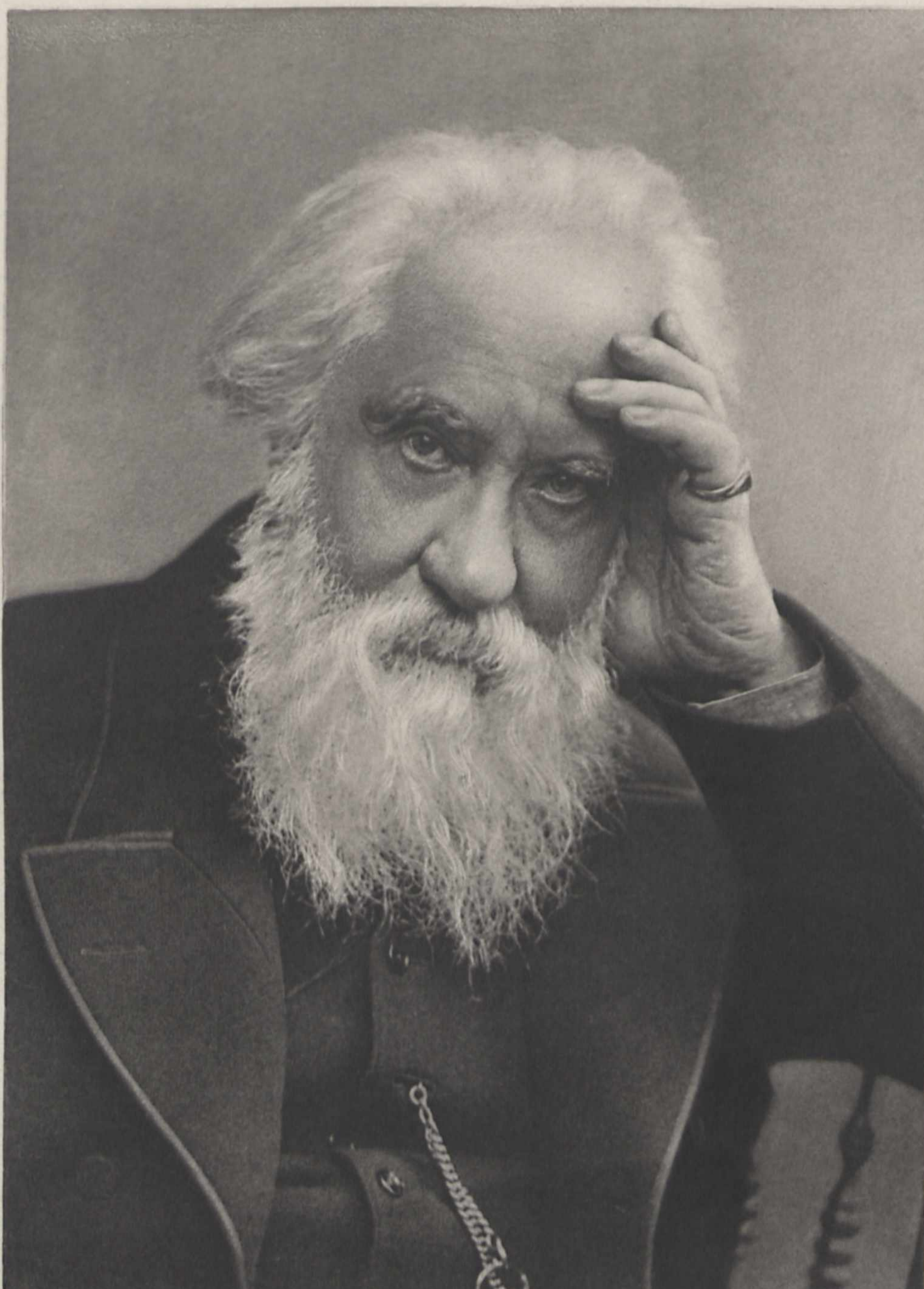


Walker & Cockerell, ph. sc.

William Huggins

THURSDAY, JULY 4, 1901.

SCIENTIFIC WORTHIES.

XXXIII.—Sir William Huggins, K.C.B.

Far from the noisy centre of London, in Upper Tulse Hill, there is a quiet house. The welcome accorded to one who has the good fortune to enter at its hospitable doors reminds one of Philemon and Baucis, and the visitor amidst the artistic decorations of the house feels transplanted into another world. In the garden extending far behind the house one sees the astronomical observatory with its dome, and recognises that this is the house of a man of science, not an artist.

We are in the dwelling of Sir William Huggins, on whom the English scientific world has lately conferred the highest honour by electing him President of the Royal Society.

Sir William has been in the happy position of being able to follow his scientific inclinations without being limited by official duties. After some hesitation he decided on Astronomy and built his observatory, the description of which is contained in his first scientific publication.

At that time, 1856, astronomy was chiefly confined to measurements of the positions of celestial bodies, but a few years later quite a new field was opened out by the great work of Kirchhoff and Bunsen, and it was Sir William Huggins who first introduced the new knowledge into astronomy and fertilised it.

The new science, Astrophysics, is in great part his work, and indeed I hardly know of another example where the history of the development of a science so nearly coincides with the story of one man.

Sir William had the good fortune to come on virgin ground everywhere, so that every observation meant a great and fertile discovery; but it is his merit that he was the first to recognise the importance of the new discovery, that he invented the best methods and instruments, and that he united in himself the necessary knowledge of Astronomy, Physics and Chemistry.

The so-called "good fortune" really plays a small part in great discoveries.

> "Wie sich Verstand und Glück verketten.
> Das sehn die Thoren niemals ein;
> Wenn sie den Stein der Weisen hätten,
> Der Weise mangette dem Stein,"

as Goethe says.

As soon as the news of Kirchhoff and Bunsen's discovery reached Huggins, he saw clearly that the application of spectrum analysis to the heavenly bodies was his field of research, and in this field he has laboured during the succeeding forty years with indefatigable ardour and never wanting success. His first researches were made in conjunction with W. A. Miller, Professor of Chemistry at King's College, who had been a worker in spectrum analysis for fifteen years.

As their first result they were able to send to the Royal Society in 1863 a Report on the Spectra of Stars. It is true Fraunhofer (1814), and Lamont and Donati (1860) had seen star spectra, but the method of observation employed by Huggins was quite different, being difficult and more fruitful. It was not at all sufficient now to see lines in the spectra of stars, but their chemical origin had to be determined; and therefore the light-gathering objective prism could no longer be used, but after the method of Kirchhoff and Bunsen a slit and comparison prism were employed. As thereby the spectrum is enormously weakened and has scarcely any breadth, Huggins introduced the cylindrical lens.

Very soon the insufficient knowledge of the spectra of the elements became obvious, and Huggins undertook with great success the task of determining the position of the lines of as many elements as possible in the visible part of the spectrum. The results were invaluable at that time, and even now, after the introduction of instruments so much more accurate, they are of value.

The year 1864 brought a great triumph for Huggins in the discovery that many of the nebulæ gave spectra consisting of bright lines. This fact was of enormous importance theoretically in consideration of the Kant-Laplace hypothesis of the genesis of the universe. Also of great importance were the observations on the new star in Corona, published by Huggins in 1866. Here he saw for the first time bright and dark lines combined in the same spectrum, and as the explanation he suggested an enormous convulsion of the star, excited, perhaps, by the approach or collision of a dark star.

In this and the following years he found opportunity to observe spectra of comets. Although they were too weak to enable him to pronounce any definite opinion on these mysterious phenomena, they sufficed to show that the light was partly reflected and partly emitted by the comets themselves. This result was confirmed when in 1868 the bright comet of Brorsen appeared, and Huggins found that its spectrum contained bright bands, which he recognised as belonging to carbon.

In the short period of five years Sir William had been the pioneer over a vast territory. Fixed stars, nebulæ, comets and even a new star were forced to disclose their mysteries. It would seem that the possibility of absolutely new discoveries were now excluded, that only the more detailed study of the same phenomena was left to science. But the genius of Huggins found new work for the spectroscope. Doppler's principle, that the wave-length of light is altered when the observer and source of light alter their distance apart, was certainly recognised as true, but nobody had thought of applying it to the extremely important case of stellar motion in the line of sight. Huggins was the first to do this, in 1868, with a new instrument, the result of some years of consideration.

The fertility of this new method, the beautiful and unexpected results which it has given in later years, is well known, and there is no doubt that in the future it will be the means of revealing to us much that at the present time remains mysterious.

At about the same time Huggins had tried to observe the prominences of the sun in the absence of an eclipse. He solved the problem and published an account of his methods, so that although he was preceded in the observation itself by Janssen and Lockyer, his high reputation was sustained. Immediately afterwards we find, as his contribution to the development of the subject, a description of a method for not only determining the chemical constitution, but also the actual shape of the protuberances.

In still another region Huggins has been a pioneer. As early as 1864 he had tried to photograph star spectra, but with his small and imperfect apparatus he only obtained spectra without lines. He did not, however, lose sight of the problem, and after the invention of dry plates he constructed a spectrograph out of rock crystal and Iceland spar which, with a Cassegrain telescope, gave the well-known beautiful spectra, among the novelties of which may be mentioned the revelation for the first time of the ultra-violet series of hydrogen.

The continued application of photography to the spectra of the various celestial bodies, the discovery of innumerable important and interesting results, occupy the following decades of a laborious life. It is impossible to follow in detail the whole of Huggins' achievements, contained as they are in nearly a hundred publications. To do so would require volumes, not one short article; nor is it possible to point out how Huggins was enabled by the construction of his spectroscopes to produce those excellent photographs which have excited our admiration during the last twenty years. There does not exist, I believe, any stellar spectrograph which does not involve in its construction ideas taken from Huggins' models. One obtains a superficial insight into the immense progress made by Huggins in the photography of stellar spectra in the book which he has presented to science under the title "Atlas of Representative Stellar Spectra," by Sir William and Lady Huggins. This and all the later publications of Sir William Huggins are signed also by Lady Huggins, in whom Sir William has found an "able and enthusiastic assistant." It would therefore be unjust not to mention Lady Huggins in a description of Sir William's work.

This necessarily very short and incomplete review, in which only a few of the most important discoveries could receive mention, while many others, such as, for instance, the detection of the band spectrum of water-vapour, had to be passed over, will show how productive and beneficent to science his life has been. The child to whom he gave life, Astrophysics, has been the object of his care and attention and has now developed into a strong and beautiful man.

The father can look with pride upon his child, and well may he be happy to see the progress which has been made and the number who now devote their energy and knowledge to this part of science.

But above all Huggins is distinguished by the extraordinary accuracy of all his publications. He has always been very cautious in drawing conclusions from observations; with an enthusiastic heart he has combined a cool head. He has scarcely ever been forced to retract or modify a statement, and therefore his views are universally accepted and his authority remains unrivalled, which I think to be the highest reward and greatest honour to which a scientific man can attain.

William Huggins was born in London, 1824. He built his private observatory in 1856, became President of the Royal Astronomical Society, 1876; President of the British Association, 1891; President of the Royal Society, 1900. He has received a Royal medal, the Rumford medal and the Copley medal from the Royal Society, and two medals from the Royal Astronomical Society. He married Miss Margaret Murray, of Dublin, in 1875.

H. Kayser.

ENGLAND'S NEGLECT OF SCIENCE.

England's Neglect of Science. By Prof. Perry, F.R.S. Pp. 113. (London: T. Fisher Unwin, 1900.) Price 2*s.* 6*d.*

UNDER the above title Prof. Perry publishes a collection of seven short papers dealing with several questions relating to the position of science and the method of teaching it in England. The little book itself takes its title from the second of these papers, an article which appeared in Nature in July 1900.

The subject is one of such great magnitude and intricacy that it is scarcely possible for a private individual to bring a sufficient knowledge of details to bear upon it. Nothing short of a commission of men of science would suffice to collect the mass of statistics which is necessary for the complete discussion of the shortcomings of England in her relation to scientific education. We must, therefore, be content to deal with it from a few points of view only, most of these being indicated by Prof. Perry himself.

Prof. Perry is well known to be, like several of his colleagues in science, dissatisfied with the position of science in England, with its influence in the affairs of State, and with the provision made for its support and development. When, however, he speaks of "England's" neglect of science it would be well if he made a distinction between England as a *nation* and England as a *Government*. It is not true that the English people as a whole are indifferent to the supreme claims of science in the modern world, but it is most unfortunately true that the men placed by the people at the heads of the Government departments are sadly wanting in a knowledge of science, and are, as a result, almost indifferent to its interests. Indeed, at the hands of the typical English Government official the profession of scientific education shares with science itself the results of this indifference. There is unquestionably a marked want of sympathy on the part of our Government officials with all those whose business it is to spread scientific knowledge among the people. What is the cause of this? The simple and direct answer is—the public schools. These institutions—some of them venerable as to age, all of them venerable as to ideas—supply almost exclusively the professional politicians to whose care the interests of the great departments of the Government are committed, and in all of them the dominant educational ideals are classical and mediæval. The career of the English professional politician is fairly well stereotyped. A classical education at one of the fashionable public schools, followed by something very similar at an ancient University, accompanied probably by the pursuit of some branch of athletics, and almost certainly by a continuous neglect of all branches of science, is the typical training of the heads of English officialdom. Neither science nor those whose profession is the teaching of science can hope for much encouragement from rulers developed by such a system as this. As for zeal in the promotion of invention or discovery before the thing aimed at becomes a visible and established fact, let no man look to an English Government department for that.

If the root of the public evil—England's *official* neglect of science—is to be found in the mediævalism of the public schools, the cause of the evil in the schools themselves is, to a great extent, to be sought in the *classical clerics* who are almost invariably placed over them; for very few of the head masters are men who have received any training in modern science. It is doubtful, however, if this is the *whole* cause of the unscientific character of the public schools; for in most, if not in all, of them some science is taught, and in several there are to be found laboratories erected at a cost of many thousands of pounds. But the "modern side" does not rank high in the estimation of the public school, and science is dignified with the name of "stinks." Modern science seems to fit the English public school about as well as a new piece fits an old garment; and if a knowledge of science is a desirable and important thing in the upper classes of this country, the whole system of the public schools must be overhauled.

Prof. Perry himself says some plain words on this matter (p. 14):—

"Much of the evil we suffer from is due to our average young men being pitchforked into works where they get no instruction, as soon as they leave school. If ordinary school education were worth the name, and if schoolmasters can be brought to see that we do not live in the fifteenth century, if boys were really taught to think for themselves through common sense training in natural science, things would not be so bad. But the average boy leaves an English school with no power to think for himself, and with less than no knowledge of natural science, and he learns what is called mathematics in such a fashion that he hates the sight of a mathematical expression all his life after."

It is most true, as Prof. Perry said recently in a lecture to working men at South Kensington, that, under our present unscientific educational system, "the most prominent Englishmen understand nothing of those sciences which are transforming all the conditions of civilisation."

But it is sometimes said in reply to those who complain of the want of scientific knowledge and sympathy on the part of the heads of Government departments, "you must remember that the real managers of these departments are not the heads but the permanent subordinate officials." This may be so, but it is very doubtful if we are any better off in the hands of these permanent officials. The higher appointments of the Home Civil Service are now filled by candidates selected from those who have successfully passed the examination for the Indian Civil Service; and an investigation will show that about 80 per cent. of the successful candidates obtain their places by means of classics; thus the chances of an infusion of scientific thought into the Government offices are not great.

It is vain to say, as some of our politicians are fond of telling us, that England must depend for the encouragement of science upon private benefactions and not upon Government support; a Government which adopts such a principle is simply shirking one of the greatest of its obligations.

A striking illustration of the unsympathetic attitude of English Governments towards men of science, and more especially the teachers of science, is always furnished by a perusal of the "New Year" and "Birthday" list of honours. Peerages and baronetcies are given somewhat freely to brewers and political supporters, and a perfect shower of knighthoods and minor honours to a host of officials of whose achievements the nation in general is profoundly ignorant. Now and then a Kelvin, a Lister, or a Stokes appears; but, though England possesses scientific inventors and discoverers in large numbers, very few of them are thought] worthy of national recognition.

Setting aside the radical weakness of our school system—its mediævalism—there are some defects that are more easily rectified; and among these Prof. Perry specially emphasises the orthodox procedure in the teaching of mathematics. Nothing but the ingrained conservatism of the English people would continue to base a boy's first knowledge of geometry on the peculiar language and the abstract reasoning of Euclid. Euclid, as has been repeatedly and vainly pointed out, was never written for boys; Euclid is difficult and not particularly well ordered; but Euclid is *classical*, and therefore Euclid is acceptable to the public schools, notwithstanding the fact that most boys waste years in attempting to acquire the somewhat grotesque language in which Euclidean logic is couched without attaining a real knowledge of even the nature of *an angle!* To know how Euclid shapes in the minds of the majority of schoolboys, to understand what a keen logical sense and expression they acquire from it by years of practice, one must conduct a public examination in the subject—and then not despair of the human race.

Prof. Perry does not confine his attack on our system of teaching mathematics to Euclid; he holds that a boy's scientific knowledge, generally, should not be primarily based upon abstract reasoning.

"Why not let a boy jump over all the Euclidean philosophy of geometry and assume even the 47th proposition to be true? Why not let him replace the second and fifth books of Euclid by a page of simple algebra . . . ?"

Some such procedure as Prof. Perry here indicates is really the key to improvement in our scientific teaching; and the objections which his proposal is likely to meet are met by him with a certain forcible humour:

"Because the embryo passes through all the stages of development of its ancestors, a boy in the nineteenth century must be taught according to all the systems ever in use and in the same order of time. Think of compelling emigrants to pass to America through Cuba, because Cuba was discovered first. Think of making boys learn Latin and Greek before they can write English, because Latin and Greek were the only languages in which there was a literature known to Englishmen 450 years ago!"

And this is, substantially, our procedure. Prof. Perry's remedy for our waste of time in mathematical teaching is contained in his advocacy of what he calls "Practical Mathematics," which may be described as a short cut to all the most important results and methods of science without the preliminary passage through a train of abstract reasoning in the old order—not, we presume, that the abstract reasoning is to be abolished altogether, but that it will come later and more easily when the results which it was originally employed to establish have become familiar practical truths by experience and measurement. This contention of Prof. Perry's does not, of course, agree with the pure *a priori* nature of mathematical reasoning hitherto accepted as orthodox truth. Indeed, it is not uncommon to hear even some scientific men objecting to such a principle as Prof. Perry's in some such terms as these: "Mathematics is primarily an education of the mind, and it must be regarded as an end in itself; the object of education is not the short and rapid attainment of practically useful knowledge, but the *cultivation of thought*." The simple answer to this is that, in view of the pressure of competition in the affairs of practical science, we cannot afford to take things in the old leisurely manner. Moreover, as already said, the re-ordering of our mathematical teaching according to the plan sketched by Prof. Perry in his chapter on "Practical Mathematics" does not involve, by any means, the *abolition* of abstract reasoning, but the *postponement* of it until the mind of the pupil is in the best condition to employ it.

