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THE NEW CENTURY.

SCIENCE is cosmopolitan. Electricity abolishes time and envelops both hemispheres with a new idea as soon as it has emerged from the brain of the Thinker. Mechanics, by its space-annihilating power, has reduced the surface of the planet to such an extent that the human race now possesses the advantage of dwelling, as it were, on a tiny satellite. Both these agencies, then, combine to facilitate a rapid exchange of new ideas and commodities, as well as of those who are interested in them in whatever capacity.

These considerations indicate some of the most momentous changes which have occurred in the world's history since the last century dawned.

How have they been brought about? M. Maurice Lévy, in one of those allocations—always so admirable in thought and style—pronounced by the President of the French Academy of Sciences at the annual public meeting held each December, answered the question for us last month.

"Let us never forget that if applied mechanics has arrived to-day at such marvellous results, if we can now calculate beforehand the parts of the most complex machines, it is because long ago the shepherds of Chaldea and Judea observed the stars; because Hipparchus combined their observations with his own and handed them down to us; because Tycho-Brahe made better ones; because two thousand years ago a great geometer, Appolonius of Perga, wrote a treatise on conic sections, regarded for many centuries as useless; because the genius of Kepler, utilising this admirable work and the observations of Tycho-Brahe, gave us those sublime laws which themselves have been considered useless by the utilitarians; and, finally, because Newton discovered the law of universal gravitation."

From this discovery of Newton, M. Lévy points out, first came the study of Celestial Mechanics, from which was derived later General Mechanics, from which again, later still, Industrial Mechanics, which are now applied every day, has taken its origin. He adds:

"It is well to impress the fact that Industrial Mechanics has come down from heaven, upon the utilitarians; upon those who appreciate science only so far as it can be immediately profitable to them; who are always complaining that too much is taught at school, and who regard as superfluous everything they cannot find in a formulary, manual or aid to memory."

All our progress, then, if we accept the view to which M. Maurice Lévy has given expression, has come from the study of what was useless at the time it was studied. There is no doubt that this view is correct, and that future developments, probably as momentous as those to which we have already referred, will in the future come to us from the same source.

To study the useless, therefore, is as important as to apply the useful, from a cosmopolitan point of view; and all wise governments and institutions should use their most strenuous efforts to aid the first endeavour, the second can very well take care of itself.

There can be no question that the progress of science and of the applications of science to industry will go on in a geometrical ratio, and that eventually every country will benefit by this advance; but if we quit the cosmopolitan point of view and endeavour to form an idea of the results of this advance on any country in particular, another set of considerations comes in.

Our Empire, as it exists at present, and our great national wealth, are the results of the sea-training and prowess of her sons and of the stores of natural wealth in the shape of coal and iron which the first appliers of mechanics found to their hand. The output and first user of coal and iron depended upon the applications of mechanics, and the first user of all these combined enabled us to flood the markets of the world, and for years Britain was the Tubal Cain among the nations. Not only had we a monopoly of export, but so high an authority as Sir Andrew Noble acknowledges that, fifty years ago, British machinery was immeasurably superior to any other. But even this statement does not exhaust all our then advantages. Because we were the great producers we became the great carriers of the world; hence the supremacy of our mercantile marine, and, flowing from this, our command of the sea. At that time Germany did not exist as a united nation, France was mainly agricultural, and the United States were engaged in developing their enormous and almost unpopulated territories.

But what has happened since? As we have said, science is cosmopolitan, and the levelling effect of this has been that the *material* advantages we possessed in the first instance have disappeared. Other countries, chiefly those we have named, have now their coal and iron and applications of science as well as ourselves.

First among these applications at the beginning of the last century came steam locomotion, the gift to the world of a former "instrument maker to the University of Glasgow," and from the work done on the Forth and Clyde Canal in 1802 have sprung all the navies and railways of the world.

For traction purposes steam is now giving way to electricity; but how different is the *rôle* that Britain is playing at the beginning of the new century compared with that she filled at the beginning of the old one. We import instead of exporting. The chief London electric railway is American, American coal is producing gas to light the streets of the Metropolis, American cars are now found on our English trains, which on some lines are drawn by American locomotives. British applications to facilitate locomotion, therefore, have ceased to be paramount, and at the same time we no longer occupy the proud position of being the only nation of shopkeepers.

Were this all, it would be abundantly clear that our old supremacy must cease, and from no fault of our own, as it is but a direct consequence of the general progress of science, which includes the facilitating of intercommunications. But, unfortunately, it is not all.

At a time when our ancient universities occupied no higher level than that, according to Matthew Arnold, of "hauts Lycées," and when there was little or no attempt at educating the large majority of the population, Prussia, which, with the rest of the German States, had profited by Luther's appeal in favour of the education of the people, had occupied herself, crushed though she was after Jena, with the founding of universities and with the highest education; while live seats of learning in great numbers were being founded in the United States. The beginning of the new century, then, finds us in a position which every day differs more and more from that occupied by us in the old one, for not only are our natural resources relatively reduced in value, but our intellectual resources are not sufficiently superior to those of other nations to enable us to retain our old position by force of brains.

But even this statement does not truly paint the situation. From time to time since this journal was started in 1869, it has been our duty to insist upon our relative deficiencies in regard to the advancement of science and the higher scientific instruction. Thus, in the very first volume of NATURE, the absence here of the great facilities and encouragement given in Germany to these matters was clearly indicated. As an early instance of the result of this state of things we may refer to Mr. Perkin's account, in 1885,[1] of the migration of the coal-tar industry to Germany. In later years ample proof has been adduced that in many directions the present British intellectual equipment is not only not superior, but actually inferior to that of other countries, and none too soon the matter is engaging attention in the daily press. Within the last week the *Times*, *Daily Mail* and *Pall Mall Gazette* have called special attention to the reasons which may be assigned for this new and alarming state of things; a writer in the *Fortnightly* has gone so far as to ask, "Will England last the Century?" while Sir Henry Roscoe has expressed his opinions in a letter to the *Times* as follows:—

"There can be no manner of doubt that a crisis in our national well-being has already been reached. The news brought to us from all quarters proves that our industrial and commercial prosperity is being rapidly undermined. The cry that we are being outbid on all sides by Germany and America is no new one, but it becomes louder and louder every day, and now it is admitted by all those best qualified to judge that, unless some drastic steps are taken to strengthen our educational position in the direction long ago taken up by our competitors, we stand to lose, not merely our industrial supremacy, but the bulk of our foreign trade. . . . The only policy at this time is to strain every nerve to place the country educationally on a level with its neighbours. No effort, no expenditure, is too great to secure this result, and unless our leaders, both in statecraft and in industry, are quickly aroused to the critical condition of our national affairs in this respect, and determine at once to set our house in order, our children and grandchildren may see England sink to the level of a third-rate Power; for upon education, the basis of industry and commerce, the greatness of our country depends."

We must confess that when we come to consider the panaceas suggested by these writers we find much more vagueness than might be expected, and some suggestions which are entirely beside the mark.

Thus we are told that now our Colonies are being more closely united to us we may rest and be thankful; that American industry depends for its success upon the extreme youth of those who are at the head of affairs. Education is referred to as if there were no differences in the methods employed, and finally a newly-developed sloth is suggested as the origin of the apparent decadence of the most athletic nation in the world.

