impressed by Count Zeppelin's recent experiments.

"For the rest," Sir William proceeded, "I can only say that it is very often the unexpected which happens. It is my belief that after the telephone and the more recent discovery of 'radium' scientists will be very chary of using the word 'impossible.' We all thought the idea of the telephone preposterous. We knew that certain sounds could be projected from a piece of iron, but to suppose that all the varied intonations of the human voice could be so conveyed was impossible. Yet it is so, although I, for one, confess that even now I do not understand *why* it should be so. As regards 'radium,' little or nothing can be said at the moment from the practical point

of view. But, as an example of seemingly continuous energy—something of which we had previously no conception—who can tell of what fresh achievement it may be the forerunner?"

Sir William Crookes did not tell me—as he might well have done—that he himself was on the verge of discovering the Röntgen rays some years before the German scientist bestowed upon the world this valuable aid to the surgeon's art. This interesting circumstance was incidentally mentioned to me a day or two later, when I called upon Mr. J. W. Swan, F.R.S., the electrician and inventor, in Holland Park.

"I remember Sir William," said Mr. Swan, "once showing me just such rays in the course of some experiments he was making with phosphorescent effects, although neither he nor I had any idea as to their extraordinary penetrative effect. On



From a Photo. by]

MR. J. W. SWAN.

[George Neumes, Ltd.]

another occasion, it seems, Sir William complained of some finger-marks on photographic plates which he attributed to carelessness in manufacture, although there can now be little doubt that they were brought about by his own work in producing X-rays, as they are now called."

My conversation with Mr. Swan, whose incandescent lamp associates his name with that of Edison, suggested that one of the greatest achievements of the twentieth century may be the substitution of some new chemical for the present mechanical method of generating electricity.

"At present, of course," Mr. Swan remarked, "the chemical method is much the more difficult and expensive. At this Holland Park Station on the New Central London Railway machinery of something like 3,000 horse-power is employed to generate the electricity for driving the trains and lifts and for the lighting. Well, at the present time an incalculable number of batteries would be required to provide an equivalent amount of electricity. For the time being the attempt to generate electricity chemically has been almost abandoned. Yet in some respects the electric current would be more convenient in the form of a battery than it is distributed from a generating station, and there is no reason in the nature of the case why some fresh discovery in the new century should not show that it can be produced chemically with much greater cheapness, although I don't profess to have any idea what sort of discovery it will be.

"The increasing cost of motive-power will probably stimulate efforts in this direction. More general use and further improvement in lamps will doubtless cheapen electric light very much, but, after all, the great impediment is the increasing cost of motive-power.

It is true that we get out of coal only from 10 to 15 per cent. of the energy it contains, and many efforts have been made to prevent this waste, but, so far, without success."

"Then you are not too sanguine, Mr. Swan, that in the new century Electra will become a sort of omnipotent fairy, doing all the hard work in daily life?"

"No, although I have no doubt that the use of electricity in industries, both large and small, will be much extended. But I don't think it likely that it will be found advantageous for, say, cleaning the windows and scrubbing the floors of our houses, as imaginative writers have suggested, although a few people may choose to employ it as an exquisite way of having such things done. Nor would I dare to commit myself to the opinion that, in the next century, electricity will entirely supersede gas as an illuminant."

As might be expected, electricity was much in evidence in Mr. Swan's own house; everywhere electric lights and bells, of course, whilst in the drawing-room I noticed an electrophone, and in the extensive basement inspected several laboratories and workshops wherein such motive-power as is required proceeds from electricity.

In contrast with Mr. Swan's studied moderation may be quoted the roseate views of M. Berthelot, the world-renowned French scientist, who occupies the representative position of secretary to the Academy of Sciences. M. Berthelot was unfortunately



From a photo. by

M. BERTHELOT.

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[Dornac.

away from home when I endeavoured to see him in Paris, but he kindly referred me, in the place of an interview, to an address which he delivered in April, 1897, at a dinner of the "Chambre Syndicale des Produits Chimiques." In this address, which, although partly humorous in form, had throughout a serious meaning, M. Berthelot clearly indicated his belief that in the twentieth century the greatest scientific achievement would be the chemical manufacture of food, although this is to be preceded by an equally revolutionary change in motive-power.