We cannot afford space to discuss Prof. Perry's syllabus of practical mathematics in detail, but we may say that all those who have either the good fortune or the bad, according to the scene of their labours, to be employed in the teaching of mathematics, will find their work facilitated by adopting the system of graphic representation and graphic solutions so strongly advocated by Prof. Perry. The graphic method of solution of problems otherwise insoluble constitutes a wonderful interest both for the pupil and for the teacher; but, unfortunately, this fact is as yet very imperfectly recognised.

There is one branch of the question of school teaching which is scarcely noticed by Prof. Perry—the question of the preparatory school. The growth of the preparatory school in England within the last twenty years is most remarkable. This somewhat costly institution is, as a rule, an exact copy of the public school. The methods, the language, and, above all, the athletic ideals and aims of both are the same. The unscientific career in the greater institution is carefully initiated and cultivated in the less. Now, although nearly every branch of physical science is full of facts, principles and methods, the experimental illustration of which would awaken a far greater interest in the mind of a young boy than can be awakened by Greek or Latin grammar, the teaching of the elements of physical science in the preparatory stage of youth is almost unknown. There is a great deal of the elementary, but very important, portion of the science of electricity which every boy of the age of twelve (or less) should know, and could learn with no difficulty whatever; but he is kept rigorously aloof from all such knowledge, and we see him at the age of thirteen or fourteen fully equipped at his preparatory school for his public school exhibition or scholarship, absolutely ignorant of every electrical fact in existence.

This refers, of course, to boys of the better classes—those who look forward to a public school education. Prof. Perry remarks on the subject (p. 95):—

"I see no reason why the principles of physics should not be intimately known to every child who has passed the age of twelve years. . . . An examination of the work carried on in the model national schools in Ireland will show that in many cases children of eleven and twelve years possess a fair knowledge of physics and chemistry, and when they do not possess this knowledge it will be found that too much attention has been paid to Euclid and grammar, and perhaps practical geometry has not been studied at all."

In taking leave of Prof. Perry's suggestive little book, we would say that if the average English parent is content that his son should be brought up according to the classical model of the public school, with its athletic ideals and that superior "tone" with which it is generally credited, it might not be proper for any one to interfere with his choice; but when we reflect that these classical institutions are those in which our political rulers acquire their training and form their ideals, without appreciable modification by a subsequent career in an old University, the whole nation has a right to complain. The professional politician is apt to look down upon the professors of science; and until science makes its presence felt in the Government of the country by having eminent scientific men in its councils, we shall have to continue to deplore "England's neglect of science."

GEORGE M. MINCHIN.

GRANT DUFF'S NOTES FROM A DIARY.

Notes from a Diary, 1889–1891. By Sir Mountstuart E. Grant Duff. Vol. i. Pp. viii + 287. Vol. ii. Pp. 272. (London: Murray, 1901.) Price 18*s*.

IT might truly be said of Sir Mountstuart Grant Duff as was once said of Van Dyck, "During these years all noble England passed before him and remained immortal." He is a member of the best clubs—the

Athenæum, the Literary Society, The Club, &c.; he was for many years in the House of Commons, has been Under-Secretary for India, Under-Secretary for the Colonies, Governor of Madras, &c. He has thus had great opportunities, of which he has made the most. As was said of Archbishop Williams, he has "read the best, heard the best, conferred with the best; excribed, committed to memory, disputed; and had some work continually upon the loom."

Moreover, he has not only striven, and successfully, to know the ablest statesmen, literary men and men of science in our own country, but abroad also—V. Cousin, Hubner, B. de St. Hilaire, J. Simon, Taine, and many others were among his friends. The diary of such a man could not but be most interesting.

He has acted on the motto from Renan, which he places at the head of his first volume: "On ne doit jamais écrire que de ce qu'on aime. L'oubli et le silence sont la punition qu'on inflige à ce qu'on a trouvé laid ou commun dans la promenade à travers la vie."

Several of his reviewers have expressed the opinion that there are parts of the book which might have been spared, but I doubt whether they would have agreed which should be left out. The botany has been more than once suggested for omission; but to that I for one should, of course, demur. Sir Mountstuart has always loved natural history, and as a statesman has rendered valuable services to botany. He quotes with natural pleasure Sir J. Hooker's dedication to him of the 117th vol. of the *Botanical Magazine*, "as a slight acknowledgment of the valuable services which you rendered to botany and horticulture when Under-Secretary of State, first for India and then for the Colonies, and lately when Governor of the Madras Presidency; to which I would add, in memory of our long friendship, and our delightful rambles at home and abroad, in pursuit of our favourite science."

The whole book is full of good stories, of wise and witty sayings, of which, of course, we can only give a very small sample; for instance,

"—— is forty years old, Gladstone is eighty years young."

"Talleyrand remarks that 'Les affections lointaines sont un asile pour la pensée.'"

"Lady Alwyne Compton 'divided biography into autobiography, and ought—not to biography.'"

"Evarts, being asked if he was going to the funeral of a man whom he very much disliked, said, 'No, I shall not attend, but I quite approve of it.'"

"Woman was made after Man, and has been after him ever since."

"Two young ladies discussed for some time the colour of the Devil, when at last one said, 'I think you will *find* that I am right, dear.'"

"As Lady Blennerhassett left the dining-room she asked me, 'Do you like women's votes?' and supplied the answer, 'I like women who de-vote themselves.'"

"Mrs. Montgomery said of a friend, 'She gives me the impression of having been in the garden of Paradise before the Fall, but, having got a hint of what was about to happen, escaped before the coming of Original Sin.'"

While imbued with the scientific spirit, and thoroughly sympathising with the most liberal views of Stanley, Jowett and Renan, Sir Mountstuart Grant Duff has a deep feeling of reverence for the mysteries of existence. We meet again and again evidence of the profound impression made upon him by the récit d'une sœur; he speaks with affectionate veneration of Newman, and he tells us how much he valued the benediction which he sent him when he was starting for his Madras Government.

In his view of our religion he seems (though he does not expressly say so) to agree with Renan that

"Il ne sera remplacé que par un idéal supérieur; il est roi pour longtemps encore. Que dis-je? Sa beauté est éternelle, son règne n'aura pas de fin. L'Eglise a été dépassée, et s'est dépassée elle-même; le Christ n'a pas été dépassé."

The diary ends with an admirable address to the girls of the High School, Oxford. He gives them excellent advice: "Remember that to live a great and beautiful life is a far higher achievement than anything that can be done in life save by the very rarest genius."

He dwells first on what they should not learn—no higher arithmetic, no mathematics—no learning by heart, except some masterpieces, which should be kept up—no English grammar. Latin and Greek only as rewards.

Next what they should learn—reading, writing, drawing, book-keeping, needlework, cooking, enough French and German to read an ordinary book, some short treatise on logic, and enough music to enable them to enjoy the work of others, and some knowledge of the world in which we live. Lastly, he recommends them all to read four books—the "Meditations of Marcus Aurelius," the "De Imitatione," Gracian's "Oraculo Manual," and "Joubert's Pensées."

No one, I think, will put Sir Mountstuart's book down without a kindly feeling for the author, and a hope that he might have his characteristic wish to "come back every ten years, say for three weeks, just at this season, when the lilac, laburnum and wild hyacinth are out, to see how you are (the world is) getting on."

AVEBURY.

FIELD EXPERIMENTS ON WHEAT.

Cultura del Frumento, 1899-1900. *xiii Anno di cultura continua del Frumento e del Granturco.* By Prof. Italo Giglioli. Pp. xx+159. (Portici: Premiato Stab. Tipografico Vesuviano, 1901.)

IN the year 1887 Prof. Italo Giglioli, director of the R. Scuola Superiore Agraria di Portici, commenced a series of experiments on the growth of wheat under various manurial conditions at Suessola, in the Province of Caserta. The experiments are maintained by the Neapolitan Association of Landowners and Farmers, assisted, during the last few years, by grants from the Department of Agriculture.

The experimental field covers nearly two acres, and is divided by paths into 123 plots of about 45 square metres each. In most cases two or more plots (sometimes six or even twelve plots) receive the same treatment, and in this way the actual number of distinct experiments is reduced to forty-five. The produce of each of the 123 plots is, however, separately cut and weighed.

In the first year of the experiments wheat alone was grown, but owing to very favourable climatic conditions, and the character of the soil, it was subsequently found possible to grow two cereal crops each season—wheat from November to July and maize from July to October. The results show that the average yield of wheat is a good deal lower than in England, for instance; but the two crops taken together furnish an amount of grain in excess of the yields of the single crops obtained in England, Germany and the north of France. The character of the climate of Suessola is further illustrated by the fact that Rabi wheat from Oudh tends to give increased crops when grown in this district. English wheat, on the other hand, was found to deteriorate.

As regards the effect of the different manures on the wheat crop, horse-dung with sulphate of ammonia, applied in the spring, gave the highest yield, both of grain and straw. Sulphate of ammonia alone, applied in the spring, gave a higher yield of grain, but less straw than when applied partly in the autumn and partly in the spring; this result is attributed to the excessive rainfall during the winter months. With nitrate of soda there was a much lower yield of grain and rather less straw than with sulphate of ammonia. In accordance with what has been observed at Rothamsted and at Woburn, Giglioli obtained a greater weight per bushel under the influence of sulphate of ammonia than with nitrate of soda. Both these manures proved to be very effective when applied in conjunction with horse-dung. In this connection it may be mentioned that, quite recently, Hiltner has found that when humous sandy soil and heavy soil were inoculated with certain denitrifying organisms an increased production of oats was obtained. These results lend support to the view, now very generally accepted, that, in practice, the danger of any considerable loss of nitrogen under the influence of denitrifying organisms has been a good deal over-estimated.

Basic slag alone very considerably increased the yield of wheat grain; a still further increase in grain and also in straw was obtained when horse manure, or a mixture of sulphate of ammonia, nitrate of soda and potassium chloride were applied in addition to basic slag. Exclusively nitrogenous manures in addition to basic slag yielded about the same amount of grain, but more straw, than basic slag alone. Mineral superphosphate gave less satisfactory results than basic slag. Leucite, which occurs in large quantities in Italy, especially Roccamonfina, increased the yield of wheat when applied along with nitrate of soda; in conjunction with basic slag and nitrogenous manures, it produced about the same effect as potassium chloride under the same conditions.

Some interesting results are recorded on the effect of manganese dioxide, applied with various manures. These experiments, which have now been continued for three years, tend to show, in the majority of cases, that manganese dioxide in some way benefits the wheat crop. Further experiments on the subject, in which other crops, such as mangels, might be included, are desirable.

Electro-culture experiments with wheat manured with horse-dung showed a distinct gain both in grain and in straw when atmospheric electricity was employed, the increase in grain being relatively the greater. Voltaic electricity produced a still more marked effect, and increased the yield both of grain and straw by about 10 per cent.

It has not been possible within the limits of this short notice to give much more than a general indication of the lines of Prof. Giglioli's carefully conducted series of experiments, which, as time goes on, cannot fail to gain in interest and value. The present Report is well arranged for reference, and contains excellent bibliographies of some of the subjects investigated. The second Report, dealing with the results of the maize experiments, will, it is hoped, be ready before very long.

N. H. J. M.

EARTH CURRENT MEASUREMENTS.

Die Erdströme im Deutschen Reichstelegraphengebiet und ihr zusammenhang mit den Erdmagnetischen Erscheinungen. By Dr. B. Weinstein. Pp. vi + 78, and Atlas to ditto. (Brunswick: Friedrich Vieweg and Son, 1900.) Price, Mk. 4.

OF late years, when the interests of the electric railway and tramway have clashed with those of the observatories in which magnetic and earth current measurements are made, it has frequently been urged by the opponents of the observatories that they continue year after year accumulating data of which no use is ever made. Unfortunately, in most cases, owing, no doubt, to the very inadequate staff and multitudinous duties they have to perform, there is a certain amount of truth in this contention. It must, however, not be forgotten that the material is always available and can be worked up at any future date, while if the observations are interrupted, for however short a time, no amount of money or trouble expended at a subsequent time can replace the missing measurements. In this connection it is, therefore, with considerable pleasure that we welcome this pamphlet of nearly eighty pages, together with a quarto volume of curves, which give an account of the measurements made of the earth current curves obtained in two lines, one running between Berlin and Dresden, and the other between Berlin and Thorn during the epoch 1884–1888.

The author considers, in the first place, the manner in which the earth currents change, and in the second place to what extent these changes are connected with simultaneous changes in the terrestrial magnetic field.

In order to investigate the periodic changes in the earth currents, the ordinates of the photographic curves were measured for every hour and the means were used to calculate the coefficient of a Fourier expansion. The agreement between the values of the coefficients derived from the means for the various years is quite surprising considering the irregularity which one associates with all earth current phenomena.

The two lines being very nearly at right angles, and making the supposition that the current measured in the line is proportional to the current which traverses the earth, the author is able to calculate for each hour of the day the azimuth in which the current is flowing through the earth's crust. He compares the azimuth of this resultant current with the azimuth of the trace of the vertical plane passing through the sun. The results of these measurements, as well as a consideration of the way in which the earth currents change in magnitude and direction for the various months of the year, are all most clearly shown by means of vector diagrams. Vector diagrams are also given to show the changes in the earth's magnetic field for various stations, and a comparison between the two classes of curves shows a striking resemblance between their more salient features. It is quite impossible in such a notice as this to deal with the mass of data contained in the work, but we have no doubt that all interested in the fascinating subject of terrestrial magnetism will read the book with very great interest and feel, with the reviewer, that a great debt is due to Dr. Weinstein for the enormous amount of labour he has expended and for the satisfactory manner in which he has carried out his task.

OUR BOOK SHELF.

The Life of the Bee. By Maurice Maeterlinck. Translated by Alfred Sutro. Pp. 348. (London: George Allen, 1901.) 5*s*. net.

So far as our present knowledge extends, there are only four groups of animals which live in organised and more or less civilised communities at all resembling our own; and these are not mammals, or even vertebrates, as we might have been inclined to imagine *a priori*, but insects—ants, wasps, bees and termites. Hitherto entomologists have been inclined to award the palm of intelligence to the ants, but M. Maeterlinck thinks that the intelligence of the hive-bee has been somewhat underrated, at least as regards the readiness with which bees accept and adapt themselves to new conditions; and he also argues, as others have done before him, that the proceedings of human beings would probably appear far less intelligent to beings as far removed from man as man is from the bee, than do those of a bee-hive to ourselves. The book is not a romance in which bees are anthropomorphised, but an actual presentation of the life-history of the bee, and it appears to be abreast of the latest knowledge on the subject. The subject is discussed from the standpoint of a moderate agnosticism, and is interspersed with philosophical reflections on the various phases of bee-life as compared with human life, and of the equal mystery surrounding both. A fairly good list of some of the principal works on bees, in which English writers hold a very prominent position, is given at the end of the book. Incidentally, we are sorry to see the very unfavourable picture drawn, in § 94, of the peasantry of Normandy. We hope and believe that it is by no means universally applicable to the peasantry of other countries, including our own. As the work has doubtless been translated under the supervision of the author, it is probable that his meaning has been fairly grasped and expressed by his translator. As a specimen of the style of the book we may quote a short passage from pp. 302, 303: "Were an observer of a hundred and fifty times our height, and about seven hundred and fifty times our importance (these being the relations of stature and weight in which we stand to the humble honey-fly), one who knew not our language, and was endowed with senses totally different from our own; were such an one to have been studying us, he would recognise certain curious material transformations in the course of the last two-thirds of the century, but would be totally unable to form any conception of our moral, social, political, economic or religious problems." Here and there (as in the case of the word "importance" in the above passage) we find a word used which seems, from the context, hardly to express the author's meaning in English; and more rarely we find a technical error, as where *Sphinx Atropos* is once called a "butterfly" instead of a moth. These trifling defects can easily be remedied in a second edition, and in no way impair the interest of a book of somewhat unusual character. We should add that M. Maeterlinck is himself a practical bee-keeper (as well as an eminent man of literature), and has therefore the advantage of an acquaintance at first-hand with the general subject. W. F. K.

West African Studies. By Mary H. Kingsley. Second Edition, with Additional Chapters. Pp. xxxii + 507. (London: Macmillan and Co., Limited, 1901). Price 7*s*. 6*d*.

WE are glad that a popular edition of the late Miss Kingsley's "West African Studies" has been issued at a price which puts it within the reach of the humblest student; for, as we pointed out in our review of the first edition some twelve months ago, the book is worthy of the widest and closest study not only by students of primitive religion, but also by all those who have the interest of our West African colonies at heart. Before she started for South Africa Miss Kingsley had arranged to issue this edition, and though she did not live to see it through the press, the task of editing the volume has been completed by Mr. George Macmillan on the lines already approved by her. The new edition differs from the old by the omission of the appendices by the Comte de Cardi and Mr. John Harford, which, when once on record, are always accessible to the student, while their absence of general interest would have hardly justified their inclusion in the present reprint. In their place room has thus been found for a number of lectures and magazine articles which Miss Kingsley delivered and wrote shortly before her death. The new matter includes her Hibbert lecture on "African Law and Religion," some articles on "Property in West Africa," reprinted from the *Morning Post*, and two lectures on Imperialism in general and "Imperialism in West Africa." The bulk of the volume has been reprinted in its original form.

Mr. George Macmillan has prefixed an interesting introductory notice to the second edition, in the course of which he sketches the circumstances which led Miss Kingsley to undertake the researches which will always identify her name with West Africa; at the same time he gives a brief sketch of her character. We cannot refrain from quoting one passage, which seems to us to explain her personality more concisely and more truly than any other appreciation of her that we have yet seen.