The question arises, Is there no scientific method open to us to get at the real origin of the causes which have produced the present anxiety?

M. Maurice Lévy, in his allocation, did England the honour to point out how large a share Newton had in founding the industries on which our commercial greatness in the last century was based. It seems to us to be our duty, at the beginning of the new century, to suggest that at this critical time it would be criminal to neglect the labours of another great Englishman—Darwin—which may be appealed to to help us to see what has gone wrong and to forecast what the future has in store for us if we apply the suggested remedies or if we neglect them. In this we possess an advantage over our forerunners. Those labours have shown the working of an inexorable law which applies exactly to the conditions under which we find ourselves.

The enormous and unprecedented progress in science during the last century has brought about a perfectly new state of things, in which the "struggle for existence" which Darwin studied in relation to organic forms is now seen, for the first time, to apply to organised communities, not when at war with each other, but when engaged in peaceful commercial strife. It is a struggle in which the fittest to survive is no longer indicated by his valour and muscle and powers of endurance, but by those qualities in which the most successful differs most from the rest. We must accept the conclusion that, with material outfits now much more equally distributed for this struggle for existence, if Britain be at a disadvantage in relation to any other nation with regard to these qualities, it must go under if such a condition of things is allowed to go on. If this appeal to a natural law leads to such a dire conclusion, it is the duty of every Briton, from the highest to the lowest, to see to it that some efficient remedy be applied without delay.

It follows from what has already been stated that we need not look for these national differences among natural products for the reason that, day by day, such differences are being levelled by the present ease and rapidity of intercommunication.

We do not think that the differences will be found in any very great degree in our primary and technical instruction as it is going on to-day.

If we regard our primary, secondary and higher education, it must be acknowledged that great improvements have been carried out during the last quarter of a century. The establishment of new universities, adapted to the present conditions of civilisation, in several great centres and the promise of more, has clearly shown that, in the opinion of our most important mercantile communities, strong measures are necessary, and that they are prepared to make great pecuniary sacrifices to carry them out. Still, the facts show that what has already been done

[1] NATURE, vol. xxxii. p. 343.

is not sufficient, and that we must do more in these directions; but the present difference in these respects is not entirely sufficient to account for the present condition of things.

Continuing our process of exclusion we finally arrive at the possibility that the present superiority of our competitors depends as much upon Liebig's introduction of practical scientific work and research into the general higher education as did our former supremacy upon Watt's introduction of the steam engine. Voltaire said, "On étudie les livres en attendant qu'on étudie les hommes." The proper study of Science gives us a third term, the study of things and laws in action; a study in which the eye and hand and brain must work together to produce the scientific spirit or properly organised common sense.

The Scientific spirit existed among our European competitors much more generally than it did with us long before Liebig, and it was utilised over a far wider field of knowledge; but from Liebig's time it has existed among them as the dominant factor in Industry and Commerce, and the closer union between Science and Industry in other countries is, we believe, the true origin of the present difference between them and our own.

Here, we tried to start chemical industries by employing chemists, as Mr. Perkin has told us, at "bricklayers' wages." In Germany they are now carried on by scores, in one case a hundred, of the best trained chemists the country can produce, in research laboratories attached to all the great works. At this moment German artificial indigo threatens to replace the natural product in all the markets of the world as a result of these scientific industrial methods. So soon as Science was acknowledged to be the most important commercial factor, the Reichsanstalt was established by the Government at a cost of 200,000*l*., and a yearly expenditure of 15,000*l*. to weld science and industry more closely together. An American professor thus summarises the results:

"The results have already justified, in a remarkable manner, all the expenditure of labour and money. The renown in exact scientific measurements formerly possessed by France and England has now largely been transferred to Germany. Formerly scientific workers in the United States looked to England for exact standards, especially in the department of electricity, now they go to Germany." And again, "Germany is rapidly moving toward industrial supremacy in Europe. One of the most potent factors in this notable advance is the perfected alliance between science and commerce existing in Germany. Science has come to be regarded there as a commercial factor. If England is losing her supremacy in manufactures and in commerce, as many claim, it is because of English conservatism, and the failure to utilise to the fullest extent the lessons taught by science."

Britain, of course, is the country in which such an institution ought to have been established more than half a century ago. We are now compelled to imitate it; but the new institution which, before long, may be instituted is on such a microscopic scale that its utility in the present struggle is more than doubtful.

The next conclusion the appeal to the law provides us with is that the improved scientific instruction of those engaged in Industry is not the only line along which our defences must be strengthened. The scientific spirit must be applied as generally in England as elsewhere.

The increasing complexity of industrial and national life requires a closer adjustment of means to ends, and this can only be attained by those who have had education on a scientific basis, and have therefore acquired the scientific habit. In this way only can we lift the whole standard of our national life to a higher plane, and weld the various national activities together.

We must have a profound change of front on the part of the Ministry and the personnel of Government departments, only very few of whom have had any scientific education and who at present regard all scientific questions with apathy, on the ground, perhaps, that in their opinion the Nation has no direct concern with them. This feeling may be strengthened by the fact that at present, while the laws of the realm are well looked after by the most highly paid servants of the State, the laws of Nature are left without anybody to form a court of appeal in difficult questions. It is true that to fill this gap our men of science are always ready, when called upon, to spend time and energy on affording, gratis, to the Government advice on any questions which may be submitted to them; but because this advice costs nothing its value is, perhaps, estimated by what it costs.

Our rulers must recognise that, in virtue of the law to which reference has been made, it will not do to confine their energies and the national expenditure, so largely as they do now, to matters relating to the Navy and Army, the functions of which are to protect our world-wide Empire at present well worth conquering, our industries, and our argosies on every sea—products, all of them, of our old scientific and therefore commercial supremacy.

Several obvious corollaries from the law in question indicate very clearly the proper course to pursue, in our own case to retain our position, in the case of our competitors to improve their own in relation to us, and therefore at our expense. There are many signs that our competitors, at all events, have faced this problem and are working on true scientific lines; of this the heavy subsidy of the German mercantile marine may be given as one instance out of many, and here, indeed, we are brought face to face with the consideration that the scientific outlook should really be as important to those in charge of the Nation's future well-being as that concerned with international politics.

If the other nations, by their scientific activity, increase their commerce and therefore their commercial fleets, their national fleets must be increased also. Our present policy with regard to our fleet is well established, so that we are committed to its continuous and well-defined increase, while it seems to be the duty of no Government department to look after the scientific advances which are the only bases of the commerce which is to provide for the constantly increasing expenditure. So that if, in the future, a constantly reduced commerce and commercial marine, and therefore reduced national income, are in store for us, we shall have, because of this condition of things, to face a constantly increased expenditure upon our fleet.

These considerations are only typical of others which are well worth considering at the present juncture by men possessing the scientific spirit. What is the best way of utilising the combined forces of the Empire, in times of peace, under the present conditions? It is clear that no merely sentimental bonds will be sufficient. We may add that peaceful conflicts between industrial peoples are not alone in question.