"It is easy," observes M. Berthelot, "to conceive the principle of this invention. It will be necessary to utilize the heat of the sun and the heat at the centre of our globe. The incessant progress of science gives rise to the legitimate hope of capturing these sources of limitless energy. In order to capture the central heat, for example, it will be sufficient to sink wells at a depth of four to five thousand mètres—which does not surpass the powers, perhaps, of present-day engineers, and certainly will not those of future engineers. We shall find in this heat the support of all life and all industry. Thus the water at the bottom of these wells would reach a temperature and possess a pressure capable of driving any possible number of machines.

"With the day," continues this distinguished Frenchman, "on which energy can be obtained thus economically would come the manufacture of food of all kinds with carbon extracted from carbonic acid, with hydrogen taken from water, with nitrogen and oxygen taken from the atmosphere. That which vegetation produces at present, with the aid of energy borrowed from the surrounding universe, we shall yet accomplish, and we shall accomplish it better,

in a fashion more extensive and more perfect than by the action of Nature—for such is the power of chemistry.

"In the next century the day will come when everybody will carry his little gaseous tablet, his little ball of fatty matter, his little bit of sugar, his little bottle of aromatic spice, according to his personal taste; all these things produced more economically and in inexhaustible quantities by our chemical manufactories, independently of seasons, of rain or drought, of heat, which dries up plants, or of cold, which blights fruit; all free from the microbes which cause epidemics and are the enemies of human life."



SIR HENRY ROSCOE.

From a Photo. by W. & D. Downey.

This was the first theme, regarded in a somewhat less sanguine spirit, of Sir Henry Roscoe, who was President of the Chemical Society in 1882 and of the British Association in 1887. I had a quarter of an hour with Sir Henry in the Athenæum Club, at which temple of learning his is probably one of the most familiar faces, as it certainly must be one of the most cheerful.

"More," he answered, emphatically, when I inquired of Sir Henry whether he considered that science was as likely to do as much for

mankind in the coming as it has done in the past century. But he was much less emphatic in speaking of the particular achievements by which the chemist and other scientists would make good this prediction.

"We hear much," Sir Henry remarked, "as to the artificial preparation of natural products by chemical means. As an example of this I may quote the case of the artificial production of indigo and also of cane sugar, although up to the present the chemist's sugar cannot compete in price with that of the vegetable product. The power of the chemist is such that he may look forward to the artificial preparation of any material possessing a gaseous, a liquid, or a crystalline

form, many of these, doubtless, with practical advantage.

"But I don't think there is much substance in the speculation, advanced in some quarters, as to the possibility of the men and women of the next century taking their food generally in a concentrated chemical form. The most important articles of food, after all, are grain and flesh, and our present knowledge does not suggest the possibility of the chemist providing, even in the course of a century, a satisfactory substitute for bread, beef, or mutton—inasmuch as so far the production by artificial means of material possessing organized structure seems beyond the power of the chemist's synthesis."

"In which direction, Sir Henry, do you consider, then, that science is likely to achieve most?"

"That is very hard to say. In one direction the twentieth century will, in my opinion, not witness such changes as have occurred in the nineteenth. Thus science has solved the problem of cold storage, and has been instrumental in bringing food from where it is not required to where it is. But, so far as I can judge, the annihilation of distance in this and in other respects which our century has witnessed cannot be carried very much farther in the next; the Atlantic voyage, for instance, which can now be accomplished in five days, is not likely to be reduced to one. We must look in other directions for similar progress of an epoch-making character. Perhaps the most important question with which science is now concerning itself is the utilization of fresh sources of energy, and the increasing cost and decreasing quantity of coal must stimulate its efforts in this direction. The next century, I should say, will certainly witness the harnessing of many Niagaras.

"Unfortunately our own country, which has had so great an advantage in its abundance of coal, is comparatively deficient in falling water. It is true that attention is also being directed to turning to account the force of the tides, and in this respect, as an insular country, we should be gainers. But it is difficult to see how the tides could be utilized without great expenditure on engineering, and for this reason I am afraid that in the next century tidal power will not be an effective competitor of the force, say, of the Niagara or the Zambesi."

Sir Henry Roscoe then expressed a view which explained his emphatic affirmative in answering my first question.