"Not long after her death a friend who knew her well, a man qualified to speak by long experience of men and affairs, summed up the rare combination of overflowing sympathy and intellectual grasp which constituted at once the power and the charm of Mary Kingsley by saying that 'she had the brain of a man and the heart of a woman.' Speaking of her time in West Africa, she herself said, on one occasion, that she was 'doing odd jobs, and trying to understand things!' The phrase was characteristically modest, but here again we see how the heart which inspired the 'jobs,' which were always for some one else's benefit, worked deliberately in concert with the brain which was ever 'trying to understand things.' Together the two phrases strike the keynote of her life."

The Use of Words in Reasoning. By Alfred Sidgwick. Pp. xi + 370. (London: Adam and Charles Black 1901.) 7*s*. 6*d*. net.

THE name of Mr. Alfred Sidgwick is a sufficient guarantee that this book will be of value to all who are genuinely interested in the processes of reasoning, and desire, without plunging into the shadowy land where logic merges itself in metaphysical speculation, to extend their research somewhat further than a study of the formal logic of the schools will take them. The old-fashioned formal logic, "Pass Mods" logic, is, in fact, of little use except as a mental discipline for University passmen; others will hardly find in the ancient jingle of *Barbara Celarent Darii Ferioque prioris*, with its many combinations and permutations, a sufficient explanation of all the phenomena of reasoning. As Mr. Sidgwick says (p. 338): "Logic . . . might really quicken our sense of bad reasoning; but what formal logic does is only to quicken it in the least interesting and important direction, and so to draw our attention away from the serious dangers. In fact, we agree . . . that a man may improve his reasoning habits by studying logic, but we would lay rather more stress on the condition, 'if he has the sense to know when formalities are out of place.'" Mr. Sidgwick sketches the main points of his objections to the scholastic logic in a way which can be easily followed; and in his last chapter, on "How Logic might be Taught," he gives a succinct and simple explanation of the main processes which are employed in reasonable hinking.

Holidays in Eastern Counties. Edited by Percy Lindley. Pp. 96. (London: 30 Fleet Street, E.C.)

IT would be easy to select many places in which to spend a restful holiday from those described and attractively illustrated in this guide-book. The eastern counties possess many points of interest to students of nature and archæology, and are worth exploration in the days of leisure.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

A Vertical Light-beam through the Setting Sun.

THE not very frequently observed appearance of a vertical pillar of light through the sun when nearly setting was so very remarkably distinct and bright this evening as to deserve, perhaps, a particular description. I observed it in the Victoria Park, near Hackney, in the north-eastern part of London, from about 7h. 30m. to 8h. 10m. p.m. The setting sun at the first of those times was about 7° or 8° above the horizon, and its light was but little dimmed and tinged with yellow yet, by faint cirro-stratus cloud-bands among which it was shining, which ruled the western sky obliquely downwards towards a point of the horizon about 45° northwards from the sun. The light-column then, when I first saw it, was yellow coloured, bright and narrow at the base, but more diffused above, where it could be traced up to a length of 5° or 6°, while its base rested upon, or extended very little, if at all, below the sun. The summit grew narrower and higher as the sun descended lower, while the base became brighter and followed the sun down until, at about ten or fifteen minutes to 8, the sun was much dulled in light and assumed an orange yellow colour in entering a bank of haze about 5° from the horizon. Below that altitude the light-column's base never descended; but when at about 8 p.m. the sun had acquired the magnificent appearance of a great crimson disc, still about 2°, or some four of its diameters, clear from the level park horizon, the tall column shone beautifully above it as a perfectly straight, vertical, narrow streak of light about the sun's apparent diameter in width and 8° or 10° in length (from about altitude 5° to altitude 15°, and very faintly rather higher), bright yellow at its base, but becoming insensibly whiter and dimmer, without lateral diffusion till lost across the faint cloud-streaks which seemed here and there just visibly to lengthen it and very faintly extend it somewhat higher. It shortened gradually, and died out at last about 8h. 10m. p.m., soon after the sun itself vanished in the haze before reaching the horizon, but without changing the altitude, about 5°, of its base; and it retained to the last the straight, vertical appearance of which many of the vast number of people enjoying the fine evening in the extensive park were admiring watchers. I noticed no horizontal belt of light through the sun, nor mock-suns at their usual distances on its right and left hands, where the bands of cirro-stratus yet extended far enough to have given rise to them if they had consisted of cloud-materials of a fit and suitable description to produce them; and nothing very notable, except the vertical light-beam across the streaky clouds and the sun's intensely red-coloured orb below it, seemed to be of very marked meteorological significance in the beautiful display.

It seems hardly doubtful that the vertical light-beam must proceed in some way from passage of the sun's nearly level rays through horizontal refracting surfaces, such as those, for example, of thin, flat, hexagonal snow-crystals. A natural tendency which such floating crystals and collections of them into flat snow-flakes possess, in fact, of remaining horizontal while falling through perfectly still air, as flat leaves of paper, especially symmetrically shaped ones, if started horizontal on their journeys also may be seen to do,[1] affords fair grounds for an assumption that the sun's slightly sloping rays are really dispersed into these observed vertical light-beams by passing through the horizontal faces of such thin, flat, floating crystals. In what further way the light is spread upwards and downwards in passing through the thin transparent plates seems, indeed, to be a rather more doubtful subject of conjecture; but either want of perfect parallelism of the plates' flat surfaces, perhaps through partial melting, or refractions through the thin plates' bounding faces which give them chisel-edges, supposing these edges to be also slightly rounded off by partial melting, would certainly suffice, in the large proportion of a snow-cloud's floating crystals which optical considerations show must always be suitably oriented to produce refractions of the sun's rays upwards or downwards in directions either vertical or as nearly vertical as possible, to account for the columnar light-beam's well-defined extension in a vertical direction. Yet for better insight into its origin and surer proofs of the correctness of its theoretical explanation, fresh attention to the features and meteorological circumstances of the beam's display when it is well developed would certainly be desirable, and of great value to increase and improve our knowledge of this rather rare and singular form of halo, or occasional form of cloud illumination by the sun and moon. A light north-west wind was blowing on the ground, and the sky seemed to be dimmed by the faint streaks of cirro-stratus only in that quarter of the horizon where the slender beam of yellow light was visible; but the air might easily be quite calm and motionless aloft, in that thinly clouded region of its very high upper strata. A. S. HERSCHEL.

Observatory House, Slough, June 26.

A New Method of using Tuning-forks in Chronographic Measurements.

THE tuning-fork, when used for making time traces in chronographic work, is usually made to vibrate, by bowing with a violin bow, or by percussion, or by rapidly removing a metal block from between the two prongs, or by an electro-magnet the circuit of which is interrupted by the fork itself. When many details have to be attended to in an experiment, the first-mentioned methods are inconvenient, and the last one, namely the electrical, is not without an element of error. In order to obtain the convenience of the electrical method without introducing the error due to the electrical driving of the fork, two forks of the same period are used; the fork which makes the trace is furnished with an electromagnet, but no contact-breaker, the current being controlled by the second fork, which has a contact-breaker. This method of driving a chronographic fork is well known. My new way of using this combination is to cause the chronograph, during the short period during which the records are made, to cut out entirely the electrical circuit from the fork used to make the time trace and to close the circuit again immediately after the records are made. By this means the recording fork is not hampered with a contact-breaker, nor is it subject to the influence due to the electro-magnet, while its trace is being made on the moving surface of the chronograph. After the time trace is made, the circuit is again established, so that the vibration is maintained, and the fork is ready for the next experiment.

Trinity College, Oxford, June 28. F. J. JERVIS-SMITH.

Long-tailed Japanese Fowls.

WITH reference to Mr. J. T. Cunningham's letter on these birds in NATURE of June 13, I should like to be allowed to point out that the very interesting evidence he gives is yet not sufficient to prove his point. The words of his correspondent do not necessarily imply that he had personally witnessed the manipulation part of the process adopted to secure extreme length of

[1] This is a rather surprising experiment to those who may have been accustomed, as I have always been used hitherto, to see paper clippings, when tossed up at random, pirouette like little windmills or teetotums in falling through the air. But held by a corner for a moment, out of air-draughts, horizontal, if the hand's support is withdrawn quickly, letting them go at the same time without any impulse, squares, circles, hexagons, or other small cuttings of flat paper will all be found to fall to the ground from any height with very little oscillation, or even sometimes remaining throughout their fall quite horizontal.

feather; and the practices of keeping the birds on perches and of tying up their tails were already known. Such manipulation as is described would be extremely likely to result in the pulling out of the feathers concerned altogether, for all fanciers are well aware that a growing feather is only too easily extracted or knocked out, often to their disappointment.

Moreover, manipulation of the *tail*-feathers, even if it be really practised with the result described, would not account for the likewise abnormal elongation of the saddle-feathers or rump-hackles, or for the fact that the tail-feathers and tail-coverts of the hens of this breed are also slightly elongated, as may be seen in the Natural History Museum specimen.

That a breed of ornamental poultry with the hackles and tail-feathers abnormally elongated could be produced by continual selection of variations in the right direction no breeder would doubt, and so the living specimens of long-tailed fowls one sees in Europe present no special difficulty. Indeed, even the goose, a bird, as Darwin remarked, of singularly inflexible organisation, has produced a breed with abnormally lengthened plumage—the well-known Sebastopol goose.

The difficulty mentioned by Mr. Cunningham, that European specimens of the long-tailed fowls do not approach the length of feather seen in Japanese examples, is undoubtedly a real one. But a simpler explanation than the very unlikely one given by that gentleman would be that the true long-tailed breed is the offspring of a "sport" endowed with more or less continuously-growing feathers, analogous to the rootless teeth occurring in so many mammals, and that the European specimens fail to produce such feathers either on account of a different environment, which is known to have an influence on the growth of feathers, or because they are not good examples of the breed.

It may be objected that continuously-growing feathers are not known to exist in wild birds; but neither do we find in these the duplicated hallux, or the very heavy feathering of the feet, both of which points occur in domestic fowls, and the last in pigeons also.

As to the inheritance of acquired characters, the annals of the poultry fancy furnish no evidence of this, so far as I am aware, nor do they encourage a belief in the theory that the naked head-appendages of the fowl, and its long hackles, are due to stimulation caused by fighting. For the most pugnacious of all breeds, the Aseel of India, has the comb and wattles almost rudimentary, and the hackles, like the rest of the plumage, unusually short and scanty. The same remark applies to the allied Malay or Chittagong breed, while the old English fighting game was hardly modified from the jungle-fowl, and certainly has not a large comb. On the other hand, the large-combed breeds of the Spanish type are not particularly pugilistic, and the size of their head-appendages is recognised by fanciers to be due to selection. So much for the supposed effects of stimulation on living structures.

It may not be irrelevant here to mention a case of manipulation by oriental fanciers which recently came under my notice in India. I had observed some red or chestnut-coloured pigeons with white bars on the wing, and asked my friend Mr. W. Rutledge, who has been a dealer and fancier for nearly half a century, to what breed these birds belonged. He replied that they were of no breed, but that the marking in question was produced by plucking out the feathers constituting the bars three times, when they would be produced white, as I had seen them. But, he added, the birds would not breed young resembling them in this point. I have thought this instance worth recording as illustrating the lengths to which some Eastern bird-fanciers will go, and as showing that experienced men are well aware that acquired characters are not inherited. FRANK FINN.

c/o Zoological Society, 3, Hanover Square, London.

Decomposition of Copper Oxide.

IN the course of some recent experiments which involved the heating of copper wires in vacuo to temperatures of 1000° or 1050°, several facts were noticed which seem to me worthy of record and of further investigation.

The wires in question were heated in a porcelain tube 12 inches long, the lowest quarter of which was at a uniform temperature, the maximum, while above this the temperature gradually fell off till it reached that of the room.

It was noticed that whenever the vacuum had not been as good as usual the consequent oxidation of the copper in the hot end of the tube did not extend over the whole length of heated wire, but that ¾ inch or so of wire was perfectly bright, with considerable oxidation both above and below the bright region.

The temperature of that part of the wire at which brightness occurred was about 950° C. At first sight it appears from this that copper oxide, probably the black variety, decomposes somewhere in the neighbourhood of 950°, but recombines again at a higher temperature.

Another possibility is that the change is connected with the formation of the red oxide, though the appearance of the bright portions of the wires does not favour this idea.

Volatilisation of the metal itself appears to go on at the bright parts, but it is difficult to account for the observed phenomena on an hypothesis of volatilisation alone.

University College, London. PHILIP HARRISON.

The Subjective Lowering of Pitch.

As a question arising out of Mr. Harding's letter (p. 103), it would be interesting to know what is the effect produced by sounding a note loud enough to produce the subjective distortion, while at the same time the note to which it appears to be flattened is sounded more quietly. I suppose discord would be inevitable, but possibly a musical ear would be able to judge whether subjective distortion was prevented in the loud, or produced in the softer, note.

Mr. Allen's argument (p. 182) may, I think, be disposed of in the following manner. He states that the singer should be conscious of flatness. Now if he is singing with an instrument, the note he sings is the only one he can possibly sing without being conscious of discord. If he sings so much higher that his distorted note is depressed till it sounds (in the absence of the instrument) as though it were the correct note, he produces discord with the instrument. His only course is to sing the note of the instrument, reinforce it, and so unconsciously cause the subjective depression of both. I am writing in ignorance of whether the effect is observed in unaccompanied singing and solos on the violin. E. C. SHERWOOD.

St. Peter's College, Westminster.

A Curious Phenomenon.

A CURIOUS phenomenon occurred to some volunteers while on outpost duty on the Delagoa Bay Railway in the Transvaal.

A search-light was fixed up in the station, which was used nightly in scanning the wide stretches of veldt. We were on solitary outpost duty about three miles from the station, and on the still silent nights which are frequently experienced in the clear atmosphere of the high veldt we distinctly heard a low "purring" sound as the ray of light of the station passed over us. As the light approached us one could hear the sound gradually increasing, being loudest as it switched over us and passing away into the nothingness of the silent night. We were too far off the station to hear any vibrations from the mechanism of the search-light, and we all came to the conclusion (being a collection of unscientific men) that the high velocity of the light waves created a sound audible to our ears. On other nights when there was only a slight breeze no noise could be detected.

Can any one of NATURE'S readers tell me if this is a known physiological effect? STANLEY B. HUTT.

Broxbourne, June 20.

THE ANTARCTIC EXPEDITION.

THE instructions to the commander of the National Antarctic Expedition —*verbosa et grandis epistola*— have now been published, together with a similar document, of much greater brevity, addressed to the director of the civilian scientific staff. Most of the former, much even of the latter, would not interest our readers, so we print only a few extracts relating more immediately to the matters recently under discussion. We take first (though not in order) the following clause :—

The *Discovery* is not one of His Majesty's ships, but is registered under the Merchant Shipping Act, 1894, and is governed by it. Copies of this Act will be supplied to you. You will see that the officers and crew sign the ship's articles as required by the Act. The scientific staff will not sign articles, but are to be treated as cabin passengers. You must be careful not to take more than twelve persons as passengers.

So it is now quite clear that the *Discovery* is not on His Majesty's service in any sense of this phrase; the demand also that the members of the civilian staff should sign articles has been dropped as impracticable; so we fail to see why an officer of the Royal Navy without any experience of Polar exploration should have been preferred for the command to a captain in the merchant service familiar with work of this character and less likely to stand upon the dignity of his rank.

We observe also that the civilian director is carefully warned off from interference with all scientific work done by the officers of the ship by the following clause:—

The scientific work of the executive officers of the ship will be under your immediate control, and will include magnetic and meteorological observations, astronomical observations, surveying and charting, and sounding operations.

We may remark that, throughout, the instructions indicate that the framers of them are not quite easy in their minds, for it is solemnly impressed on the commander that he has a grand chance which he must on no account throw away, and advice is given to both which might be put in the homely form, "We hope you will be good boys and not quarrel."

We pass on to the definitions of the objects of the expedition:—

The objects of the expedition are (*a*) to determine, as far as possible, the nature, condition and extent of that portion of the South Polar lands which is included in the scope of your expedition; and (*b*) to make a magnetic survey in the southern regions to the south of the 40th parallel, and to carry on meteorological, oceanographic, geological, biological and physical investigations and researches. Neither of these objects is to be sacrificed to the other.

Geographical discovery and scientific exploration by sea and land should be conducted in two quadrants of the four into which the Antarctic regions are divided for convenience of reference, namely the Victoria and Ross Quadrants. It is desired that the extent of land should be ascertained by following the coast lines, that the depth and nature of the ice-cap should be investigated, as well as the nature of the volcanic region, of the mountain ranges, and especially of any fossiliferous rocks.

Whenever it is possible, while at sea, deep-sea sounding should be taken with serial temperatures, and samples of sea-water at various depths are to be obtained for physical and chemical analysis. Dredging operations are to be carried on as frequently as possible, and all opportunities are to be taken for making biological and geological collections.

Whether the *Discovery* should or should not winter in the ice is left to the discretion of the commander. In that event the following direction is given:—

Your efforts, as regards geographical exploration, should be directed, with the help of depôts, to three objects, namely, an advance into the western mountains, an advance to the south, and the exploration of the volcanic region.

And it is kindly added:—

The director and his staff shall be allowed all facilities for the prosecution of their researches.

In the event of not wintering, the commander is instructed to land a party between Cape Crozier and Cape Johnson, if a suitable place can be found. In regard to magnetic observations special directions are given, from which it appears that the authors of the instructions have taken pains that at any rate this branch of science shall not be neglected.

The instructions to the director of the civilian scientific staff cannot be said to err on the side of precision. For information as to the objects of the expedition they refer him to the instructions given to its commander, which, it is said, will also suffice to indicate his position relatively to the latter. The director can certainly claim to be unfettered as to his methods and objects of work, for there is no direct mention of anything but the disposal of the results. It might, however, have been well for those responsible for these instructions to have indicated the points on which information was especially desired. Still, they have not omitted the precaution of informing the director and members of the civilian staff that they join the expedition at their own risk.

But who is this director? The instructions name two officials, Mr. Hodgson (biologist), Mr. Shackleton (physicist), and the two medical officers, Dr. Koettlitz and Dr. Wilson, who will act respectively as botanist and zoologist when their other duties permit. We are aware that Mr. George Murray will occupy he position of director at the outset of the expedition, but it has been publicly stated that he will not accompany it beyond Australia or New Zealand. Is he to devote himself during his voyage out to training up one of these four in the way that he should afterwards go as his successor, trusting, as with a plant, to quick development under the tropical sun? or is there still a lingering hope of picking up a director somewhere in the Antipodes?—that would indeed be a feat worthy of the *Discovery*!