With regard to preparation for war, history has already taught us much. Of two competitors, if one be fully armed both for offence and defence, and the other is not, there is no doubt as to what will happen. That nation will be the best off which utilises the greatest number of its citizens both for war and peace. A large standing army in times of peace is a clear indication that the scientific spirit has not been sufficiently applied to the problem, and it is to be hoped that now the future of the Nation is being discussed, the attempts to put our house in order will be made on scientific lines.

EDITOR.

RECENT ADVANCES IN THE CHEMISTRY OF THE PROTEIDS.

Chemie der Eiweisskörper. Von Dr. Otto Cohnheim. Pp. x + 315. (Braunschweig: F. Vieweg und Sohn, 1900.)

SINCE the publication of Drechsel's article on proteids in Ladenburg's Encyclopædia, no complete account of the chemistry of the proteids has appeared. The accounts given in the best known text-books of physiological chemistry are necessarily brief and incomplete. Dr. Cohnheim's book is therefore a very welcome addition to the literature of physiological chemistry, giving, as it does, a detailed account of the present state of knowledge with regard to the proteids.

The book is divided into a general and a special part. The first deals with the physical and chemical properties of the proteids, then with the products of their decomposition, and finally discusses their structure and classification. In the second part, the characteristics of the different forms of proteids are considered in detail.

In reviewing the book as a whole, it is impossible to do more than emphasise those features in which it shows a distinct advance as compared with its predecessors.

The chief characteristics which distinguish the proteids as a sharply limited class of organic compounds are the following. They contain the elements carbon, hydrogen, oxygen, nitrogen and, as a rule, sulphur in fairly constant proportions, and although their constitution is as yet unknown, the similarity in their chemical behaviour is so great that they may all be regarded as having a common chemical structure. Provisionally they may be divided into three groups, the native simple proteids, the compound proteids—in which a simple proteid is united to some other organic body—and the earlier decomposition products which still retain, in large measure, the chemical properties of the proteids from which they have been derived. The compound proteids may contain, in addition to the elements already mentioned, phosphorus and iron.

Their properties may be divided into physical and chemical. Taking the former first, the author selects, as their most characteristic property, the tendency of all native proteids to pass readily out of solution in the form of a more or less permanently insoluble precipitate or coagulum.

Means otherwise chemically indifferent, such as mechanical agitation of their solutions, contact with porous substances, or evaporation of part of the water of solution, result in the separation of a flocculent precipitate, which, on microscopic examination, is found to consist of minute particles tending to cohere so as to form membranes or threads of coagulated proteid. It is this property of proteids which explains their indiffusibility and the difficulty with which they undergo crystallisation.

Chief amongst the physical agents which produce this change is heat. To the subject of coagulation by heat a special chapter is therefore devoted. In the presence of a fixed quantity of neutral salt of the metals of the alkalies, and a very faint acid reaction, the temperature of coagulation is fairly constant for each native proteid, and has proved of considerable value in their separation and classification. A variation in the quantity or nature of the salt used alters the temperature of coagulation of any given proteid. Further, the proteid that separates out from a faintly acid solution carries with it some of the acid, so that the solution after coagulation is found to be less acid than before, or may even be neutral. The latter fact renders the coagulation of proteids by heat specially liable to fallacy as a method for their separation. The part played by the neutral salt in heat coagulation is still doubtful. Most observers have found that proteids, in solutions freed as far as possible from salts by dialysis, do not coagulate on heating; but the addition of a small quantity of neutral salt to the previously heated solution results in the separation of a coagulum. Cohnheim, therefore, regards coagulation by heat as invariably associated with the formation of an acid albumin insoluble in salt solution; but soluble in the least excess of the acid used. The evidence, however, on the influence exerted by neutral salts on the temperature of coagulation is conflicting. There is evidence that, in some cases, a proteid solution, freed as far as possible from salts by means of dialysis, coagulates at a lower temperature than when a small quantity of neutral salt is present. By means of dialysis alone it has not, as yet, been found possible to obtain a native proteid free from ash, so that the influence of heat upon a native proteid solution free from mineral matter has not yet been studied.

The next section of the book deals with the methods used for salting out proteids, and contains a complete account of the relative value of various salts as precipitants. Of all salts of the metals of the alkalies and alkaline earths, ammonium sulphate has the greatest precipitating power. Saturation with it precipitates all the native proteids from solution, and, with the exception of peptone, all the products of peptic or tryptic digestion still retaining proteid characters. Its precipitating power is increased by the addition of dilute acids, and, in the case of some of the products of digestion, the addition of an acid is found necessary for precipitation. In neutral solution, the concentration of salt necessary for precipitation is found to vary with the nature of the proteid. Hofmeister and others have ascertained for a number of proteids the limits of concentration of ammonium sulphate necessary for their precipitation, and upon this basis have founded the method of fractional precipitation. By this means it has been found possible to separate from a mixture of proteids fairly well defined chemical individuals.

Another method of separation that is being used to an increasing extent is that of crystallisation; but, unfortunately, its application is somewhat restricted. Dr. Cohnheim has, probably for this reason, relegated the subject to the second part of his book. Egg-albumin, serum-albumin and lactalbumin are the only simple proteids of animal origin that have been obtained in a crystalline form. The first method devised is due to Hofmeister. He succeeded in obtaining crystals of egg-albumin from egg-white by first of all precipitating the globulin by half saturation with ammonium sulphate. When the filtrate was allowed to slowly evaporate, egg-albumin gradually separated out in the form of minute globules. By re-dissolving the globules and repeating the process, he ultimately obtained well-defined crystals of egg-albumin which were purified by recrystallisation.

A much simpler and more satisfactory method has been discovered by Hopkins and Pinkus. After half saturating the egg-white with ammonium sulphate some ammonia is given off, and it was found that, after neutralising the ammonia with dilute acetic acid and then adding sufficient excess of acid to produce a slight precipitate of proteid, the crystallisation of the egg-albumin was rendered much more rapid. The crystallisation induced by this method occurs in closed vessels without any concentration of the solution, and therefore without the risk of the separation of ammonium sulphate crystals along with the proteid ones. Fifth normal sulphuric acid has been also used, instead of acetic acid, with similar results. Up to the present few attempts have been made to separate different forms of albumin by means of fractional crystallisation; but, since the work of Hopkins and others has simplified the process, one may hope for farther applications of the method in the future. The method may possibly be found capable of extension to forms of proteid other than the albumins.

In the succeeding chapter an account is given of the average composition of the simple proteids, and of the methods used in determining their molecular weight. None of the physical methods that have as yet been tested are sufficiently delicate to permit an accurate estimation of the molecular weight of the proteids. Measurements of the lowering of the freezing point and of the osmotic pressure have been tried; but are very difficult to apply on account of the practical impossibility of obtaining proteid free from admixture with inorganic substances. A full account is given of the chemical methods, which yield more trustworthy results. Although the risks of fallacy are numerous, the results yielded by the chemical methods in many cases render it possible to give at least a minimum value for the molecular weight.