"I am disposed to think that the greatest progress of the next century will be made in

the application of science for the benefit of humanity, as well as in fresh invention or discovery. In sanitation on scientific principles, and especially in preventive medicine, science has an important part to play. In this respect we have made some progress during the latter part of this century, but that is insignificant in comparison with what we may legitimately look forward to in the coming century for the prevention of epidemic disease and the amelioration of the ills to which, hitherto, flesh has been heir."

From the standpoint of medical science, Mr. Thomas Bryant, the President of the Royal College of Surgeons from 1893 to 1896, whom I consulted finally, spoke to some extent in indorsement of this view.

"Twenty or thirty years ago," said Mr. Bryant, as he received me in his Grosvenor Street consulting-room, "an eminent surgeon of that time committed himself to the opinion that in our profession the acme of scientific achievement had been reached, that we had gone about as far as it was possible to go. How absurd such a statement seems to-day! One is inclined to think that the man who made it, a man of great skill and scientific knowledge, too, must have been mad.

"It is true that practically no further advance has been made with the two great achievements of the earlier part of this century—the use of anæsthetics and anti-septics. With regard to them we may have reached the end of possibilities. But, on the eve of the new century, I feel that in medicine and surgery we can look forward to even greater achievements and discoveries. Some of them we can clearly see coming."

"And the greatest of these is——?"

"Well, the bacteriological work of the past few years clearly foreshadows both the prevention and cure of diseases that are now generally regarded as hopeless, such as cancer and phthisis or consumption. The cure of consumption has, I know, been prematurely announced more than once, but from what has already been achieved there is good reason to believe that it will really become an accomplished fact before the new century is very far advanced. For similar reason we may look forward to the extirpation of the plague in India. We are now in what may be called the second stage of this work, the discovery of the friendly bacteria—for bacteria, you know, can be friendly as well as hostile to human life—and this is certain to be fruitful in great results.

"Another achievement which is, I think, not very far off is the prevention of malaria. It is now well established that mosquitoes are the principal agency in the spread of this fever, and with drainage and other sanitary measures mosquitoes might be exterminated or rendered innocuous. It is my impression that some time during next century such fever spots as the West Coast of Africa—in fact, tropical climates generally — will be rendered as healthy as, say, the Fens of Lincolnshire, which before their irrigation were also breeding-places of disease."

"What is to be expected in surgery or medicine, Mr. Bryant, from the use of the X-rays?"

"Well, although the utility of Röntgen's discovery has, of course, been demonstrated beyond all doubt, it is hard to say of what achievements it may be the forerunner. At present we are like children in the use of the rays, and, as several cases have suggested, for some time to come the greatest caution will be necessary in applying them for curative purposes, although their value in this way may prove to be very great. On the other hand, there can be no doubt that the X-rays, although they can hardly add much to our knowledge of anatomy, will so facilitate the diagnosis of disease, as well as of wounds, that in this way Röntgen's discovery may bring about great achievements in preventive medicine. In fact," laughingly

continued Mr. Bryant, "our profession is undermining itself in all directions. In the next century it may become necessary to introduce the plan of the Chinese, who pay their doctors so long as they are in good health."

"Nevertheless, nervous disease is said to be on the increase. In this respect is hypnotism likely to achieve any great result next century?"

"Ah, who can say? It is unfortunate that hypnotism has hitherto been so much in the hands of quacks and charlatans, bent only on exploiting it for money-making purposes. I am certainly of opinion that the subject ought to be earnestly taken in hand from the medical standpoint. Although no definite result can be at present anticipated, it does undeniably offer great possibilities, and for this reason should be attractive to young, enthusiastic students and investigators."

Mr. Bryant himself still seems enthusiastic if he is no longer young, even judged by our *fin-de-siècle* standard: he is seventy-two. Before taking my

leave I endeavoured to obtain his opinion as to the longevity of the twentieth century man. But on this point Mr. Bryant's prophetic instinct did not get so far as a figure. And I did not dare to remind him that in the belief of a Russian doctor, M. Elie Metchnikoff, the twentieth century man will, if it so pleases him, live for ever!



MR. THOMAS BRYANT.

From a Photo. by Charles F. Treble, Lavender Hill.