Magnetic work, as we have said, is happily not neglected. Biological work also, so far as it can be done from the ship, will probably receive attention; how far it will be carried out on land must be left, as we have seen, to the chapter of accidents. Geology has to be content with a bare mention, and the Antarctic ice is just named. Yet a thorough study of its phenomena should have been made prominent among the objects of this expedition. The ice cap of the Antarctic region, as has long been known, is in all probability on a much grander scale than even in Greenland. It is as large as, if not larger than, any which existed in northern latitudes during the glacial epoch. Here, then, if anywhere, information can be obtained as to the work and the indications of such an ice-cap. Certainly these questions will not be solved, nor "the depth and nature of the ice-cap" investigated, by following the coast-line or by anything less than by the researches of a party stationed for a considerable time on the land. But to make information on these questions really valuable it must have been collected by one who is thoroughly familiar with them and can distinguish between trivial and important phenomena. Can we say that any member of the staff possesses these qualifications? Indeed, as we see from the description quoted above, no one of the present staff even claims to be a geologist.

One other point deserves notice. In a covering letter, signed by the chairman of the final committee of the Royal and Geographical Societies, sent with the instructions to their presidents (to which, as it is not marked confidential, we presume we may refer), we find a statement that the instructions have been settled in their present form in consequence of Prof. Gregory's resignation. The reason for bringing in his name is not easy to discover, unless it be that the committee felt ill at ease; for it is a wise policy, when conscious of being in a very questionable position, to hint to all the world that the other party is to blame. Any such innuendo Prof. Gregory can afford to disregard. His actions have been throughout above board and consistent. The Royal Society, as we have already pointed out, has displayed, through its representatives, little care for the interests of science and a lack of moral courage in fighting its battles. We can now only hope for the best; but we fear events will prove that these things also are better managed in Germany than in England.

THE SIMPLON TUNNEL.

FEW undertakings have had to encounter so many difficulties as those which have impeded the construction of the Simplon Tunnel. Apart from the purely mechanical scheme which proposed to cut a narrow space in a definite direction through hard rock for a distance of some 20,000 metres, at a considerable depth below the surface, and the difficulties of a physical character connected with temperature and sanitation, there must be added financial considerations of a very onerous character, possibly increased by the subtle and continuous opposition on the part of existing interests. That all difficulties, save, of course, the actual labour of tunnelling, have gradually disappeared speaks eloquently of the energy and mechanical resource displayed by the engineers, and of the policy and address exhibited by the management. Rumours have appeared now and again in the newspapers of strikes among the workmen and of delays arising from that source; but such inconveniences have always to be anticipated in long-continued workings owing to the gradual changes that occur in the condition of labour. Such annoyances may delay the completion, but they cannot prevent it.

We commented on some of the difficulties and some of the advantages attendant on the construction of the tunnel in a previous article on April 20, 1897, when the project had entered on the stage of a practical undertaking. Four years having passed since that time, it is not uninteresting to review the progress that has been made, and see how far the ingenuity of the engineers has triumphed and what prospect there is of a completion within the term originally assigned. The contract for the construction of the tunnel was signed by Messrs. Brandt, Brandau and Co. on August 13, 1898, but this firm stipulated for three months' grace before boring operations should commence. Consequently, November 13 is the date from which the five and a half years demanded for the construction of the tunnel is to be reckoned, and the critical epoch will be May 13, 1904, when a fine of 5000 francs a day will be demanded from the firm for the non-fulfilment of the contract, or a reward of similar amount be paid to them for the earlier completion. Practically, 2000 days have been assumed as sufficient to bore through 19,734 m. of rock, consequently the average daily progress should be 9·86 m. Of course, this perforation applies to the distance traversed at both ends, because the work really consists in making two tunnels of approximately equal length, whose ends shall join in the middle of the mountain. From data supplied in an article by Herr L. Ernst in *Die Umschau* for April 13, it is easy to compare the actual advance made at either end with the daily average that the contractors hoped to make. The attack on the north side was begun on November 22, 1898, and at first the boring machines encountered a tolerably soft stone, and the progress was proportionately rapid, attaining a daily maximum of 6·5 metres. But on reaching the gneiss, of which the general mass of the mountain is composed, the workmen had to content themselves with a daily average of 5·28 metres. But on January 1, 1901, or 769 days after commencing operations, a tunnel of 4119 metres actually existed, and this gives an average advance of 5·4 metres daily. On the south side, owing to some difficulties with the Italian Government, who objected to the employment of dynamite for blasting operations, the boring machines did not get to work till December 24. Further, a much harder stone had to be penetrated on the southern side, and the daily progress was only 3·71 m.; but the employment of more efficient water power has raised this slow advance to 4·5 m. Effectually, a tunnel of 3148 m. had been bored by January 1; and this gives an average progress of 4·3 m. Clearly, therefore, the daily advance at the two ends is slightly behind the anticipated amount by 0·26 m., but by the removal of initial difficulties and greater experience on the part of the management, this slight deficit may be wiped out.

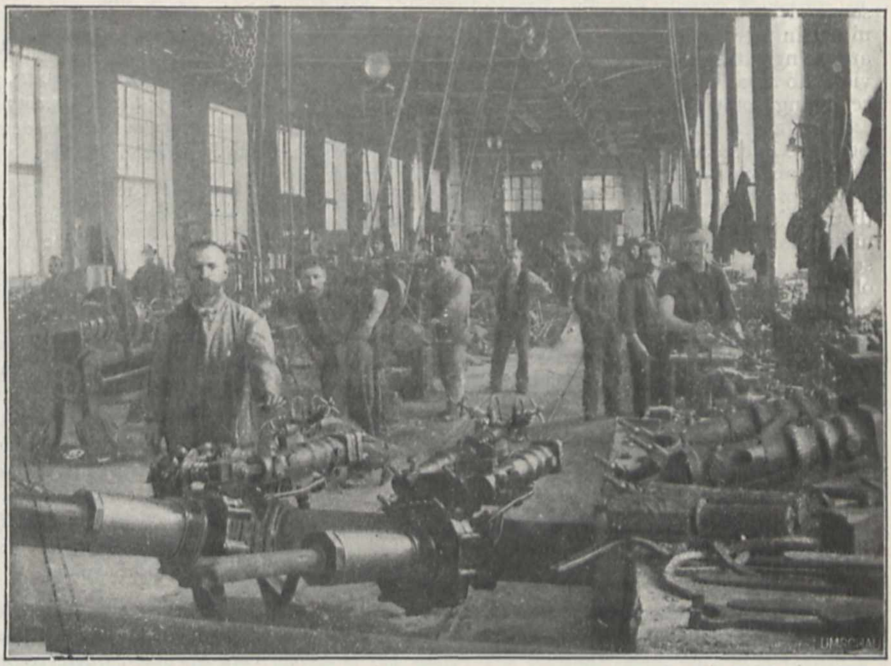


FIG. 1.—Workshop in Brieg, Switzerland, at the foot of the road leading over the Simplon Pass. In the foreground are two boring chisels mounted on one stand. (From *Die Umschau*.)

Very considerable modifications have been introduced in the form and manner of working of the boring machines. In the earlier constructed tunnels the boring chisels, faced with diamond, cut their way into the rock, the motive power being compressed air, the compression being effected by hydraulic machinery. Herr Brandt recognised the loss of mechanical power in this arrangement, and decided to use water pressure direct on the boring apparatus. At the same time he dispensed with the diamond cutting process, which, by means of rapid rotation, worked its way into the stone as a saw, substituting a hard steel face to the chisel, which is driven against the rock and rotates slowly, about six times a minute. The boring tool is made hollow, and the detached fragments collect in the tube and are expelled by water power. Two boring chisels are mounted on each stand and are worked simultaneously (Fig. 1). The aperture of each borer is 10 cm., and is driven into the rock a distance of 2 m. Into the aperture thus formed a cartridge of dynamite is placed and exploded, the rock shattered by blasting has to be removed, and the borer is then pushed forward and the operation continued. On the northern side this cycle of boring, blasting and removal is effected in about seven hours, on the southern side in about an hour less, more time being required to remove the *débris* on the north than on the south. The transport of the masses of rock detached by the blasting is necessarily a work of enormous labour, and compels the boring machine to be idle while it is effected. Herr Brandt designed a machine to accelerate the removal of the rubbish by making it slide along smooth iron plates arranged to receive it. But the application has not proved so useful as was anticipated, and its employment is at present abandoned.

In the explosion of the blasting charge, liquid air or oxygen has been used with good effect. The charcoal covering of the charge is, shortly before use, steeped in liquid oxygen, and the recovery of the gaseous form has the advantage of mitigating some of the evils the presence of carbonic oxide tends to produce. But improvements in this process are still demanded, and experiments are being carried on by Prof. Linde, of Munich, with a view to making the combustion more perfect and removing some of the noxious vapours due to blasting.

We gather that the attempts made to lower the temperature in the cutting have not proved quite as successful as was anticipated. As mentioned in our former article, it was proposed to effect the necessary cooling by the distribution throughout the workings of a water dust under considerable pressure. In pursuance of this plan some 70 litres of water per second, and under a pressure of 100 atmospheres, are scattered throughout the gallery by means of machines placed in the crossway alleys that lead from the main boring to the parallel gallery. Such a liberal expenditure of water has been found sufficient to enable miners to continue working at depths where the ordinary temperature is greater than has been encountered in the Simplon. But Herr Ernst is not yet satisfied; he says that the temperature question is still unsolved, and gives the following figures for comparison with the Gotthard workings.

	Temp. at 7·3 km. from north entrance.	Temp. at 7·05 km. from south entrance.
April and May, 1880 ...	30°·46 C.	30°·53 C.
June, 1882 (after perforation) ...	23·73 C.	23·39 C.
July, 1883 ...	22·20 C.	23·1 C.

But in the Simplon, at only 1400 metres from the southern entrance, a temperature of 30° C. has been experienced, while the water of a spring near that point showed a temperature of 33° C. Fortunately, the water supply is adequate and easily accessible whether on the north or south side. On the north the Rhone feeds a reservoir formed 44 m. above the tunnel entrance at the rate of 6000–8000 litres per hour. At the southern end, near Isella, the Diveria is equally available, and from both sources it is estimated that the undertaking has at hand the equivalent of 2000 h.p., sufficient for the driving of the pressure-pumps and boring machinery, the ventilation of the shaft, the mechanical workshops, the electric illumination and numerous experimental works.

Recalling the carelessness of life and enervating sickness that decimated the workpeople in the case of the Gotthard tunnel, it is refreshing to notice the care and attention that are bestowed on the comforts of the operators in this instance. Provision is made for frequent baths, and changes of clothes are insisted upon, the maintenance of a simple system ensuring regularity and obedience. A school and hospital, not to mention a theatre, are provided for the use of the workpeople, and hostelries are erected wherein the meals are arranged at fixed and certainly very low prices. A regular meal of soup, meat and vegetables costs but 50 cents, the full ration for the day being 1·10 francs. The daily wage does not seem large at 3 or 4 francs, but apparently is sufficiently attractive, and we are assured that the careful wage earner can send a modest contribution to his relatives every month. A whole colony has settled down under the shadow of the Simplon, but the man whose genius has called into being this hive of workers, whose activity has encouraged and animated the whole undertaking, whose resourceful energy has overborne so many difficulties, is no longer at the fore to guard against future dangers and to guide the whole to a successful issue. Herr Brandt died in November 1899, when progress was slow but assured. He has, however, left four able lieutenants, who, trained in his school and possessed of not less devotion and energy, will carry through the arduous work and permit us to see yet another and the longest tunnel under the Alps pushed to a successful termination.

NOTES.

PROF. E. VAN BENEDEN, professor of zoology and comparative anatomy in the University of Liège, has been elected a correspondant of the Paris Academy of Sciences in succession to the late Sir William Flower.

THE next meeting of the American Association for the Advancement of Science will be held in Denver, Colorado, on August 24–31. The membership of the Association is now larger than it ever was before, more than eight hundred new members having been elected within the past year. As already mentioned, it is proposed to hold a winter meeting each year in the week in which New Year's day falls, and the summer meeting may eventually be omitted altogether. Of the fourteen universities forming the Association of American Universities, twelve already do not open their terms until after the week in which New Year's day occurs, or have arranged not to do so, and it is expected that the remaining two will come to the same decision. A convocation week will thus be set aside for the annual meetings of scientific and learned societies, and the difficulty of getting men of science together during the summer holidays will be avoided.

A NEW magnetic observatory is being established just now in France. It is situated at a distance of only thirty miles from Parc St. Maur, where records have been rendered impossible, electrical railways using the earth for return currents having been laid in almost every direction. The new observatory is situated in the small parish of Villepreux, in a district occupied by farms, cornfields and woods. The authorisation was granted by the Government only when the railway companies had paid to the National Treasury a sum of 1200*l*., sufficient for paying all the expenses of the new building. These have been greatly diminished because the land covers about ten acres belonging to the Government, and some old buildings without any artistic value can be demolished for procuring the stones required in order to construct the magnetic pavilions and a house for the observer. M. Moureau will continue to reside at Parc St. Maur, and the new observatory will be considered as an accessory to the old one.

THE importance of the scientific study of Africa and its native inhabitants has often been urged in these columns. We notice, therefore, with much satisfaction that the African Society has been formed with the object of enlarging and extending the work done by the late Miss Mary Kingsley, so as to include the whole of Africa in the field of operations. The Society will thus not only commemorate the name and continue the investigations of Miss Kingsley, but should lead to the organised investigation of the native races of Africa, the natural history, resources, diseases and other subjects upon which exact knowledge is required. In Germany the publication of a journal, as well as of some books dealing with many of these subjects, has already been inaugurated under the auspices of the Government. In France an independent society, more on the lines of what is now proposed, is at work in French Africa, and other European nations are advancing in the same direction. England ought not to be behind in this work, and the new society will do good service by encouraging interest in its objects. At the meeting held on Friday last, when the first meeting of the Society was held, the Marquis of Ripon, who occupied the chair as president, pointed out the need for scientific research in Africa. In order to discharge the responsibilities of Empire it is essential, he remarked, to set to work to understand the full and complete nature of the problems with which we had to deal, to study the whole field of African affairs, and, above all, to endeavour to understand, so far as might be possible, the thoughts, the views, the opinions and laws of the people. It is only by this means that we can arrive at a state of things in which our administration is likely to be successful. The secretary of the Society is Mr. R. Sewell, 22, Albemarle Street, London, W., to which address all communications should be sent.

THERE is no doubt that the establishment of an experimental tank in which models of ships could be tested for resistance, form, stability and other qualities would benefit the science of naval architecture in this country. The subject was brought before the meeting of the Institution of Naval Architects at Glasgow last week, and received much support. Dr. Elgar directed attention to this question in describing how the Government tank at Washington was available for the use of private shipbuilders on the payment of a fee merely covering expenses. Mr. A. F. Yarrow, referring to this statement, pointed out that the British Admiralty had an experimental tank of their own at Haslar, near Portsmouth. There was one other tank in this country, which was owned by a private shipbuilding firm. Mr. Yarrow submitted that, having in view the rapid increase in competition in shipbuilding, it was desirable that no stone should be left unturned by the shipbuilders in this country to keep well to the front, and that all the means modern knowledge could give should be made available for ship designers. He therefore proposed that the Institution of Naval Architects should take into consideration whether such a tank should not be established under its auspices, so that it might be available, not only for shipbuilders in this country and members of the Institution, but also for all willing to pay for the information to be obtained, irrespective of nationality. Sir Nathaniel Barnaby referred to the immense benefit that had accrued to the science and practice of naval architecture by the investigations of the late Mr. Froude, which he had carried out by means of the experimental tank he ad originated, and by means of which various qualities of different forms of ship could be determined with models of practicable size. At the present time all types of British war vessels were tried in this way. The resolution suggested by Mr. Yarrow was to the following effect:—"That this meeting, having regard to the desirability of establishing a tank in this country for testing the resistance of models, and which might be available for all shipbuilders, request the council of the Institution to take the matter into serious consideration with a view to arriving at the best means of carrying out the suggestion." This was put as a motion by Lord Brassey and seconded by Sir Nathaniel Barnaby, and carried with acclamation.

DURING the past few days exceptionally high temperature conditions have prevailed in New York and the neighbourhood, and have resulted in numerous deaths from heat apoplexy. On Monday shade temperatures from 103° Fahr. to 111° Fahr. were recorded, and the official reading was 98° Fahr. The minimum night temperature was 87° Fahr.

THE Berlin correspondent of the *Times* announces the death of Prof. Johannes Lamp, one of the scientific members of the expedition which was charged with the demarcation of the boundary between German East Africa and the Congo State in the neighbourhood of Lake Kivu. Prof. Lamp, who was born at Kiel, was for some time employed at the Geodetic Institute in Berlin. He was afterwards appointed to the observatory at Kiel, and held a professorship at the University of that city.

WE learn from the *British Medical Journal* that a bust of Dr. Armauer Hansen, the discoverer of the bacillus of leprosy, will be unveiled with appropriate rites in the Lungegaards-Hospital at Bergen on August 10. In order to give the ceremony as much of an international character as possible, an invitation has been issued to prominent members of the medical profession throughout the world by Prof. Rudolf Virchow, president of the committee. Gerhard Henrik Armauer Hansen was born at Bergen in Norway in 1841, and has spent the whole of his professional life in that town, where he was for many years on the staff of the Lungegaards-Hospital.

IT is stated by the *Engineer* that the General Electric Company of Berlin has just completed near Naples, in the valley of Pompeii, an installation for the transmission of electric energy, all the conductors used being of aluminium. This installation comprises three horizontal turbines of 150 horse-power, working at 190 revolutions per minute. These turbines each drive a triphase alternator, and the current, at a tension of 3600 volts, is led along three aluminium lines to Pompeii, Sarno and Torre Annunziata. The first of these lines, which has a length of about 3 kilometres, leads to a substation comprised of two three-phase transformers of 45 kilowatts. The second line, which leads to Sarno, has a length of 15 kilometres; it conducts the current to a tri-phase motor working at 3500 volts, and driving a continuous-current dynamo of 36 kilowatts capacity. This installation supplies a three-wire system at a tension of 240 volts. Finally, the line to Torre Annunziata has a length of 3·5 kilometres, the current serving for motive power in the macaroni factories in the district.