The author passes in the next place to a consideration of the chemical characters of proteids. They have the character of potential acids or bases, according to the alkaline or acid reaction of the solution. When one compares the different forms of proteid, one finds that either the basic or acid character may predominate. The simplest forms of proteids, such as the protamines and histones, have a well marked basic reaction. The greater number of the remaining simple proteids play the part of base or acid with almost equal readiness. As a rule, however, the acid character is more emphasised. Simple proteids have, as acids, a distinctly dibasic character. The compound proteids, for example, nucleoproteids, nucleoalbumins and glycoproteids, have a still more marked acid character; but in their case the acid reaction is mainly due to another organic group that has united with a molecule of a simple proteid.

In addition to these salt-like compounds of albumin, one finds compounds with inorganic material, for example, the halogens or iron, in which the halogen or iron is present in a more stable organic combination, and not as an ion. Some of these have been prepared artificially; others by means of vital processes. It appears certain that the organism is capable of forming a stable organic compound of proteid containing iodine in which the character of iodine as an ion is lost, even when the only substances in the food given contained iodine in an inorganic form.

The chief characteristic reactions of proteids next considered may be divided into precipitation and colour reactions. In virtue of their basic character, most proteids, when in the presence of an acid, may be precipitated by the precipitants of the alkaloids. As acids, proteids form insoluble salts with most of the heavy metals. On these facts, methods have been founded for the estimation of the basic or acid equivalents of various proteids. Cohnheim illustrates this by the following example. The hydrochloric acid salt of a proteid and calcium phosphomolybdate = the insoluble compound of the proteid with phosphomolybdic acid and calcium chloride. Since the hydrochloric acid salt of a proteid reacts as an acid to phenolphthalein while calcium chloride is neutral, the diminution of acidity after precipitation can serve as a measure of the basic equivalent of the proteid. The more basic forms of proteid, for example, histones and protamines, are precipitable by reagents for the alkaloids from neutral or even alkaline solutions.

The colour reactions of the proteids are dependent on the presence of certain organic radicles in the proteid molecule, and owe their importance to the light which they throw upon the chemical structure of the proteids. The failure or success of any given colour reaction indicates the absence or presence of the corresponding organic group in the proteid molecule. By a careful study of the colour reactions and of the simpler decomposition products of the proteids, it may be possible in the future to subdivide the different proteids into structurally distinct classes, and thus to establish a classification of the proteids upon a chemical basis.

The most important of the colour reactions is the biuret reaction. The conditions necessary for its occurrence have been very fully studied by Schiff. It is given by all chemical bodies containing two $CONH_2$ groups united either directly or by means of an atom of carbon or nitrogen. The oxygen in the $CONH_2$ groups may be substituted for sulphur without interference with the reaction. As all proteids give this reaction, the proteid molecule must contain at least one organic group corresponding to one of the three forms described by Schiff.

The simplest forms of proteid, the protamines, and their digestive products the protones, give the biuret reaction, but none of the other colour reactions of the proteids.

Kossel gives $(C_{30}H_{57}N_{17}O_6)_n$ as the formula of clupein, one of the most thoroughly examined protamines. On further hydrolytic decomposition, the protones yield the hexone bases, arginin, $C_6H_{14}N_4O_2$ (guanidin-α-amido-propionic acid), and histidin, $C_6H_9N_3O_2$, a base of unknown constitution. The hexone bases appear to be the only primary products of decomposition. Their relative proportion varies considerably, according to the particular protamine examined. None of these hexone bases give the biuret reaction, nor does any other one of the products of decomposition of the proteids of known constitution. The biuret reaction is therefore in general use as a criterion, distinguishing the proteid bodies in the widest sense from their simpler products of decomposition.

The protamines are chemically and, as the work of Miescher and others has shown, probably genetically the precursors of the more complex forms of proteid. The basic organic groups in proteid which give the biuret reaction are also the most resistant to the action of digestive enzymes, and make up the greater part of Kühne's so-called anti-group. Starting from these facts, Kossel has suggested that the nucleus of the proteid molecule has a structure resembling that of protamine. To this nucleus other organic groups become added, so as to form proteid bodies of more complex structure, and he has suggested that upon these facts might be founded a chemical classification of the different proteids. The steps of the synthesis of proteids within the organisms of plants and animals are still, however, too vaguely known to admit of such a classification. Further, Kossel's conjecture has not proved to agree completely with the facts, proteids being known which give a well-marked biuret reaction, although, upon hydrolytic decomposition, they yield a relatively small quantity of the hexone bases. One may therefore conclude that proteid bodies giving the biuret reaction do not always contain a protamine nucleus in the sense originally suggested by Kossel ; but the evidence that a group of basic character giving the biuret reaction forms the nucleus of the proteid molecule is fairly conclusive. The biuret group may belong to any of the types defined by Schiff, and there is evidence that several biuret groups are present in the more complex proteids. One of these groups contains a relatively large percentage of sulphur.

The majority of the other colour reactions of the proteids are dependent on the presence of an aromatic or of a carbohydrate radicle. Millon's reaction is given only by bodies which contain a benzene group in which one atom of hydrogen has been substituted for hydroxyl. The xanthoproteic reaction indicates the presence of a benzene group.

The colour reactions resulting from the presence of a carbohydrate radicle may be grouped together as furfurol reactions. On heating with mineral acids many of the proteids yield furfurol, which may be detected by the colour reactions which it gives with α-naphthol and thymol. In those proteids which contain both an aromatic and a carbohydrate group, the addition of thymol or α-naphthol is unnecessary, a colour reaction being obtained by the action of the furfurol on an aromatic radicle split off from the proteid itself. The chief reactions which indicate the presence of a carbohydrate as well as an aromatic group are those of Liebermann and Adamkiewicz.

There are a number of other colour reactions which, as yet, have not been so carefully studied as those already mentioned. Of these the most important are Petri's diazo-reaction, which is also given by the hexoses and is, therefore, probably dependent upon a carbohydrate group, Würster's quinone reaction, which appears to depend on the presence of the tyrosine group in proteid, and Reichl's reaction with benzaldehyde, which is also given by indol and scatol. Dr. Cohnheim has omitted the discussion of the latter reactions, possibly because their significance has not been sufficiently determined.

Within the limits of a review it would be impossible to discuss the next section of the book, which deals with the simpler products of the decomposition of proteids resulting from the action of various hydrolytic agents, concluding with a very interesting account of the processes of decomposition in the metabolism of plants and animals.

After completing the study of the products of decomposition, Dr. Cohnheim gives a suggestive summary of the views held with regard to the mode of union of the elements present in the proteid molecule. It is noteworthy that in no part of the book is an account given of the various attempts to synthesise proteids.

At the outset of the following chapter, on the classification of proteids, the author shows a certain hesitation in adopting the usual method of classification, but ultimately decides that at present it is impossible to give a satisfactory classification based upon differences of chemical structure. He therefore practically adopts Hammarsten's latest classification, which, with some modifications, is essentially the same as that proposed by Hoppe-Seyler and Drechsel about fifteen years ago.

Limits of space will not permit one to give more than a brief reference to the remainder of the book. In the order of treatment of the subject, Dr. Cohnheim has adopted a significant departure from the order of classification.