IN an interesting and useful supplement to the Daily Weather Report, the Meteorological Council have published values for pressure, temperature, rainfall and bright sunshine for each month of the year. The sunshine values refer to a period of twenty years, temperature and pressure thirty years, and rainfall thirty-five years, all ending with the year 1900. With regard to temperature, a glance at the tables shows when the highest maxima of the period occurred. The maxima in London were: 96° (August 1876), 91° (June 1878), 95° (July 1881), and 91° (September 1898). The coldest winters occurred in 1881 and 1895, the lowest readings in London being respectively 9° (January) and 10° (February). Much lower readings were registered in other parts of England and in Scotland.

WE have received the Report of the director of the Liverpool Observatory, Bidston, containing the result of the astronomical and meteorological observations taken in the year 1900. The work of this Observatory dates back to the year 1845, and the observations, which are taken with every care, form a very valuable contribution to our knowledge of those sciences. The transit instrument has been used continuously for the determination of time and continues to give entire satisfaction, and the self-recording meteorological instruments have worked without failure the whole of the year. A Milne seismometer, provided by the Earthquake Committee of the British Association, has recently been added to the existing apparatus. As in former years, a useful comparison has been made between the records of Osler's and Dines' anemometers, and the results for each day tabulated. During a very severe gale on December 28, 1900, the Osler instrument recorded a pressure of 44·4 pounds on the square foot, the resulting maximum velocity shown by the Dines' anemometer being eighty-two miles.

M. ARÇTOWSKI, of the *Belgica* Expedition, contributes to *Ciel et Terre* a note on the climate of glacial periods. Assuming the changes in the level of the snow-line to have been due to changes of temperature only, M. Arçtowski compares its present position at Cape Horn and in South Georgia, and estimates the corresponding differences of mean temperature, obtaining for a difference of level of 800 to 900 metres a difference of temperature of about 8° C. He urges the special importance of studying the conditions in oceanic climates, and expresses the opinion that the exploration of the Antarctic regions will give the true explanation of the occurrence of glacial periods.

WE have received from the authors a reprint of a paper published in the *Memoires* of the Belgian Academy of Sciences, by MM. H. Arçtowski and A. F. Renard, on the soundings and bottom deposits obtained during the expedition of the *Belgica*. Although this is a preliminary report, it is not expected that the detailed examination of the deposits, which remains to be completed, will seriously modify the conclusions arrived at. The most important points disclosed by the soundings are the existence of a depression of 4040 metres to the south of Staten Island, and of a continental plateau extending south of the 70th parallel. It is noteworthy that the boundary of this plateau is indicated by the isobath of 500 metres rather than by the usual 200 metres. In examining the deposits, the methods employed by Thoulet have been employed in preference to those of Murray and Renard, as the samples are chiefly terrigenous. The chief interest lies in the obvious iceberg origin of most of the deposits, indicating the presence of glaciers on continental land to the south and east of the region of the *Belgica's* drift. Another feature is the interruption of the zone of diatom ooze in this region.

AN account of the first voyage of the Norwegian fishery steamer, *Michael Sars*, during the summer of 1900, by Prof. Hjort, is published in the last two numbers of *Petermann's Mitteilungen*. The paper consists of three distinct parts—(1) oceanographical results, by Bjorn Helland-Hausen; (2) the distribution of some of the chief forms of Plankton in the Norwegian Sea, by Dr. H. H. Gran; and (3) fishery investigations, by Dr. Hjort. The course of the expedition was from Bergen, across to Iceland, along its north coast to Denmark Strait, thence to Jan Mayen, the Lafotens, Porsanger Fjord, Bear Island, westward to near long. 10° E., and home. The cruise lasted from July to September, and these preliminary results afford important extension and confirmation of the work of the Danish *Ingolf* expedition in the same regions.

THE July Pilot Chart for the North Atlantic and Mediterranean, issued by the Meteorological Office, shows graphically the general circulation of the air and of the sea for the month. The region in which gales form as much as 10 per cent. of the wind observations is now limited to the immediate neighbourhood of the southern extremity of Greenland. With the month of July the conditions in the tropics begin to assume a more disturbed appearance, and the seaman consequently finds the letterpress to be largely devoted to a description of West Indian hurricanes and a concise summary of practical rules for handling ships in or near these storms. The path of one of the hurricanes of July 1837 is shown on the chart. As only 355 hurricanes have been recorded in 300 years, the annual average is little more than one, but in July 33 were experienced last century, so that one may be expected every three years in this month. A good deal of information is given on the winds in the Dardanelles. An inset chart gives a thunderstorm type of pressure distribution over western Europe, the remarks stating that there are three distinct classes, (1) those coming from the southward; (2) those forming locally; and (3) those appearing as secondaries to depressions in the north. The first of these is the one illustrated. It is interesting to observe how the shading representing fog has been expanding month by month, until in July it extends without a break right across the Atlantic between 40° and 50° N., but it is only about the middle of the Bank of Newfoundland that the frequency amounts to 50 per cent. Mariners going up the Labrador coast are informed that during the few days of summer the displacement of the horizon by mirage in this neighbourhood occasions great difficulty in obtaining good observations for position. The north-eastward extension of the Gulf Stream drift towards our coasts, which was shown to be interrupted in May and re-established in June, is again overcome by a general southward flow of the surface water between 10° and 30° W., the Gulf Stream water apparently not extending northward of the 50th parallel even on the western side of the ocean. Icebergs have at last appeared about the banks, a number having been sighted between April 30 and June 1, nearly all clustering about 48° N. 48° W., but one in 46° N. 56° W.

WE drew attention in NATURE (January 17) to the first number of the *Geologisches Centralblatt*, which is edited by Prof. Dr. K. Keilhack. We have since received Nos. 2 to 10, the last named published on May 15. The total number of works dealt with is 1027, so that our estimate that about 2500 will be recorded in the year is probably correct. It is hardly possible to judge of the completeness of the record until the volume for the year is published, but we think that space could be saved by shorter notices of works that are not original articles, such as excursion notes, popular general papers on geology and economic products, text-books, &c. As an illustration of somewhat unequal treatment we observe that the notice of the Summary of Progress of the Geological Survey of the United Kingdom occupies two pages, and that of the Summary Report of the Geological Survey of Canada only five lines. A valuable feature in the work is the insertion of tables showing new groupings of strata and revised classifications of organic remains. Taken as a whole, it cannot fail to be of permanent service to geologists.

THE University of Nebraska publishes a contribution (No. 5) to the Botanical Survey of Nebraska, conducted by the botanical seminar. The present instalment consists of a number of papers on the general features of the flora rather than of lists of species.

IN the *Journal* of the Royal Microscopical Society for April and June are two of Mr. E. M. Nelson's useful papers on the construction of the microscope—on tube length and on the working aperture. Mr. Nelson points out that there are no less than three different measurements known as tube lengths, viz. the mechanical tube, the natural optical tube length, and the conventional optical tube length. A table is given of the variations in the lengths of the two different optical tubes for the objectives of various makers and the effect these variations have upon the power. In the second paper Mr. Nelson advocates the importance of distinguishing more accurately than has hitherto been the practice the precise ratio of the diameter of that part of the objective which is utilised to the diameter of the lens itself.

THE report of the experiments superintended by the Department of Agriculture in Cambridge University has just been issued. The experiments are conducted on various farms in the adjoining counties, which contribute towards the expenses of the Agricultural Department at the University. The volume issued is really a bundle of reports written by different persons, and no attempt is made to describe the work as a whole. Most of the experiments are of considerable interest, and will be of practical value in their respective localities. More exact descriptions of the conditions of each experiment are, however, required if any real addition to our knowledge is intended. An analysis of a soil conveys no certain information unless we know the depth which the sample represents. We cannot interpret the variable action of manures unless we know the rainfall during the seasons in question.

IN part iv. of vol. xxii. of the *Notes* from the Leyden Museum, Dr. O. Finsch catalogues the birds of the "South-west Islands," with three coloured plates of some of the less known species. The small islands in question form a chain stretching from the northern extremity of Timor in an easterly direction to Timorlaut. Although the birds from some of these islets have been described by the officials of the Tring Museum, of others the bird-fauna is practically unknown. Dr. Finsch records a total of 123 species. One of the most striking and beautiful of these is the great red-brown fruit-pigeon named by Schlegel in honour of Dr. Hoedt, a former worker on the avifauna of these islands. For the future, the author suggests that this bird should represent a genus by itself, and be known as *Alopecaenus hoedti*.

THE number of new generic, specific and subspecific names that have been proposed for North American mammals during the last twenty years is so enormous that it was a matter of the greatest difficulty for a student to be certain that he had exhausted the list in any particular group upon which he might be engaged. This difficulty has been removed by the appearance of a "Synopsis of the Mammals of North America and the Adjacent Seas," by Dr. D. G. Elliot, which forms vol. ii. of the zoological series of publications of the Field Columbian Museum. The synopsis is well illustrated by reproductions from photographs of skulls. Although the author states that many of the species and subspecies recorded are probably nominal, the task of abolishing such superfluous names is left to his successors. In the main the work appears to be very accurate, but we notice a few omissions, and when describing the wood-bison the author states that it is a larger animal than its cousin of the plains, although the measurements given of the two forms indicate just the contrary.

IN the issue of *Die Umschau* of June 15, Prof. W. Amalitzky announces the discovery of gigantic anomodont and other reptiles in a Permian deposit at Sokolki, on the Dwina, Russia. The bones occur in an old river channel cut in Lower Permian beds and subsequently filled up with sandstone. Regular excavations have been undertaken, with the result that a very large number of skeletons and separate bones have been disinterred. Most of these are embedded in hard nodules, and a considerable sum of money is required for their proper development. Most noticeable is the discovery of no less than from fifteen to twenty skeletons of the huge anomodont Pariasaurus, hitherto known only from South Africa. One of these has been developed, and measures 11 feet in length. Remains of Dicynodon and other anomodonts, as well as dinosaurs and a labyrinthodont, are likewise recorded. According to Prof. Amalitzky, the reptilian remains are associated with ferns belonging to the well-known "Glossopteris flora"; and it would accordingly appear that this peculiar southern fauna and flora, which formed a belt round the globe in low latitudes during early Mesozoic times, had a northern extension into eastern Europe.

THE *American Museum Journal* for April and May contains a figure of one of five specimens of the Greenland musk-ox which have recently been mounted for exhibition. This form of musk-ox, it will be remembered, was described not long ago in NATURE as *Ovibos moschatus wardi*; and the American Museum has now acquired a fine series of specimens, which have enabled Dr. J. A. Allen to point out characters regarded as sufficient to justify the assignation of specific rank to this animal. On a later page of the same journal, stress is laid on the importance of exhibiting in museums groups of mounted mammals and birds amid their natural surroundings, as it is by this means alone that their full educational value can be obtained from the specimens. By the aid of liberal donations from private sources, much has already been done in this way in the American Museum, and it is confidently hoped that still more will be accomplished in the near future. It is a matter for regret that, so far as the larger mammals are concerned, little or nothing of this sort has hitherto been attempted in our own national collection. But millionaires in this country do not seem inclined to devote some of their spare thousands to such objects.

AN address on the historical development and the problems of anthropology, delivered by Dr. B. Hagen at the anniversary gathering of the Senckenberg Society of Natural Science, Frankfort on the Main, last year, has been translated by Mr. W. L. H. Duckworth and published by the Anthropological Laboratory, Cambridge. According to the translation, which alone has reached us, Dr. Hagen adopts a common but somewhat arbitrary division of the science of man into "anthropology," which deals with the physical structure of man and "the mode of life," and into "ethnology," or psychical aspect, comprising folk-lore, comparative psychology, sociology and psycho-physics. It is not clear what "the mode of life" means or why that is regarded as physical and the investigation of the senses and sense organ entirely relegated to "ethnology." Speaking of craniology, Dr. Hagen states that "we are not at the present day in a position to determine with certainty the racial identity of a given skull, with the exception, perhaps, of hyper-typical examples of Australians or Negroes." He believes there is but a single cranial type, the mesocephalic, of whose varieties the dolichocephals and brachycephals are the opposite extremes. "Stature is also a dangerous pitfall for metrical anthropology in general." Evidently the "anthropologists" of this classification cannot reduce the facts of the study of man into order without the help of the "ethnologists;" but we are warned that "the linguist must not regard the ethnologist, nor he in turn the anthropologist, with disdain."

CATALASE is the name given to a new enzyme of general occurrence described by Dr. Oscar Loew in Report (No. 68) of the U.S. Department of Agriculture (Division of Vegetable Physiology and Pathology) with special reference to the tobacco plant. This enzyme possesses the power of producing catalytic decomposition of hydrogen peroxide, a decomposition which, according to the author's experiments, is probably not produced by any other known enzyme. The enzyme appears to exist in an insoluble and in a soluble form, which are designated α- and β-catalase respectively. The former is probably a compound of the soluble catalase with a nucleo-proteid, while the β- form is an albuminose and can be liberated by the action of very dilute alkaline media upon the insoluble catalase. The behaviour of the enzyme towards various salts, acids, bases and other reagents has been carefully investigated. Experiments on the nature of catalase indicate that it is an oxidising enzyme, the most characteristic reaction studied in this direction being its rapid oxidation of hydroquinone to quinone. Numerous tests have established the general occurrence of catalase in the vegetable kingdon. No living plant or vegetable organ tested was found free from it, some plants containing more of the soluble, others more of the insoluble, form. In the animal kingdom it also appears to be widely distributed, having been found in aqueous extracts of spleen, pancreas, liver, kidney, brain, muscles and blood serum. Infusoria, insects, worms and molluscs were also examined, with positive results.

THE additions to the Zoological Society's Gardens during the past week include two North African Jackals (*Canis anthus*) from Algeria, presented by Mr. G. E. Hope; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mrs. Mould; a Suricate (*Suricata tetradactyla*) from South Africa, presented by Captain R. Feilden; a Leopard (*Felis pardus*) from Africa, presented by Captain G. Burrows; two Stanley Cranes (*Anthropoides paradisea*) from South Africa, presented by Mr. A. W. Guthrie; a Yellow-cheeked Amazon (*Chrysotis autumnalis*) from Honduras, presented by Mrs. Bullock; a Rough-legged Buzzard (*Archibuteo lagopus*) from Norway, presented by Dr. E. A. Williams; a Leopard Tortoise (*Testudo pardalis*) from South Africa, presented by Major J. Day; five Leith's Tortoises (*Testudo leithi*), eight Basilisk Chameleons (*Chamaeleon basiliscus*), two Common Chameleons (*Chamaeleon vulgaris*), three Schneider's Skinks (*Eumeces schneideri*) from Egypt, presented by Mr. Stanley S. Flower; a Spix's Macaw (*Cyanopsittacus spixi*) from North Brazil, two Barbary Wild Sheep (*Ovis tragelaphus*) from North Africa, a West African Python (*Python sebae*) from West Africa, fourteen North American Trionyx (*Trionyx ferox*), six Lesueur's Terrapins (*Malacoclemmys lesueuri*) from North America, seven Roofed Terrapins (*Kachuga tectum*) from India, two South American Rat Snakes (*Spilotes pullatus*) from South America, three Cunningham's Skinks (*Egernia cunninghami*) from Australia, two Wallace's Lories (*Eos wallacei*) from Waigiou, a New Zealand Parrakeet (*Cyanorhamphus novae-zealandiae*) from New Zealand, deposited; two Spoonbills (*Platalea leucorodia*), European, purchased; a Burrhel Wild Sheep (*Ovis burrhel*), a Squirrel-like Phalanger (*Petaurus sciureus*), two White Ibises (*Eudocimus albus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

SPECTRUM OF NOVA PERSEI.—In the current issue of *Comptes rendus* (vol. cxxxii. pp. 1542-1544) M. Deslandres gives a third series of observations of the spectrum of Nova Persei as obtained at the Meudon Observatory. Since the previous communication, spectrographs of varying power have been installed for use with the two telescopes of 0·84 metre and 0·60 metre aperture, and both photographic and visual records of the spectrum obtained during the periods of minima, although unfavourable weather has considerably interfered with their continuity. In this later work special attention has been devoted to the expected detection of the principal nebular lines. M. Deslandres states that during the first stages the principal green lines present were distinctly not the nebular lines, but the lines of parhelium, λ492 and λ5015, this being well shown in a photograph taken on March 3. On a plate taken on April 17, however, the measured position of the chief green line was λ5008, but on account of breadth of line the value is of course only approximate. The star was near its minimum brightness on this date. The gradual varying intensity of this line relative to the H_β line of hydrogen is then described, the details being in close agreement with those already published by other observers.

On May 14 a fainter line was seen near the next nebular line, about λ4959, the star being less than 7th magnitude, and he concludes that at that time the spectrum of the Nova was completely nebular, also mentioning that M. de Gothard had detected the ultra-violet nebular line λ386 in the spectrum of the star.

DARK SPOT ON JUPITER.—In the *Astronomische Nachrichten* (No. 3724) Mr. T. E. R. Phillips gives the results of several observations by others and himself extending from March 2 to June 2.

The spot as seen by these observers is in the white north tropical zone, in about latitude +15°. At present it appears to be quite detached from the northern edge of the north equatorial belt, but when first seen gave the impression of being merely a dark projection from that belt into the north tropical zone. Possibly the reason for the present appearance is the apparent narrowing of the belt which has been observed for some time past.

A table is given showing the results of nine determinations, the discussion of which indicates a period of 9h. 55m. 29·7s.

THE METEORIC EPOCH OF JULY AND AUGUST.

METEORS are generally rare in the early part of the year, and, in May and June, twilight is so strong that it obliterates faint objects and leaves only the more conspicuous class of meteors observable. But in July, though the sky is still very light and the nights extremely short, these objects become fairly plentiful and particularly so during the last week of the month, when the horary rate of apparition is about three times as great as it is on ordinary nights of spring and midsummer. The meteoric observer regards July and August not only as one of the most productive seasons of work, but one which in the interesting character of its results will compare favourably with that of any other epoch of the year.

There is a rich shower of Aquarids annually visible on about July 27-31, and apart from this stream the great system of Perseids, which has rendered the month of August so famous in meteoric annals, has actively commenced and supplies no inconsiderable proportion of the shooting stars visible at the close of July. Other showers are plentifully distributed over the firmament, but the majority are very feeble and may only be distinguished by close and prolonged watching during several clear nights.