An analogy is frequently drawn between the proteids and the carbohydrates in the sense that the native proteids are considered to bear to the primary products of their hydrolytic decomposition, namely, the proteoses and peptones, a relation similar to that which the more complex polysaccharides bear to the dextrins.

Under the influence of this analogy, Dr. Cohnheim deals with the chemistry of the proteoses and peptones before commencing his detailed account of the individual forms of proteid. One almost regrets that the author had not departed still farther from the usual order of treatment. Following Kossel's suggestion, he might first of all have dealt with the hexone bases and their anhydrides, the protones and protamines. Kossel originally proposed the name hexone-bases to mark the analogy between them and the hexoses. The protones would, according to this scheme, be considered as comparable with the dextrins, and the protamines as comparable with starch. It is true that our knowledge is still too incomplete to enable us to carry the process still further, so as to trace with accuracy the connection between the protamines, on the one hand, and the proteoses and peptones on the other; but that need not prevent us from considering the subject in the order above described, especially since this arrangement has also the advantage of passing from the simple to the more complex. A short reference has already been made to the hexone bases, the protones and the protamines. To that account the following facts may be added. The protamines resemble other proteids in being lævorotatory, and have a toxic action similar to that of the albumoses. It is worthy of mention that, although the salts of the protamines with mineral acids are lævorotatory, those of the hexone base, histidin, are dextrorotatory. The protamines also resemble the proteoses and peptones in not being coagulated by heat.

Intermediate between the protamines and the native proteids lies a somewhat ill-defined class of proteids termed the histones. These have a well-marked basic character, being precipitated from their solutions by the addition of ammonia. They are not precipitated by heat unless a neutral salt of the alkalies be present, and even under those conditions they are incompletely precipitated. Within the organism they are never found in the free form; but always in combination with some other organic group, usually either nucleic acid or a pigment. It is asserted that they are occasionally found in the urine.

Their chemical properties place them in a class intermediate between the protamines and the simple native proteids. On account of their tendency to form compounds with other proteids, they appear to be well fitted to serve as precursors of the more complex forms of proteid. In neutral solutions they give precipitates with egg-albumin, serum-globulin, and caseinogen containing the two components in a fixed quantitative relation.

The most important recent advances in our knowledge of the proteoses are due to the work of Hofmeister and his pupils. They have applied the method of fractional precipitation by means of ammonium sulphate and of zinc sulphate to the separation of the proteoses resulting from the peptic digestion of various proteids, and, although it has not yet been found possible to separate by these means chemically distinct bodies, the complete separation of the proteoses into chemical individuals may be looked upon as a probable attainment in the near future. The chief difficulty of the separation is due to the fact that the proteoses, being all either of an acid or basic character, tend to unite together so as to form salt-like compounds. Only the briefest summary of the more recent results can be given here.

The proteoses may be divided into three classes.

The first class yields, on farther hydrolytic decomposition, a large quantity of monamido- and diamido-acids of the fatty series. It also contains a benzene radicle in which none of the hydrogen atoms are substituted for hydroxyl and a relatively large proportion of both loosely and firmly combined sulphur. It corresponds in type to Kühne's anti-group and, from the large proportion of diamido-acids which it yields, may be regarded as more closely allied to protamine than either of the two other classes. It is very resistant to hydrolytic agents.

The second class contains loosely and firmly combined sulphur, a benzene radicle in which one hydrogen atom has been substituted for hydroxyl and yields a relatively small quantity of monamido- and diamido-acids of the fatty series. It easily undergoes hydrolytic decomposition, and is termed the hemi-group.

The third class has been less thoroughly investigated. It is distinguished from the two former classes by the presence of a carbohydrate radicle, and is apparently absent from the molecule of many native proteids. One may regard the molecules of the majority of native proteids as being built up by the union of these three groups in varying proportions.

The chemical nature of the peptones is still the subject of much controversy. They are characterised mainly by not being precipitated by saturation of their acid solutions with ammonium sulphate, by giving a well-marked biuret reaction, and by yielding on farther hydrolytic decomposition the hexone bases amongst other products.

A detailed account of the individual native proteids is next given. Then there follows a description of the compound proteids which consist of one or more molecules of a simple proteid united with some other body, which may be either nucleic acid, chondroitinsulphuric acid, a pigment, or a nitrogenous derivative of the polysaccharides probably bearing the same relation to mucosamine or glucosamine as starch does to glucose. Cohnheim places the nucleoalbumins amongst the simple proteids, and suggests phosphoglobins as a more suitable name for the group.

The book terminates with a description of the chemical and physical properties of the albuminoids.

In conclusion, one cannot but feel that Dr. Cohnheim has earned the gratitude of both chemists and physiologists by his thorough review of the present state of knowledge of the chemistry of the proteids. In no other branch of chemistry is the literature scattered throughout so many journals of very diverse branches of science, and this makes the task of reviewing the literature a most arduous one.

As a work of reference the book is indispensable to all workers in physiological chemistry. J. A. MILROY.

MODERN LENS MAKING.

Contributions to Photographic Optics. By Dr. Otto Lummer. Translated and augmented by Prof. Silvanus P. Thompson, F.R.S. Pp. xi + 135. (London: Macmillan and Co., Ltd., 1900.)

DR. LUMMER and Prof. Thompson have given us in the above volume a thoroughly practical treatise on that part of optics with which it deals, and the book does much to prove the truth of a statement of the translator's preface: "In fact the science of the best optical instrument-makers is far ahead of the science of the text-books."

The history of the book is interesting. Dr. Lummer, when working up the subject of photographic optics for a new edition of Müller-Pouillet's text-book of physics "looked about fruitlessly for a guide"; he found nothing to help him, and the volume now under review, which has been translated and amplified by Prof. Thompson, is the result.

Let us consider the problem; the photographer needs to produce on a flat surface an exact picture of a distant object. To take in a wide field of view the plate must subtend a considerable angle at the centre of the lens; the rays of light traverse the lens in very various directions, some are parallel to its axis, others are oblique, and the angle between them and the axis may reach 30° to 40°.

It is impossible to attain this result with any single lens; we must examine, then, in what respects an actual lens differs from the perfect instrument of Gauss's theory, what are its defects, and how they are to be remedied.

Now this theory is an approximation for real lenses depending on the assumption that the angle between any ray and the axis of the system is so small that all its powers above the first may be neglected.

We wish to inquire, then, what are the conditions which must hold in order that a refracting system may produce an image coinciding with that given by Gauss's theory, even when we retain in our mathematical theory powers of the obliquity above the first. This was done by L. von Seidel in the years 1856, 1857 (*Astronomische Nachrichten*, 835, 871, 1027–1029) for the case in which powers of the obliquity up to the third are retained. His work is hardly known in England. He found that to this degree of accuracy a perfect image could be obtained provided five separate equations of condition between the curvatures and refractive indices of the lenses and their distances apart were satisfied. These five conditions, which we may denote by $S_1 = 0 \ldots S_5 = 0$, are sufficient for all cases in which the light employed is of definite refrangibility; to correct, however, for dispersion, two other conditions are required, and the modern photographic objective, possible only in consequence of the discovery by the Jena factory of special "anomalous" glasses, is the outcome of the attempt to satisfy these conditions.

In the work before us no attempt is made to prove the above equations; this is not part of the scheme of the book, but it is shown that to each condition a distinctive physical meaning can be attached, and this physical meaning is brought into very clear light.

The first equation, $S_1=0$, is the condition that the image of a point on the axis may be a point, free, therefore, from aberration, even when the full aperture of the lens is used.

Let this be satisfied, and suppose the point source to move away at right angles to the axis to some neighbouring position, let the refracted beam be received on a screen perpendicular to the axis; in general, a blurr of light, more or less pear-shaped, will be formed at the screen; in some positions the narrow end of the pear is towards the axis, in others it is removed from it. The shape varies as the screen is moved, but unless the lens is corrected a point image is never formed. This is the defect or aberration called coma, so beautifully shown by Prof. Thompson to the Physical Society last session.

Now we know that when a *small* pencil of rays is obliquely refracted, the refracted rays diverge from two focal lines which lie in perpendicular planes; and we may look upon the finite pencil as composed of a series of small pencils incident at different parts of the lens. To each of these corresponds two focal lines, a primary and a secondary. But the refraction produced by the lens is such that the primary line belonging to a small pencil traversing the lens near its edge does not coincide with that of the central pencil. The primary focal line has a different position for each of the small pencils into which the finite incident pencil has been resolved; if, for a moment, we look upon the primary line as an image of the source, the position of this image depends on the portion of the lens by which it is formed. The next step, then, is to superpose these partial focal lines so as to form two single, primary and secondary, focal lines for the whole pencil, and this is the meaning of Seidel's second condition, $S_2=0$. This condition, which was known to Frauenhofer, is shown to be identical with a law distinguished as the Sine-law, which states that if P be a point on the axis of the system, and Q its image, and if a, a' be the angles which an incident ray through P and the corresponding refracted ray through Q make with the axis, then $\sin a/\sin a'$ is a constant for all rays. If a small object be placed at P, perpendicular to the axis, and a perfect image of this be formed at Q, then, as von Helmholtz showed, the ratio $\sin a/\sin a'$ measures the linear magnification of the image. The connection between this and the physical meaning of the condition $S_2=0$ is an obvious one.

But if this condition be satisfied, we are far from having a point image of our source; we have, instead, two linear images—one lying at right-angles to the axial plane through the point, the other, the secondary image, lying in that plane. If, instead of considering the image of a point, we deal with a plane cutting the axis at right-angles in P, we get, as the image of this plane, two curved surfaces, the one made up of primary lines, the other of secondary lines; these both cut the axis at right-angles in Q, the image of P. If by any means we can make the primary and secondary lines coincide, we shall have a point image of our point source; and this is done if the condition S_3 is satisfied. Such an image is said to be stigmatic, or sometimes an-astigmatic. If this be done for the whole field, the curved surfaces move up to coincidence; the image of the plane is a single surface, not two; in general, however, this image surface will be curved, and as we cannot dish out our photographic plate to get it, we must, if possible, make it plane. The equation $S_4=0$ expresses the condition for this.

Thus, if these four conditions are satisfied, we obtain a plane stigmatic image of any object lying in a plane normal to the axis of the lens.

But this alone is not sufficient to give us a perfect image; it must be similar to the object, there must be no distortion. It is found that the equation $S_5=0$ expresses the condition for this.

In some such manner as the above, Dr. Lummer and Prof. Thompson explain the meaning of the five conditions of no aberration, and then proceed to show how each is satisfied.

For the details of this the reader must refer to the book; there is one other point, however, which it is desirable to follow up more completely here. The system must be free from chromatic aberration. Now let us, for simplicity, deal with two lenses in contact; let f, f' be their focal lengths, μ, μ' their refractive indices, and let $1/\nu$ $1/\nu'$ represent their dispersive powers, so that $\nu=(\mu-1)/(\mu_v-\mu_r)$, μ_v and μ_r being the indices for the rays it is desired to achromatise, while μ refers to some mean ray.

Then the condition for achromatism is

$$\frac{1}{\nu f}+\frac{1}{\nu' f'}=0.$$

Now it is shown in the book that for this case the condition that the field may be flat—Seidel's fourth condition—reduces to

$$\frac{1}{\mu f}+\frac{1}{\mu' f'}=0.$$

Thus the focal lengths must be of opposite sign, and the lens with least focal length—the concave lens that is in a photographic combination—must have the greatest refractive index. But, in order to satisfy the condition for achromatism, this same lens must have the greatest value for ν'.

Now achromatic lenses have usually been made by combining a convex lens of crown glass with a concave lens of flint; with such glasses, however, it is found that when μ is large ν is small, and *vice versâ*. Thus, for example, ordinary light flint has a greater refractive index than silicate crown glass, and hence an achromatic combination is possible; but since the value of ν for such flint is less than for crown, the combination when made will not give a flat field.

Dr. Lummer defines as an "old achromat" a pair of achromatised lenses made of such glass.

One of the results, however, of the experiments of Abbe and Schott at Jena has been the discovery that by the addition of barium salts a crown glass can be obtained having both a high refractive index and a high value for ν. Such a glass could take the place of the flint glass in an achromatic combination, and with this advantage, that the condition for flattening the field could be nearly, if not completely, satisfied.

The condition above given for a flat field was discovered by Petzval in 1843; in principle it had already been published by Airey ("Coddington's Optics," 1829). Von Seidel, however, was the first to point out that it was impossible with the lenses then available to satisfy both it and the condition for achromatism, and it was not until the Jena glass became available that an achromatic lens with a flat field was possible. Such lenses are called by Lummer "new achromats."

Having shown, in the first eight or nine chapters of the book, what are the conditions to be satisfied, Prof. Lummer proceeds to describe the various ways in which this is done in practice. The condition of no distortion is readily satisfied by combining two identical sets of lenses symmetrically placed into a double object glass with the stop midway between. These, if of the new "anomalous" glasses, can have a flat field. But such a combination will not be completely stigmatic; to secure this, other conditions must be satisfied besides those which are possible in a symmetrical combination, and the best result has been obtained by combining, in what is known as an anastigmatic-aplanat, a new achromat with an old achromat. The astigmatic effect of the old achromat is opposite to that of the new; hence by the combination it is possible to secure a flat image which is also stigmatic and achromatic, while, by adjusting the distance between the lenses and properly placing the stop, the condition of no distortion is satisfied.

Details of combinations satisfying these various conditions are given in the book, and not the least of Dr. Thompson's services are the chapters in which he calls attention to the excellent work done by various well-known English makers. His description of Dallmeyer's Tele-objective is specially welcome, while Miethe's two views of Munich from a distance of about two miles—the one taken with an ordinary lens, the other with his tele-objective—show what a powerful weapon the latter is.

The appendix contains some more detailed accounts of von Seidel's analysis, and also a valuable example of the computation of a lens.

The book is published by Messrs. Macmillan and Co. in their usual admirable style, and supplies a very real addition to the literature of a subject too much neglected in England. R. T. G.

OUR BOOK SHELF.

A Handy Book of Horticulture. By F. C. Hayes, M.A. Pp. xi + 225. (London: John Murray, 1900.)