The writer recently undertook the rediscussion of about 260 meteors which he has recorded from the shower of Aquarids, in various years, with a view to discover whether there were any indications of motion in the radiant. Grouping the observations into short periods and deducing the place of the radiant for each of them, it was found that no displacements occurred other than those which might be fairly attributed to errors in registering the paths. The radiants came out as follow:—

		α	δ	
		°	°	
July 23-25 ...	...	335	−11	11 meteors
July 26-31 ...	..	338	−12	190 ,,
August 1-5 ...	...	337	−12	18 ,,
August 6-13 ...	...	335	−11	12 ,,
August 14, 1887	...	335	−10	5 ,,
August 18-25 ...	...	339	−11	20 ,,

The centre of radiation, like that of the October Orionids, appears, therefore, to be motionless, and it continues visible for more than a month. In observing this stream care must be taken not to confuse it with two other pretty rich and contemporary showers at 345° ± 0° and 339° − 30°. The latter is near the bright southern star Fomalhaut.

In this department the observer's efforts have to be regulated in a great measure by moonlight, and this year our satellite will interfere in the earlier and later part of July. But it is probable that, with suitable weather, the first indications of the Perseid display may be well observed on about July 11-15. As the radiant centre of this system travels E.N.E. with the time, the observer should keep his materials for each night separate, and determine the place of radiation on every date when the conformable paths are adequate for that purpose. This position can scarcely be defined, either with safety or accuracy, when less than five well-observed meteors have been registered from it. But it is often satisfactorily obtained when two observers at separate stations record the same meteor. In a case like this the evidence is conclusive as to the position of the radiant, though it may be rendered a little inexact by errors of observation. But in instances where meteors are seen at one place only there are possibilities of mistake in attributing the radiants, for these have necessarily to be assumed from the directions of flight and visible aspect of the objects observed. In the case of the Perseid shower there is not, however, much probability that serious errors will occur in this respect, but everything depends upon the discrimination and discretion of the observer.

In recent years many amateurs have participated in systematic observations of the Perseids, and the number of doubly observed meteors has been greatly augmented. In July, 1900, three early Perseids were recorded in duplicate and gave heights and radiants as follow:—

	Height at beginning. Miles.	Height at end. Miles.	Radiant. ° °
July 19	81	54	17+50
,, 23	84	55	24+52
,, 30	95	50	30+52

In time it will be possible to accumulate a sufficient number of these observations to assign the radiant on every night during the last half of July. There will certainly be small errors in the individual positions, and they will not absolutely agree in showing the regular progression of the radiant eastwards, but the mean places derived from a considerable number of meteors will no doubt yield very satisfactory results.

In previous years much has been effected at the July and August epoch, but still more remains to be done. Photography, of which so much was expected, has achieved little, but its possibilities are great and it may ultimately prove as successful in this department as it has done in several others. The fact, however, remains that we are still mainly dependent upon eye observations, though they are no more than rough and hurried estimates of position, and scarcely capable of being usefully employed in any refined or critical investigations of the subject. But with care and long practice it is possible to acquire a degree of accuracy which would hardly have been credited, and we must not forget that some important conclusions have been safely based on rough eye observations. The virtual identity of comets and meteors has been established, the heights and velocities of meteors approximately determined, while the positions of some hundreds of radiants have been ascertained with fair accuracy. Features such as the motion of the Perseid centre, the stationary aspect of the Orionid and certain other radiants, and the large area of radiation of the meteors of Biela's comet, have been demonstrated. But much additional data are required, and as photography has hitherto supplied very meagre results, observers have to fall back upon the old-time method as vastly more productive if far less precise. It will be remembered that some years ago it was thought that the photographic plate would soon supersede the observer in regard to the delineation of planetary detail, but this idea has not been realised. It is true that planetary and meteoric observations are different and therefore not strictly comparable, but we have gained enough experience to see that the meteoric observer is in no immediate danger of being displaced.

W. F. DENNING.

THE "EDISON" STORAGE CELL.

CONSIDERABLE interest was aroused a short time ago by the announcement that Mr. Edison had invented a new secondary battery. As was only to be expected of a rumour, circulated mainly by the lay Press and dealing with one of Mr. Edison's inventions, it was said that the new cell was going to revolutionise entirely the electrical storage of energy and to throw open to the undisputed control of the electrical engineer the much-desired field of motor-car work. Fortunately, in this case, even if rumour has been somewhat extravagant, it has not been without foundation. Mr. Edison has in reality invented a new storage cell which is novel in principle and full of promise. A full description of the invention was given by Dr. A. E. Kennelly at the annual meeting of the American Institute of Electrical Engineers on May 21, and we are able, from a reprint of this paper which appeared in the *Electrical Review* of New York (May 25), to obtain data for a preliminary consideration of the merits of the cell.

Mr. Edison—like many other inventors, only with more success than is met with by most—set out with the object of devising a cell which should possess the following merits:—(1) Absence of deterioration by work, (2) large storage capacity per unit of mass, (3) capability of being rapidly charged and discharged, (4) ability to withstand careless treatment, and (5) inexpensiveness.

It will be best first to describe the solution that Mr. Edison has offered, and then to examine, as far as is possible from the information available, to how great a degree the above requirements are satisfied. The problem thus clearly stated by Dr. Kennelly is one which has been long realised by all interested in the matter, and by none, perhaps, more than by the makers and users of motor-cars. The one great difficulty in the construction of a good electrical motor-car, or in the equipment of a satisfactory system of accumulator tramways, has been the want of a suitable storage cell. If this were only provided, we have been told, then the electrical motor-car would know no rival, seeing that it would be free from all the objectionable noise and smell incidental to petroleum automobiles. It is, therefore, most earnestly to be hoped that the new Edison cell will do all that is claimed for it.

The cell is an entirely new departure in storage batteries, the materials used in its construction being iron and nickel oxide. The active material of the negative plate of the cell consists of iron, that of the positive plate of a superoxide of nickel believed to have the formula NiO_2. Thus the iron corresponds to the spongy lead and the oxide of nickel to the lead peroxide of a lead accumulator. The electrolyte used is an aqueous solution containing about 20 per cent. by weight of caustic potash. The E.M.F. of this combination—iron, potassium hydrate, nickel superoxide—is about 1·5 volts when fully charged and falls to about 1·15 at the end of the useful discharge. At the end of the discharge the iron is oxidised and the nickel oxide reduced; the charging process carries back the oxygen through the potash solution from the iron to the nickel plate, the energy being thus stored in the reduced iron, which, though unaffected by the solution in ordinary circumstances, is reoxidised when the cell is allowed to discharge. The solution, therefore, does

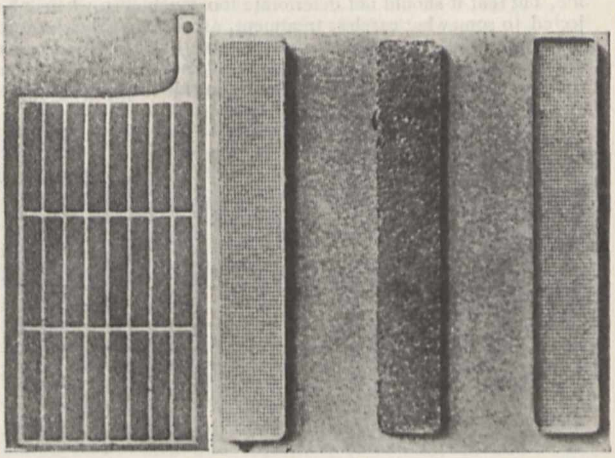


FIG. 1.—Grids and Briquettes, Edison Storage Battery. (From *The Electro-Chemist and Metallurgist.*)

not apparently enter at all into the chemical action which takes place, but only serves as a vehicle for transporting oxygen from the one plate to the other; this is of considerable advantage, as it allows a minimum of solution to be employed.

The mechanical construction of the two plates is identical, the only difference between them being in the active material used. The plates are made of comparatively thin sheets of steel (a little more than 0·5 mm. thick), out of which rectangular holes or "windows" are stamped. In the plates exhibited there were three rows of eight such windows, these holes occupying, of course, by far the greater proportion of the area, the steel framework being merely sufficient for strength and rigidity. Into these holes are fitted small nickel-plated steel boxes containing the active material in the form of closely consolidated briquettes. These boxes are somewhat thicker than the grid, being about 2·5 mm. thick in the finished plate, and are perforated, back and front, with numerous small holes to allow access of the electrolyte to the active material. The general appearance of the grid and briquettes can be seen from Fig. 1.

The positive briquettes are made by mixing a finely divided compound of iron with a nearly equal volume of thin flakes of graphite, the graphite being added to increase the conductivity of the briquettes. The mixture is pressed in a mould under an hydraulic pressure of about two tons per square inch. The surface area of each face of the briquette is about 3 inches by ½ inch. The negative briquettes are made in a precisely similar way, only a compound of nickel is used in place of the compound of iron. The method by which these compounds are obtained and their constitution was not described in Dr. Kennelly's paper, but from the patent specification it appears that the compound of iron used is the monosulphide, FeS, which is formed after being made up into the briquettes by electrolytic oxidation in a solution of potassium hydroxide. The superoxide of nickel is prepared in the same manner by electrolytic oxidation of the ordinary hydrated oxide of the metal. Cobalt, it is said, can be used instead, but is more expensive. The briquettes of active material are placed in the little nickel-plated steel boxes, a cover is put on, and the boxes are then inserted in the "windows" of the grid. The assembled plate is then subjected in an hydraulic press to a pressure of about 100 tons (about 1 or 1½ tons per square inch), thus tightly closing the boxes and, by bending their sides over the edges of the recesses in the grid, fixing them firmly in position and making the whole into a rigid plate. The plates are separated, positive from negative, by thin perforated sheets of hard rubber, and are placed in a steel box which is filled up with the potash solution. The cell is then charged by passing current through it from the nickel to the iron plate, thus oxidising the nickel compound to superoxide of nickel and reducing the iron compound to spongy metallic iron.

It is obviously impossible to say at present how far this cell will satisfy the five conditions already stated. With regard to the first and the last, for example, no data are as yet available. The first is naturally one of the most important considerations, since it is necessary not merely that the cell should have a long life, but that it should not deteriorate too much even when subjected to somewhat careless treatment, as it is certain to be if it come into at all general use for motor-cars. Certain experiments which were quoted by Dr. Kennelly lead, however, to the hope that the cell will not be found wanting in this respect. Thus it was stated that the battery would stand without injury, not only being completely run down, but even being afterwards charged in the wrong direction. Mr. Edison also states that the nickel plate can be removed from the cell and dried in the air for a week without being injured, and if charged when thus removed will not appreciably lose its charge. The iron plate, if similarly treated, will lose its charge by the slow oxidation of the spongy iron, but will not be in any way permanently injured.

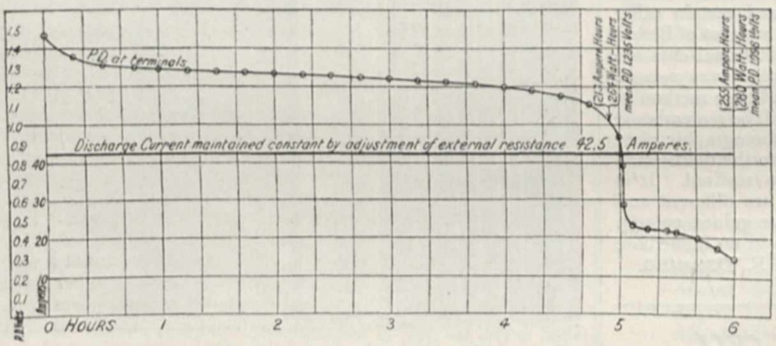


FIG. 2.—Curve of discharge of Edison cell weighing 25 pounds.

Perhaps the consideration that appeals most directly to motor-car users is lightness, or large storage capacity per unit weight. In this respect the cell compares very favourably with lead accumulators. According to Dr. Kennelly the storage capacity of the modern lead accumulator is from 4 to 6 watt-hours per lb., or from 9 to 13 watt-hours per kilogramme, whereas the Edison cell is said to have a capacity of 14 watt-hours per lb. (31 watt hours per kilogramme). It will be interesting to examine these figures a little more closely to see whether this claim to an increased storage capacity of about 3½ times is in reality justified. We reproduce in Fig. 2 a discharge curve for an Edison cell weighing 25lbs., discharging at 42·5 amperes for six hours. It will be seen that after five hours' discharge the voltage drops from 1·45 to 1·0 volt; although it may be possible to obtain the remaining hour's discharge without injury to the cell, yet it is very questionable whether this extra energy at so low a voltage as 0·5 volt would be found useful in practice. We are quite justified in saying, therefore, that this cell is only capable of giving five hours' discharge at 42·5 amperes, thus having a capacity of 213 ampere-hours, or 260 watt-hours. It has, therefore, a capacity of 10 watt-hours per lb. (22 per kilogramme), a figure somewhat lower than that given by Dr. Kennelly in the body of his paper. In an article on accumulators which appeared recently in the *Electro-Chemist and Metallurgist* (May 1901, p. 116), Mr. J. H. West gives a carefully calculated table of the capacities of all the principal accumulators exhibited at the Paris Exhibition or which took part in the Automobile Club competition of 1899. We can take from this table the figures relating to accumulators having a capacity of 200 ampere-hours and discharging in five hours, which are exactly comparable, therefore, with the Edison cell, the discharge curve of which is given in Fig. 2. Calculating from these data we get the results given in the accompanying table; there are 19 cells included in Mr. West's list, but as some of these are heavy cells intended for stationary work, a mean result has been worked out in which the heavier cells are neglected as well as a mean for the whole number.

TABLE.

Cell	Energy stored	
	Watt-hours per kilogramme	Watt-hours per pound
Mean of all cells in Mr. West's table	7	3
Mean of lighter cells ,, ,,	13	6
Lightest cell (Sherrin) ,, ,,	26	12
Edison's cell, from curve	22	10
,, ,, Dr. Kennelly's figures...	31	14

As the figures given by Mr. West only refer to ampere-hours, we have assumed in calculating the table that the mean voltage during discharge is 1·85 volts, a somewhat low estimate, and one therefore favouring the Edison cell in the above comparison. It will be seen from this table that the Edison cell when compared with the lightest lead accumulator obtainable is by no means so pre-eminent as regards energy capacity per unit weight. The Sherrin cell, it may be remarked, came very successfully through the Automobile Club's competition, being the only one which did not fall below the specified voltage more than three times during the trials. Although the figures given above may seem to militate against the claims advanced in favour of the new battery, it must be remembered that high storage capacity is not the only advantage that it is said to possess; even if it were no better than lead cells in this respect, if it proves superior to them in the other four conditions it will be a great advance. Also it must not be forgotten that the cell is quite new and that no doubt great improvement may be looked for when it is produced in large quantities.

THE BIOLOGY OF MOUNT SHASTA.

THE results of a biological survey of Mount Shasta, California, are contained in a *Bulletin* [1] recently received. This publication of 169 pages, with forty-six text illustrations and five heliotype plates, is a worthy successor to its forerunners, now so well known, and in every respect equal to the best of them.

It is the result of an investigation by the Biological Division of the U.S. Department of Agriculture under Dr. C. Hart Merriam, chief of the Biological Survey, which was decided upon in 1898, after the completion of the exploration of southern, middle, and north-east portions of the vast Californian area. The great altitude of the mountain (14,450 feet), and its position between the Sierra Nevada and the Cascades of

1 "North American Fauna," No. 16. U.S. Department of Agriculture. Washington: Government Printing Office, 1899.)

Oregon, invest it with an exceptional interest, in relation to the question of the probable limitations in distribution of the animals and plants peculiar to these; and in the end the unexpected result has been obtained that, although the gap between the Shasta and the Cascades is far less than between it and the Sierra Range, and while plants and animals representative of both ranges are present upon it, the Sierra species are predominant.

In the course of the expedition names were given to newly-discovered peaks and canyons, and at points in the ascent favourable for work and observation individual members of the exploring party were left encamped, in one case for a period of well-nigh a couple of months. The net result biologically has been the discovery of five new species of plants, eight of mammals.

The Report opens with a description of the general features of the mountain; and its glaciers, basins, canyons, streams, slopes, timber-lines, and other natural features, are in turn dealt with in an amply and beautifully illustrated manner.

There then follows a systematic report upon the forest trees and a description of the life zones above 5500 feet, that being the altitude of limitation of the "transition zone" of the mountain, the facies of which are those of the surrounding country. The fauna and flora of this are given, and the superposed heights are next dealt with under zones as follows: the Canadian zone, of 2000 feet, which is defined as a "continuous forest of stately trees"; the Hudsonian, also of 2000, the highest of the timber-belts, characterised by the presence of but two species of trees—a hemlock and a white-bark pine; and the Alpine zone, or that occupying the interval between the timber-line and upper limit of plant growth.

The fauna and flora of each of these are in turn given in full in the form of classified lists of species. Then follows a discussion, with comparison, of the boreal flora and fauna of Shasta and the Sierra and Cascades, again with classificatory lists, and of the surrounding gaps and rivers, regarded as barriers to boreal species. The greater part of the Report which remains consists of a systematic list of the mammals and birds of the area, arranged in order of classification, with full diagnoses and measurements, and "remarks" which embody interesting observations on the habits of more especially the burrowing animals. There follows a chapter on the distribution of the Shasta plants. Concerning the zoological synonymy, many who are familiar with Dr. Merriam's work will be prepared for subspecies and what we in Europe are apt to regard as splitting. In this Report there is little of it, and when the richness of the materials which Dr. Merriam and his contemporaries usually command is borne in mind, criticism of this order were best left in abeyance. In the course of the strictly zoological portion of the Report several new text illustrations are introduced, and any more life-like and fascinating than those of the Rock Cony (*Ochotona* [*Lagomys*]), the Mink (*Lutreola*) and Marten, or among the birds, of the Red Tail and the Clark Crow it would be difficult to imagine.

Shasta is characterised by nothing better than its scanty moisture, and the effect of this on the plant population and zonal distribution is fully discussed. We have nought but the highest praise for this Report. It fills us with envy and arouses feelings of mute admiration for the enterprise of Dr. Merriam and his co-workers in the field. It is worthy the nation that will levy a tax to aid in the foundation and maintenance of a university, and where wealth, long lavished on scientific exploration of the land of their birth, is now bringing its reward of commercial prosperity.