THIS is a little book intended "for the class of fairly intelligent young men who are placed in sole charge of small gardens, who have little natural aptitude for gardening and no training, and who look in vain to their employers for teaching or suggestions of any kind." The questions naturally arise how such men come to have charge of gardens, and whether any book is likely to be of material service to them. For a class of better informed readers with a real interest in the subject the present book is better adapted, as the directions are simple and clear. The practical instruction conveyed is good, but, although the book is not intended for botanists, we may fairly look for accuracy and correct spelling of names.

In the following passages we have examples of loose writing, which are not the only ones that might be found:—

"The lilium is a popular family of hardy, bulbous flowers. No garden should be without a variety of them, but the species is so numerous that it would be impossible in one brief chapter to lay down general rules for their culture."

Here is another paragraph which is not remarkable for accuracy:—

"Speaking generally, a fern may be defined as a plant which bears leaves only and no flowers. The name of their order is Cryptogamia, *i.e.* hidden flowers; they have organs which produce spores, but the attractive petals are absent, and the spore cases are hidden away or take strange forms."

On the following page we have such misspelling as Calcidonicum and tigranum; elsewhere we find nemerosa, pyracanthus, azalias, Charles Lefebre; while the use or disuse of capital letters seems to be entirely a matter of caprice.

The Construction of Large Induction Coils; a Workshop Handbook. By A. T. Hare, M.A. Pp. 155. 35 illustrations. (London: Methuen and Co., 1900.)

THIS book, written by an amateur primarily for amateurs, will be found of the greatest use for all those, amateurs and professionals alike, who desire to construct Rhumkorf induction coils according to the most approved methods.

It is, indeed, so far as the present writer is aware, the only modern work which deals with the construction of large coils from a thoroughly practical standpoint. It describes in every detail the making of the apparatus, and contains much valuable information as to the general design of coils, the methods of winding and the processes of insulation, which hitherto have been the carefully preserved secrets of the very few makers of coils of the more powerful descriptions. Questions of cost are not omitted, while special chapters are devoted to contact breakers of the mercury, hand and electrolytic types.

The discovery of the Röntgen rays, and the important application that these have found in surgical and medical practice, together with the increasing employment of high tension electrical discharges in wireless telegraphy, spectroscopic analysis and other fields, have brought about a great demand for Rhumkorf coils of large size. The need for a book such as the one under review has therefore become increasingly felt of late years, and the only matter for regret is that the author did not give to the public the results of his experience at an earlier date.

The book is clearly written, well printed and well illustrated. A. A. C. S.

The Structure and Life-History of the Harlequin Fly (*Chironomus*). By L. C. Miall, F.R.S., and A. R. Hammond, F.L.S. Pp. viii + 196; plate and text illustrations. (Oxford: Clarendon Press, 1900.)

THE perfect insects of *Chironomus* are conspicuous objects on our windows, or may be seen dancing in swarms in the open air, and are often called "gnats," to which they have considerable resemblance; and, like gnats, the antennæ of the males are very plumose. The larvæ are found at the bottom of standing or slowly-running water, and those of some species are known, from their colour, as "blood-worms," while those of other species are green. The insects are easily collected and reared, and present many points of interest; and the work before us gives a very clear and fairly elaborate account of the structure and habits of these insects in their various stages. The life-histories of insects present an inexhaustible field for the investigations of any observers who care to devote their attention to this branch of entomology; and books like the present will give the beginner a very good idea of the best way to work on similar lines. Hitherto the Diptera, though one of the largest orders of insects, have been strangely neglected in England, and we have not even a good descriptive book on the order, though almost every Continental country has a good monograph in its own language. The interest felt in mosquitoes, however, at the present time will probably spread to other insects of the same order; and thus we are likely to see the study of their life-histories leading to that of the Diptera as a whole, instead of interest in the order generally, leading to researches into its life-histories, as has been the case with some of the other orders of insects.

The bulk of this work is too technical and too elaborate to admit of its being discussed in detail, and it contains much useful general information relating to allied species, nor are the parasites of the larvæ left unnoticed. One remark strikes us as specially interesting: "No insect is known to us which has more completely departed from the habits and structure of an air-breathing animal. Yet even here we find visible proof of descent from a terrestrial insect with branching air-tubes."

In an appendix we find a section on "Methods of Anatomical and Histological Investigation," and an additional note by Mr. T. H. Taylor on the swarming and buzzing of Harlequin flies. The book concludes with a good bibliography and index. W. F. K.

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.*]

On the Nature of the Solar Corona, with some Suggestions for Work at the next Total Eclipse.

IN an article on the corona, published in the November number of the *Astrophysical Journal*, I suggested a method by which the existence of the Fraünhofer lines in the spectrum of the corona might be detected. The method was based on the supposition that the light emitted by the particles, in virtue of their incandescence, so overpowers the reflected sun-light that the lines are invisible. That the coronal light is strongly polarised is well known, and there is scarcely any doubt but that the polarised light is reflected sun-light. If, now, a Nicol prism be placed before the slit of the spectroscope in such a position as to transmit the polarised radiations, these will be allowed to pass with almost undiminished intensity, while the emitted or unpolarised light will be reduced in intensity by one-half. The great change in the ratio resulting might easily be sufficient to bring out the dark lines distinctly. I feel firmly convinced that this experiment should be tried at the Sumatra eclipse of next May, for I have successfully accomplished it in the laboratory with an artificial corona. It was found that a gas flame in a strong beam of sun-light shone with a pure bluish-white light, due to the reflection or rather scattering of the sun-light by the minute carbon particles.[1] The flame thus illuminated showed the Fraünhofer lines distinctly, but by reducing the intensity of the sun-light a point was reached at which they disappeared, and the spectrum appeared continuous. The light scattered by the flame was found to be completely plane polarised in certain directions, giving us just the required conditions, namely, particles emitting a continuous spectrum, and scattering a polarised solar spectrum. In front of the slit of the spectroscope a Nicol prism was arranged in such a manner that it could be drawn into and out of position by a cord. The Fraünhofer lines could be made to appear by sliding the Nicol in front of the slit, and disappear by drawing it away. While it does not by any means follow that the use of a Nicol on the actual corona will bring out the lines, the experiment seems to be well worth trying, as it would furnish further information regarding the relative intensity of the emitted and reflected light.

Another interesting point is that the minute particles in the flame do not scatter the longer waves, the flame reflecting practically no red or orange light. Thus the Fraünhofer lines can only be traced to about the D lines. By reducing the intensity of the sun-light they disappear, first in the yellow, then in the green, blue and violet in succession. This indicates that our chances of detecting the lines in the spectrum of the corona will be greatest in the photographic part of the spectrum. Moreover, it appears to explain the absence of radiant heat in the light sent to us from the corona, the particles being too small to scatter these longer waves to any appreciable extent. Abbott, of the Smithsonian party at Wadesboro', found the corona cold in comparison with his bolometer, and infers from this that the corona neither reflects sun-light nor emits light in virtue of incandescence, expressing the opinion that the luminosity is analogous to that of vacuum tubes transmitting electric discharges. It seems to me that the polarisation of the coronal light makes this theory untenable, and that the absence of heat rays can be explained fully by the small size of the particles. I am aware that the absence of radiant heat in the *emitted* light has yet to be accounted for. My own notion, based on experiments which are now in progress, is that the reflected or scattered light is vastly in excess of the emitted, and that the absence of the Fraünhofer lines is more probably due to the line-of-sight motion of the particles than to simple drowning out by emitted light.