THE NADIR OF TEMPERATURE AND ALLIED PROBLEMS.[1]

DETAILS are given in this paper which have led to the following results:—

The helium thermometer which records 20°·5 absolute as the boiling point of hydrogen, gives as the melting point 16° absolute. This value does not differ greatly from the value previously deduced from the use of hydrogen gas thermometers, viz., 16°·7. The lowest temperature recorded by gas thermometry is 14°·5, but with more complete isolation and a lower pressure of exhaustion, it will be possible to reach about 13° absolute, which is the lowest temperature that can be commanded by the use of solid hydrogen. Until the experiments are repeated with a helium gas thermometer filled at different pressures, with the gas previously purified by cooling to the lowest temperature that can be reached by the use of solid hydrogen, no more accurate values can be deduced.

The latent heat of liquid hydrogen about the boiling point as deduced from the vapour pressures and helium-thermometer temperatures is about 200 units, and the latent heat of solid hydrogen is about 16 units.

The order of the specific heat of liquid hydrogen has been determined by observing the percentage of liquid that has to be quickly evaporated under exhaustion in order to reduce the temperature to the melting point of hydrogen, the vacuum vessel in which the experiment is made being immersed in liquid air. It was found that in the case of hydrogen the amount that had to be evaporated was 15 per cent. This value, along with the latent heat of evaporation, gives an average specific heat of the liquid between freezing and boiling point of about 6 When liquid nitrogen was similarly treated for comparison, the resulting specific heat of the liquid came out 0·43 or about 6 per atom. Hydrogen therefore follows the law of Dulong and Petit, and has the greatest specific heat of any known substance.

The same fine tube used in water, liquid air, and liquid hydrogen gave respectively the capillary ascents of 15·5, 2 and 5·5 divisions. The relative surface tension of water, liquid air and liquid hydrogen are therefore in the proportion of 15·5, 2, 0·4. In other words, the surface tension of hydrogen at its boiling point is about one-fifth that of liquid air under similar conditions. It does not exceed one thirty-fifth part the surface tension of water at the ordinary temperature.

The refractive index of liquid hydrogen determined by measuring the relative difference of focus for a parallel beam of light sent through a spherical vacuum vessel filled in succession with water, liquid oxygen and liquid hydrogen, gave the value 1·12. The theoretical value of the liquid refractive index is 1·11 at the boiling point of the liquid. This result is sufficient to show that hydrogen, like oxygen and nitrogen in the liquid condition, has a refractivity in accordance with theory.

Free hydrogen, helium and neon have been separated from air by two methods. The one depends on the use of liquid hydrogen to boil the dissolved gases out of air kept at a temperature near the melting point of nitrogen; the other on a simple arrangement for keeping the more volatile gases from getting into solution after separation by partial exhaustion. By the latter mode of working something like 1/34000th of the volume of the air liquefied appears as uncondensed gas. The latter method is only a qualitative one for the recognition and separation of a part of the hydrogen in air. In a former paper on the "Liquefaction of Air and the Detection of Impurities" (*Chem. Soc. Proc.*, 1897), it was shown that 100 c.c. of liquid air could dissolve 20 c.c. of hydrogen at the same temperature. The crude gas separated from air by the second method gave on analysis—hydrogen 32·5 per cent., nitrogen 8 per cent., helium, neon, &c., 60 per cent. After removing the hydrogen and nitrogen the neon can be solidified by cooling in liquid hydrogen and the more volatile portions separated.

There exists in air a gaseous material that may be separated without the liquefaction of the air. For this purpose air has to be sucked through a spiral tube filled with glass wool immersed in liquid air. After a considerable quantity of air has been passed, the spiral is exhausted at the low temperature of the liquid air bath. The spiral tube is now removed and allowed to heat up to the ordinary temperature, and the condensed gas taken out by the pump. After purification by spectroscopic fractionation, the gas filled into vacuum tubes gives the chief lines of xenon. The spectroscopic examination of the material will be dealt with in a separate paper by Prof. Liveing and myself. A similar experiment made with liquid air kept under exhaustion, the air current allowed to circulate being under a pressure less than the saturation pressure of the liquid to prevent liquefaction, resulted in crypton being deposited along with the xenon.

A study of fifteen electric resistance thermometers as far as the boiling point of hydrogen has been made, and the results

[1] (1) Physical Properties of Liquid and Solid Hydrogen. (2) Separation of Free Hydrogen and other Gases from Air. (3) Electric Resistance Thermometry at the Boiling Point of Hydrogen. (4) Experiments on the Liquefaction of Helium at the Melting Point of Hydrogen. (5) Pyro-electricity, Phosphorescence, &c. The Bakerian Lecture delivered at the Royal Society on June 13, by Prof. James Dewar, F.R.S.

reduced by the Callendar and Dickson methods. A table was given showing the results for seven thermometers, viz., two of platinum, one of gold, silver, copper and iron, and one of platinum-rhodium alloy.

It is noted that the lowest boiling point for hydrogen was given by the gold thermometer. Next to it came one of the platinum thermometers, and then silver, while copper and the iron differ from the gold value by 26 and 32 degrees respectively. The gold thermometer would make the boiling point 23°·5 instead of the 20°·5 given by the gas thermometer. Then the reduction of temperature under exhaustion amounts to only 1° instead of 4° as given by the gas thermometer. The extraordinary reduction in resistance of some of the metals at the boiling point of hydrogen is very remarkable. Thus copper has only 1/105th, gold 1/30th, platinum 1/35th to 1/17th, silver 1/24th the resistance at melting ice, whereas iron is only reduced to 1/8th part of the same initial resistance. The real law correlating electric resistance and temperature within the limits we are considering is unknown, and no thermometer of this kind can be relied on for giving accurate temperatures up to and below the boiling point of hydrogen. The curves are discussed in the paper, and I am indebted to Mr. J. H. D. Dickson and Mr. J. E. Petavel for help in this part of the work.

Helium separated from the gas of the King's Well, Bath, and purified by passing through a U-tube immersed in liquid hydrogen, was filled directly into the ordinary form of Cailletet gas receiver used with his apparatus and subjected to a pressure of 80 atmospheres, while a portion of the narrow part of the glass tube was immersed in liquid hydrogen. On sudden expansion from this pressure to atmospheric pressure a mist from the production of some solid body was clearly visible. After several compressions and expansions, the end of the tube contained a small amount of a solid body that passed directly into gas when the liquid hydrogen was removed and the tube kept in the vapour of hydrogen above the liquid. On lowering the temperature of the liquid hydrogen by exhaustion to its melting point, which is about 16° absolute, and repeating the expansions on the gas from which the solid had separated by the previous expansions at the boiling point or 20°·5, *no mist was seen.* From this it appears the mist was caused by some other material than helium, in all probability neon, and when the latter is removed no mist is seen, when the gas is expanded from 80 to 100 atmospheres, even although the tube is surrounded with solid hydrogen. From experiments made on hydrogen that had been similarly purified like the helium and used in the same apparatus, it appears a mist can be seen in hydrogen (under the same conditions of expansion as applied to the helium sample of gas) when the initial temperature of the expanding gas was twice the critical temperature, but it was not visible when the initial temperature was about two and a half times the critical temperature. This experience applied to interpret the helium experiments would make the critical temperature of the gas under 9° absolute.

Olszewski in his experiments expanded helium from about seven times the critical temperature under a pressure of 125 atmospheres. If the temperature is calculated from the adiabatic expansion starting at 21° absolute, an effective expansion of only 20 to 1 would reach 6°·3, and 10 to 1 of 8°·3. It is now safe to say, helium has been really cooled to 9° or 10° absolute without any appearance of liquefaction. There is one point, however, that must be considered, and that is the small refractivity of helium as compared to hydrogen, which, as Lord Rayleigh has shown, is not more than one-fourth the latter gas. Now as the liquid refractivities are substantially in the same ratio as the gaseous refractivities in the case of hydrogen and oxygen, and the refractive index of liquid hydrogen is about 1·12, then the value for liquid helium should be about 1·03, both taken at their respective boiling points. In other words, liquid helium at its boiling point would have a refractive index of about the same value as liquid hydrogen at its critical point, and as a consequence, small drops of liquid helium forming in the gas near its critical point would be far more difficult to see than in the case of hydrogen similarly situated.

The hope of being able to liquefy helium, which would appear to have a boiling point of about 5° absolute, or one-fourth that of liquid hydrogen, is dependent on subjecting helium to the same process that succeeds with hydrogen; only instead of using liquid air under exhaustion as the primary cooling agent, liquid hydrogen under exhaustion must be employed, and the resulting liquid collected in vacuum vessels surrounded with liquid hydrogen. The following table embodies the results of experience and theory:—

Initial temperature.	Initial temperature.	Critical temperature.	Boiling points.
Liquid helium? ...	5°?	2°?	1°?
Solid hydrogen ...	15	6	4
Liquid ,, ...	20	8	5 (He?)
Exhausted liquid air	75	30	20 (H)
52° C.	325	130	86 (Air)
Low red heat ...	760	304	195 (CO_2)

The first column gives the initial temperature before continuous expansion through a regenerator, the second the critical point of the gas that can be liquefied under such conditions, and the third the boiling point of the resulting liquid. It will be seen that by the use of liquid or solid hydrogen as a cooling agent we ought to be able to liquefy a body having a critical point of about 6° to 8° absolute and boiling point of about 4° or 5° absolute. Then, if liquid helium could be produced with the probable boiling point of 5° absolute this substance would not enable us to reach the zero of temperature; another gas must be found that is as much more volatile than helium as it is than hydrogen in order to reach within 1° of the zero of temperature. If the helium group comprises a substance having the atomic weight 2, or half that of helium, such a gas would bring us nearer the desired goal. In the meantime the production of liquid helium is a difficult and expensive enough problem to occupy the scientific world for many a day.

A number of miscellaneous observations have been made in the course of this inquiry, among which the following may be mentioned. Thus the great increase of phosphorescence in the case of organic bodies cooled to the boiling point of hydrogen under light stimulation is very marked, when compared with the same effects, brought about by the use of liquid air. A body like sulphide of zinc cooled to 21° absolute and exposed to light shows brilliant phosphorescence on the temperature being allowed to rise. Bodies like radium that exhibit self-luminosity in the dark, cooled in liquid hydrogen maintain their luminosity unimpaired. Photographic action is still active although it is reduced to about half the intensity it bears at the temperature of liquid air. Some crystals when placed in liquid hydrogen become for a time self-luminous, on account of the high electric stimulation brought about by the cooling causing actual electric discharges between the crystal molecules. This is very marked with some platino-cyanides and nitrate of uranium. Even cooling such crystals to the temperature of liquid air is sufficient to develop marked electrical and luminous effects.

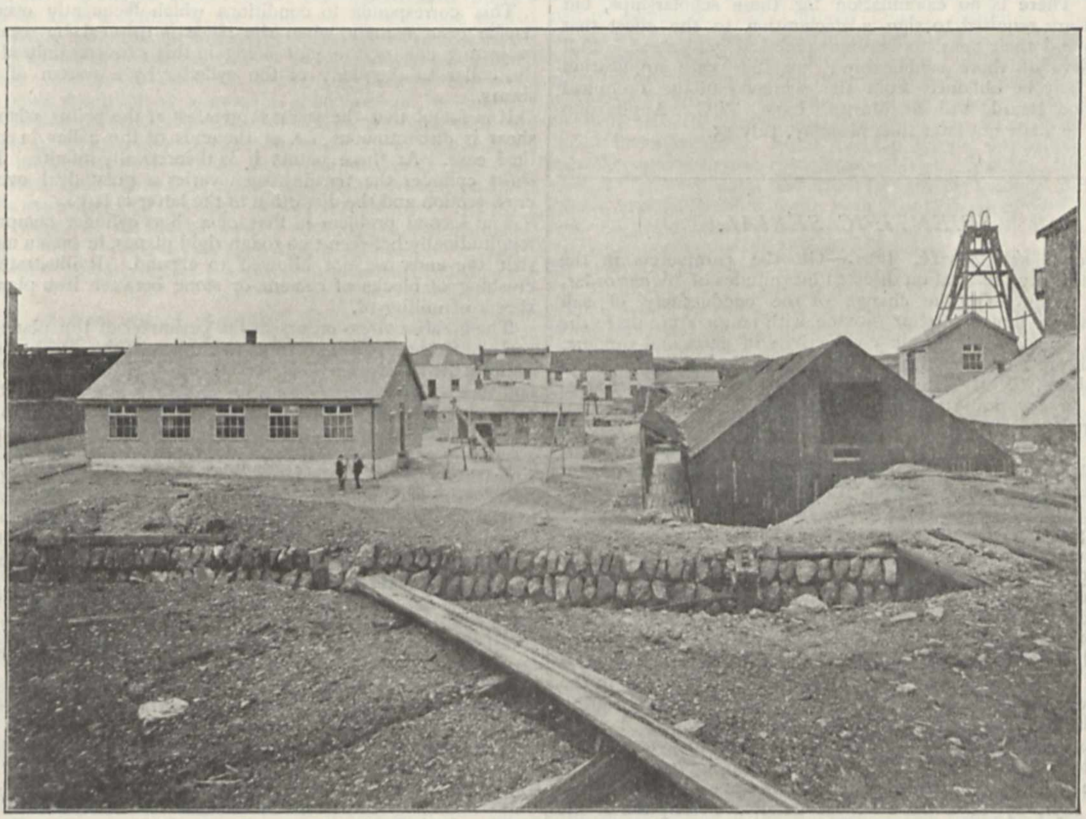
Considering that both liquid hydrogen and air are highly insulating liquids, the fact of electric discharges taking place under such conditions proves that the electric potential generated by the cooling must be very high. When the cooled crystal is taken out of either liquid and allowed to increase in temperature, the luminosity and electric discharges take place again during the return to the normal temperature. A crystal of nitrate of uranium gets so highly charged electrically that, although its density is 2·8 and that of liquid air about 1, it refuses to sink, sticking to the side of the vacuum vessel and requiring a marked pull on a silk thread, to which it is attached, to displace it. Such a crystal rapidly removes cloudiness from liquid air by attracting all the suspended particles on to its surface. The study of pyro-electricity at low temperatures will solve some very important problems.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE Education Bill has been abandoned by the Government on account of want of time to consider it adequately during the present session. A short measure dealing with the difficulties which have arisen in connection with the recent judgment as to higher elementary schools and evening continuation schools was introduced in the House of Commons on Tuesday, and it is hoped that the second reading will be taken early next week. The measure proposes to empower county or county borough councils, or technical instruction committees, to make arrangements with School Boards for the continuation during one year of the work to which school funds have been declared to be inapplicable by the Cockerton judgment. Sir Joshua Fitch writes to the *Times* to point out that this measure is unsatisfactory, for it presupposes that a local educational authority to supersede the School Board is intended to be constituted, and meanwhile entrusts the whole responsibility of maintaining or destroying the higher elementary schools and continuation schools to the county councils, which are not necessarily conversant or in sympathy with them. These schools have been created by the School Boards, and in the case of the higher elementary schools the opportunities they give for scientific study and intellectual culture are of the highest value to national progress. What is required is a short Act of Parliament, which would, for a year or two longer, leave the management and development of these schools in their present hands and provisionally legalise the needful expenditure from the rates. This, Sir Joshua Fitch remarks, "would simply postpone the controversial parts of the abandoned measure for the maturer deliberation of next session, would provide a satisfactory escape from the present *impasse*, and would, it may be hoped, encounter very little opposition."

giving practical instruction in the use of nautical instruments and in marine engineering. A building is being planned which will afford accommodation for marine engineering, naval architecture and navigation, building construction, joiner's work, and plumbing and metal-plate work, with a lecture theatre and class-rooms. Practical classes will be conducted in electrical engineering, especially in connection with ships' lighting. The top floor will comprise a large room for nautical instruments and a room for cartography and the exhibition of ships' models, a chemical laboratory, a balance room, and a physical laboratory. Connected with this floor will be a flat roof on which astronomical observations may be made with such instruments as are used on board ship, and it is probable that a small dome will be provided for an equatorial telescope.

THE prospectus of the mining school at Camborne for the session 1900-1901 tells the tale of some useful educational work which is being carried on in Cornwall. The chief point, and one for which Mr. W. Thomas, the mining lecturer,



Mine Buildings of Camborne Mining School, Cornwall.

MR. J. PIERPONT MORGAN has given a sum exceeding 1,000,000 dollars for the erection of three buildings for a Harvard medical school.

THE first annual report of the Midland Agricultural and Dairy Institute has been received. The Institute has absorbed the agricultural department of the University College, Nottingham, and now provides courses of instruction in agriculture on practical lines, and calculated to gain the confidence of practical agriculturists. The work is carried on in conjunction with the county councils of Derbyshire, Leicestershire, Lincolnshire (Lindsey) and Nottinghamshire. In addition to courses of instruction for farmers' sons, the Institute undertakes analyses for farmers and conducts experiments of interest to agriculturists at selected centres in the counties named. In a small way its work is similar to that of an agricultural college and experiment station in the United States, and every assistance should be given to enable the work to be extended.

THE Technical Education Board of the London County Council is making arrangements at the Poplar Technical Institute for

deserves great credit, is the existence of a school mine; that is to say, the school is the owner of a tin mine which is worked for educational purposes. Instead of being taught solely by lectures, diagrams and models, the student has to work below ground under the guidance of competent instructors. The school is further equipped with good chemical and assaying laboratories and a special room for teaching the useful Cornish art of "vanning," besides having a large and airy drawing office, a library and a museum. Camborne is close to Dolcoath and other large tin mines, so the student is not confined to the school mine for the purposes of instruction. The fault of the school lies in the fact of many of the lectures being delivered in the evening. Admitting the desirability and necessity of evening classes for young miners who are at work during the day, it seems hard upon the outside student, who is ready to pay full fees, that he should be made to attend lectures from 8 p.m. to 9 p.m., and even later. In the interests of the school this should be changed, even if it necessitates two sets of lectures. The accompanying illustration shows the drawing office, with the mine offices behind it; on the right-hand side may be seen the "pit-head frame," with the winding pulleys, which was erected by the students.

THE Technical Education Board of the London County Council is offering facilities for boys who are leaving, or have recently left, public elementary schools to enter upon a course of training which will fit them to become gardeners. A school of practical gardening has been established at the Royal Botanic Society, Regent's Park, and is now attended by some thirty boys, most of whom are holding scholarships from the Technical Education Board. The boys at this school go through a three-years' course, in which they have a thorough training in practical gardening and also receive instruction in elementary science and botany. The scholarships offered by the Board are open to boys between the ages of fourteen and sixteen, whose parents are resident within the County of London and are in receipt of incomes not exceeding 250*l*. a year. The scholarships provide free tuition for three years at the School of Practical Gardening, and also a maintenance grant rising from 20*l*. a year to 25*l*. a year. There is no examination for these scholarships, but parents are required to sign a declaration to the effect that they intend their sons to become practical gardeners. Full particulars of these scholarships, together with application forms, may be obtained from the secretary of the Technical Education Board, 116 St. Martin's Lane, W.C. Application should be made not later than Monday, July 15.

SCIENTIFIC SERIAL.

Annalen der Physik, June.—On the parameters in the physics of crystals and on directed magnitudes of higher order, by W. Voigt.—On the change of the conductivity of salt solutions in liquid sulphur dioxide with temperature up to the critical point. Electrolytic conductivity in gases and vapours. The absorption spectra of solutions with iodine salts, by A. Hagenbach. Various alkaline salts, chiefly iodides, were dissolved in dry liquid sulphur dioxide and the conductivities measured at temperatures up to and just above the critical point. These salt solutions behave as electrolytes, even up to the critical point. The fact that polarisation occurs, shows that the electricity is conducted in the solution by means of ions. The temperature coefficients are negative between the limits of the experiments (from 20° to 160° C.), with the exception of potassium iodide, which shows a maximum of conductivity at about 90°. In the conductivity curves the critical temperature is clearly shown, although there is no absolute discontinuity at this point. Some interesting observations were made on the state of the dissolved solid when the liquid was just above the critical point, as after the meniscus had vanished the resistance of the vapour differed according as the electrodes were in the upper or lower portion of the tube, this difference disappearing immediately on shaking the tube.—On the second law of thermodynamics, by N. Schiller.—The thermodynamics of saturated solutions, by N. Schiller.—On an improved method for the preparation of photographic plates sensitive to the ultra-violet rays, by V. Schumann. A detailed description of the methods of preparing the emulsion, coating and drying the plates, exposure and development. An example is given showing the increased length of spectrum obtained with these plates as compared with an ordinary dry plate.—On a mechanical representation of the electrical and magnetic phenomena in bodies at rest, by L. Graetz.—On changes of weight during chemical and physical changes, by A. Heydweiller. Various chemical reactions were carried out in closed vessels, and in certain cases slight changes in weight were observed which, in the opinion of the author, were outside the range of possible experimental error.—Researches on electrical discharge in rarefied gases, by W. Wien.—Experiments on the influence of capillarity on the velocity of outflow of liquids, by C. Christiansen.—Communication to the knowledge of the physical properties of silver mirrors, by C. Grimm. A study of the electrical resistance of thin silver mirrors under varying conditions of temperature, light, degree of polish, &c.—On a new experiment in dynamics, by V. v. Niesiolowski-Gawin.—On the behaviour of liquid dielectrics on the passage of an electric current, by E. v. Schweidler.—Stroboscopic methods for the determination of the frequency of alternation and lag of a motor, by G. Benischke.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, June 6.—"On the Elastic Equilibrium of Circular Cylinders under Certain Practical Systems of Load." By L. N. G. Filon, M.A., B.Sc., Research Student of King's College, Cambridge; Fellow of University College, London; 1851 Exhibition Science Research Scholar. Communicated by Prof. Ewing, F.R.S.

The paper applies the equations of elasticity to the investigation of problems connected with the circular cylinder. The solutions are symmetrical about the axis of the cylinder, and are obtained as infinite series involving circular and Bessel's functions.

The three problems treated of are as follows:—

In the first a cylinder under pull is considered, the pull not being applied by a uniform distribution of tension across the plane ends, but by a given distribution of axial shear over two zones or rings towards the ends of the cylinder.

This corresponds to conditions which frequently occur in tensile tests, namely, when the piece is gripped by means of projecting collars, the pull being in this case transmitted from the collar to the body of the cylinder by a system of axial shears.

It is found that the stress is greatest at the points where the shear is discontinuous, *i.e.* at the ends of the collar in a practical case. At these points it is theoretically infinite. For a short cylinder the tensile stress varies a great deal over the cross-section and the distortion of the latter is large.

The second problem is that of a short cylinder compressed longitudinally between two rough rigid planes, in such a manner that the ends are not allowed to expand. It illustrates the crushing of blocks of cement or stone between iron planes or sheets of millboard.

The greatest stress occurs at the perimeter of the plane ends and the "strength" is less than two-thirds of the strength under uniform compression. This result apparently contradicts the fact that the strength of stone or cement, when tested between lead plates, which allow of expansion, is very much less than when tested between millboards; but if we take into account the consideration suggested by Unwin ("Testing of Materials of Construction," p. 419) and corroborated by Prof. Ewing, that lead, which flows easily, may not merely allow, but *force* the expansion of the ends of the block, then it is shown that in tests between lead plates the strength may be much less than between millboards; moreover, such tests are indeterminate. The millboard test should give consistent results, though really introducing too large a factor of safety. The change in the form of the fracture noticed by Unwin is also confirmed by theory.

The third problem is that of the torsion of a bar in which the stress is applied, not by cross-radial shears over the flat ends, as the ordinary theory of torsion assumes, but by transverse shears over the curved surface. This corresponds to the case of a shaft or axle twisted by a frictional couple.

It is shown that the points of danger are those where the applied shear changes discontinuously. At a distance from these the solution rapidly degenerates into the ordinary type.

Physical Society, June 28.—Prof. Everett, F.R.S., vice-president, in the chair.—A paper on the effect of a high frequency oscillatory field on electrical resistance was read by Mr. S. A. F. White. The object of this paper is to discover if the action of light upon the electrical resistance of selenium can be imitated by using high frequency electrical oscillations. It is found that such oscillations permanently increase the resistance of selenium. The effect of a rise of temperature is to increase the resistance of a piece of low resistance and decrease the resistance of a piece of high resistance. The effects of the field in a piece of high resistance can be reversed by exposure to light or by reheating and subsequent cooling. In the case of tellurium a high frequency field temporarily decreases the resistance, as also does a rise in temperature. Repeated heating and cooling of a piece of tellurium permanently increases its resistance. It seems probable that all of the effects are due to rise of temperature caused by minute sparks within the mass. The rise in resistance by alternate heating and cooling may be due to the formation of tellurides with the metal of the electrodes. The large negative temperature effect of tellurium suggests that it might be usefully employed in the detection of heat radiation. The chairman expressed his interest in the paper and drew attention to the very rapid action of light upon selenium. Prof. Adams said that as the effects here noticed were not so rapid as in the case of light they were probably due to change in temperature. Prof. Bose said he had tried the effect of Hertzian radiation upon thin layers of various metals and found an increase of resistance in the case of selenium and a decrease in the case of tellurium. The effect of radiation is confined to a few layers on the surface of the conductor, but it appears that it is of the same nature in continuous solids as in coherers.—A paper by Mr. E. C. C. Baly and Dr. H. W. Syers on the spectrum of cyanogen was read by Mr. Baly. The authors have been able to obtain the spectrum of cyanogen by allowing the pure gas to flow through a vacuum tube and observing from the end of the tube. This is necessary on account of the brown deposit of paracyanogen, which renders observation in the ordinary way impossible. The spectrum obtained differs from the flame spectrum, and consists of a series of equidistant flutings through the whole of the red and yellow somewhat recalling those of the positive band spectrum of nitrogen. The experiments prove that (1) the swan spectrum is not produced by a carbon compound which does not contain oxygen; (2) the swan spectrum is that of an oxide of carbon, as it is only produced by carbon monoxide; and as this spectrum is changed at once into the carbon oxide spectrum by admission of oxygen or by intense electric discharge, and, further, as the carbon oxide spectrum is invariably given by carbon dioxide, there can be no doubt that (3) the swan spectrum is that of carbon monoxide and the carbon oxide spectrum that of carbon dioxide. Mr. Gaster said that this paper might throw light on the discussion of the arc where cyanogen, carbon monoxide and carbon dioxide are present. The presence of cyanogen might be able to explain the hissing of the arc.—The Society then adjourned until next October.

Royal Astronomical Society, June 14.—Mr. E. B. Knobel, vice-president, in the chair.—The secretary read the observations of the great comet of 1901, made at the Royal Observatory, Cape of Good Hope. The comet was first seen on April 24 by Mr. Hills, of Queenstown, Cape Colony, and rapidly became a very brilliant object, with two tails, one conspicuously brighter than the other; the fainter tail was, however, considerably the longer. Photographs taken at the Cape Observatory with a portrait lens and with the McClean 24-inch telescope were shown, and also a drawing made by Mr. Lunt, of the same observatory, which showed several smaller tails between the two main ones. The elements computed gave a parabolic orbit. Mr. Nevill, of the Durban Observatory, who was present at the meeting, said he had received a letter from which it appeared that the comet was seen in Natal the day before it was first detected in Cape Colony.—Prof. Turner gave an account of a paper by Dr. Gill on the Oxford photographic determinations of stellar parallax, and of his own reply. In the discussion which ensued the Astronomer Royal and others called attention to the various irregularities to which stellar photographs are liable.—Lord Rosse read an account of observations of Nova Persei made at the Birr Castle Observatory; further observations by Dr. Rambaut and Mr. Stanley Williams were also read. It appeared that periodical fluctuations in the light of the star (from about magnitude 4½ to 6) still occur, though there no longer seems to be any progressive decrease in its light.—Mr. J. C. W. Herschel read his observations made at Cambridge of the Lyrid meteors.—Mr. Horner read his spectroscopic observations of the sun, made in England about the time of the total eclipse that was visible in Sumatra. He recorded an observation of a most unusually rapid disappearance of a bright solar prominence.—A paper from Prof. D. P. Todd was read, describing a mechanical device for giving graduated exposures in photographing the corona. The method was a modification of that of Mr. Burckhalter, obviating the necessity of using perforated plates.—A paper, by Dr. A. W. Roberts, on the light variations of R. Carinæ, called attention to long and short period variations of a very interesting character.

Zoological Society, June 18.—Prof. G. B. Howes, F.R.S., vice-president, in the chair.—A communication was read from Prof. Ray Lankester, F.R.S., on the new African mammal lately discovered by Sir Harry Johnston in the forest on the borders of the Congo Free State, of which two skulls and a skin were exhibited. Prof. Lankester fully agreed with Sir Harry as to this mammal belonging to a quite new and most remarkable form allied to the giraffes, but having some relation to the extinct Helladotherium, and proposed for it the generic name Okapia, from its native name "Okapi." The scientific name of this mammal would therefore be *Okapia johnstoni*, Mr. Sclater having already given it a specific name based on the pieces of its skin previously received. Sir Harry Johnston, who was himself present, gave an account of the facts connected with his discovery of this animal. Sir Harry also stated that during his last excursion to the north of Mount Elgon he had found large herds of a giraffe in this country which appeared to be distinct from previously known forms of this mammal in having five bony protuberances on the head, four placed in pairs and one anterior in the middle line. Four examples of this animal were now on their way home, and would soon be here to settle the validity of this presumed new species.—The Hon. W. Rothschild, M.P., exhibited and made remarks upon specimens of a mounted male and two unmounted males and a female of the rare Abyssinian goat (*Capra walie*, Rüppell), and of a mounted male of the Abyssinian wolf (*Canis simensis*, Rüppell), which had been obtained by Captain Powell-Cotton during his recent visit to Abyssinia.—Mr. Oldfield Thomas exhibited a pair of antlers which had been sent home by Mr. Charles Hose, who had obtained them from Central Borneo. They appeared to differ from the antlers of all other known deer in being highly complicated and many-branched, with the upper portion curved forward, and the brow-tines developed into broad horizontal paddle-like structures. From this character it was proposed to term the species *Cervus spatulatus*.—Mr. R. Shelford exhibited a series of lantern slides, exemplifying mimicry amongst Bornean insects, especially amongst the Longicorn division of the Coleoptera.—A communication was read from Mr. J. E. S. Moore containing an account of his recent researches on the mollusca of the great African Lakes.—A communication from Captain H. N. Dunn contained field notes on eight species of antelopes, specimens of which he had met with during his recent sojourn on the White Nile in connection with the "Sudd" expedition.—A communication was read from Dr. R. Bowdler Sharpe on the birds collected by Dr. Donaldson Smith during the early part of 1889 in Northern Somaliland. Specimens of 103 species were contained in the collection.—A communication from M. Constantin Saturnin contained a description of a new species of hedgehog from Transcaucasia, proposed to be named *Erinaceus calligoni*. To this was added a revision of the species of the genus Erinaceus of the Russian Empire.—A communication was also read from Mr. J. Lewis Bonhote on the evolution of pattern on birds' feathers, in which it was attempted to show how all the various patterns on the feathers had been derived from a common origin, and were passing or had passed through a definite series of stages before reaching the shapes in which they were found.—Mr. J. Cosmo Melvill read the first part of a paper prepared by himself and Mr. Robert Standen, entitled "The Mollusca of the Persian Gulf, the Gulf of Oman and the Arabian Sea, as evidenced mainly through the collections made by Mr. F. W. Townsend, of the Indo-European Telegraph Service, 1893-1900." The area embraced was determined by an imaginary line (for which reasons were given) drawn obliquely from Cape Ras El Had, below Maskat (lat. 22° 50′ N.), and Panjim, India (lat. 16°). This was the first attempt towards a complete catalogue of the mollusca of this region, between 900 and 1000 species being named, of which more than one-third were of very restricted distribution.

Mineralogical Society, June 18.—Dr. Hugo Müller, vice-president, in the chair.—Mr. Alfred Harker gave a simple proof of the anharmonic ratio of four faces in a zone.—Mr. William Barlow, in continuation of his work on the partitioning of space on the principles of closest packing, exhibited models which presented accurately the symmetry displayed by potassium-alum. The symmetry of various tetartohedral minerals was also explained by the twist which must be given to certain groups of atoms in order to make the packing as close as possible.—Mr. Herbert Smith, in continuation of an examination of crystals of calaverite, showed by means of a gnomonic projection the extremely intricate character of the crystals. The general form suggests monoclinic symmetry, and a well developed face perpendicular to the prism edge frequently occurs; but the symbols which on this supposition must be assigned to the faces are, with few exceptions, very complicated. The majority of the faces lie on a lattice with triclinic symmetry, and of the remainder the majority lie on another lattice inconsistent with the former.—Mr. G. T. Prior pointed out the isomorphous relations between sulphates and orthophosphates as exhibited in a group of rhombohedral minerals, including hamlinite, $AlPO_4.SrHPO_4.Al_2(OH)_6$; florencite, $AlPO_4.CePO_4.Al_2(OH)_6$; beudantite, $Fe'''PO_4.PbSO_4.Fe_2(OH)_6$; svanbergite,

$$AlPO_4.SrSO_4.Al_2(OH)_6;$$

alunite, $AlSO_4KSO_4.Al_2(OH)_6$; and jarosite,

$$Fe'''SO_4KSO_4.Fe_2(OH)_6.$$

Similar relations are also shown by the isomorphous pairs, monazite, $CePO_4$, and crocoite, $PbCrO_4$; fergusonite, $YNbO_4$, and scheelite, $CaWO_4$; herderite, $CaFBePO_4$, and caracolite, $NaCl.PbSO_4$ (?); pharmacolite, $CaHPO_4.2H_2O$, and gypsum, $CaSO_4.2H_2O$.

PARIS.

Academy of Sciences, June 24.—M. Fouqué in the chair.—Chemical equilibria. Reactions of two bases added simultaneously to phosphoric acid, by M. Berthelot. The author has studied the distribution of the bases between the precipitate and solution obtained when sodium hydroxide and calcium (or barium) hydroxide are added to a solution of phosphoric acid. A considerable proportion of the sodium is in every case found to be contained in the precipitate.—On acetylometallic radicles, by M. Berthelot. The composition of the metallic derivatives of acetylene recently described by M. Chavastelon is shown to be capable of being represented in accordance with the views formerly expressed by the author as to the presence of acetylometallic radicles in such compounds.—Synthesis of a colouring matter derived from diphenylenephenylmethane, by MM. A. Haller and A. Guyot. Crystal violet is converted by a series of reactions into the leucobase hexamethyltriamidophenylfluorene which, when oxidised with lead peroxide, yields fluorene blue, $C_{25}H_{28}N_3Cl + 2\frac{1}{2}H_2O$. This colouring matter has a bluer tint than crystal violet, but does not differ essentially from the latter as regards its tinctorial properties.—A simple and trustworthy apparatus, capable of easy and rapid application, for facilitating existence and work in irrespirable atmospheres contaminated with deleterious gases, by MM. A. Chauveau and J. Tissot. The essential feature of the apparatus is an arrangement for the separation of the currents of inspired and expired air.—On globular lightning, by M. J. Violle. An instance of globular lightning was observed towards the end of a storm on June 9 last.—Action of an oxide or a metallic hydroxide on solutions of the salts of other metals: mixed basic salts, by M. Paul Sabatier. Observations on a recent paper by M. Recoura.—Third series of observations of the new star in Perseus, by M. H. Deslandres (see p. 240).—On the continuous deformation of surfaces, by M. D. Th. Egorov. Remarks on a recent communication by M. Tzitzeica.—Theory of linear groups in an arbitrary region of rationality, by M. L. E. Dickson.—On the integration of the equation $\Delta w - \mu^2 w = 0$, by M. S. Zaremba.—Chemical reactions in dissolved or gaseous systems. Vapour tension; Avogadro's hypothesis, by M. Ponsot. A continuation of previous papers on the subject, which is treated mathematically.—Capillary constants of organic liquids, by MM. Ph. A. Guye and A. Baud. The results described show that oximes and urethanes resemble alcohols, acids, ketones, &c., in being polymerised in the liquid state. The group of urethanes is remarkable in that the degree of polymerisation *increases* with the molecular weight.—On the preparation of phosphorous oxide, by M. A. Besson. Fresh experiments are cited in proof of the existence of the oxide P_2O, previously described by the author.—On the action of solar radiations on silver chloride in presence of hydrogen, by M. Jouniaux. When sealed tubes containing silver chloride and hydrogen are exposed to sunlight, metallic silver is formed, and, under favourable conditions, the whole of the hydrogen is eventually converted into hydrogen chloride.—Action of mercuric oxide on aqueous solutions of metallic salts, by M. A. Mailhe. The action of freshly precipitated mercuric oxide on the chlorides, nitrates and sulphates of manganese, cadmium, lead and iron is described. With sulphates no reaction occurs, as a a rule, but the chlorides and nitrates are decomposed with the formation of mixed basic salts.—Observations on basic salts containing several metallic oxides, by M. G. André. A number of complex salts were described by the author some years before the recent experiments of MM. 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