My experiments on the ratio of emitted to scattered light of a body brought to incandescence by powerful solar radiation are not yet completed, consequently I do not yet feel prepared to make any very positive statement in regard to this matter. A

[1] Since writing the above I have found that the reflection of light by a flame has been described by Mr. Burch and Sir George Stokes independently. It was noticed also by Soret at a still earlier date (1875) as I have subsequently found.

full account of this work will appear shortly in the *Astrophysical Journal*.

Any observers planning to use a Nicol prism in connection with a spectroscope in the manner described will find a gas or candle flame illuminated with a beam of sun-light, concentrated by means of a large mirror or lens, extremely useful in making preliminary experiments.

For work on the polarisation of the corona, I believe that the artificial corona, which will be described next week, will be found most useful for preparatory work. Not only is it polarised, and polarised in the same way as the real corona, but it resembles it in every respect, and can be easily made of the same brilliancy. It would be well to work with particles of different size, giving different percentages of polarisation, and the picturesque refinements for producing the polar streamers could, of course, be omitted. A lamp with a ground glass globe might be used to advantage, giving a distribution of polarisation more nearly like that of the actual corona.

Data regarding the plane of polarisation in the streamers would be useful in formulating a theory of the streamers. These, it seems to me, can be conceived as formed in two ways: they may be streams of coronal particles moving in curved paths, in which case the plane of polarisation should be everywhere strictly radial, or, what is extremely improbable, they may be caused by divergent beams of light coming from the polar regions of the sun and moving in curved paths owing to the rapid decrease in the refractive index of the sun's atmosphere in an outward direction. If this were the case, the plane of polarisation would turn with the streamer. This latter hypothesis is extremely visionary, and I do not present it seriously, for it is almost impossible to conceive of any way in which the isolated beams of light could be formed, unless, perhaps, by vortex funnels more highly luminous than the surrounding surface of the sun. Such fanciful speculations are hardly worth indulging in, though they have interested me for the moment in connection with the matter of possible curvature of light rays in the sun's atmosphere, alluded to in a recent paper by Julius in the *Astrophysical Journal*. R. W. WOOD.

University of Wisconsin.

The Alleged Decadence of German Chemistry.

As a man of business, more or less interested in the course of chemical discovery in so far as it affects chemical products of market value, I have for so many years been accustomed to take note of the rapid strides made by Germany in the chemical industries, that the statement contained in the article by "W. J. P." in your issue of December 27 (p. 214) has struck me with amazement. The writer says that "all students of contemporary chemical literature will agree that in Germany the science of chemistry has been in rapid decadence during recent years." This statement seems to me so completely at variance with my own experience that I have consulted chemical friends as to its accuracy, and I cannot find any chemist who agrees with this verdict. The consensus of opinion is, in fact, all in the opposite direction. "W. J. P." himself admits, as a generally recognised principle, that supremacy in any particular industry goes hand in hand with supremacy in the related sciences. Every one of the discoveries recorded in his own paper has been made in Germany, and he himself points out that the new industry is "almost wholly of German origin." Of course, as an English merchant, I hold no brief for German products, but having long ago recognised the importance of the connection between science and industry, which the author emphasises, and seeing what Germany has been doing of late years, I perhaps innocently attributed the progress of that country to their superior system of training in chemistry and related sciences, and to the readiness of their manufacturers to avail themselves of the results of scientific discovery. For the sake of British industry, I shall be only too glad to learn that I was mistaken; but since no chemist of my acquaintance agrees with the writer, and since he himself puts forward a whole body of German discoveries in order to tell us that chemical science is undergoing "rapid decadence" in that country, I cannot but feel that there is such a glaring contradiction between the facts recorded and the conclusions arrived at by the writer that some further explanation as to his meaning is necessary.

S. N. C.

Secondary Sexual Characters.

MR. POCOCK (p. 157) has replied to my letter, but he has not replied to my reasoning. It is no reply to say that it may be doubted whether my hypothesis is an improvement on certain others, when no reasons are given for the doubt. It is no argument to say that a problem is insufficiently supported by evidence, and may be true or false. A problem may be solved, but it cannot be either true or false, nor can it be supported by evidence. Mr. Pocock himself in his article attributed the colour of the male nilghaie and other antelopes to "male katabolism," which he now says is nothing but an imposing substitute for the "vital force" of the pseudo-scientific realists. I quite agree with him, and only hope that in future he will not explain male peculiarities by attributing them to male katabolism.

It is very difficult to reason with a naturalist who uses the terms "struggle for existence" and "influence of external conditions" as equivalent to "selection." I quite understand that to the Darwinian the only important action of external conditions is the selective action, the survival of the fittest. But the Darwinian does not appear to understand his opponents' conception of the modifying non-selective action of external conditions. Mr. Pocock does not distinguish between variations and modification. If any cause acts on *all* the males of a species and makes their colours dark or black, what effect can selection produce? If the dark colour is harmful, the species will become reduced or extinct. But selection cannot, as Mr. Pocock suggests, "check" a general modification due to a general cause without eliminating the species.

Thus the question which Mr. Pocock raised in his original article, and which he now "sets aside," the question of the initial cause of sexual modifications, is the essential question of the whole subject, and cannot be set aside in any rational discussion of the facts. Even supposing that the variations are different and not general, and that those which are beneficial are selected and preserved, selection offers no explanation of the fact that in so many cases the peculiarities in question are inherited only by the male sex. Mr. Pocock, in discussing the uses of coloration and markings, was obliged to refer to cases in which the males differed from the females both in colour and in horns. He has not yet realised the truth that no theories based on the conception of selection afford any explanation of unisexual inheritance.

Penzance, December 17, 1900. J. T. CUNNINGHAM.

The Word Physiography.

WITH reference to the question of the early use of the word Physiography to express the comprehensive study of Nature, to which you refer on p. 207 of your last issue, I should like to call attention to a fact which appears to have been almost forgotten.

The title-page of a "Dictionnaire des Termes usités dans les Sciences naturelles," published in Paris in 1834, bears as a motto the words—

"Profectò physiographiam qui colit, ullo pacto metam perfectioris cognitionis feliciùs non attinget, qùàm si aliquot dies terminis perdiscendis tribuerit."—*Linné*.

I have tried, but without success, to find this quotation in the works of Linnæus; perhaps some of your readers may be able to supply the reference. The word Physiography was certainly current in Sweden about the middle of the eighteeenth century, as in the obituary notice of Torbern Bergman, read at the Stockholm Academy of Sciences in 1786 (which I know only in the German translation), it is mentioned that he became a member "der Physiographischen Gesellschaft in Lund, 1776." "Minerva" for 1900—1901, however, states that the Physiographical Society of Lund, which still exists, was founded in 1778 for the study of the scientific and economic conditions of the province of Scania. There was at the same time a Cosmographic Society in Upsala, and the two names seem to have been used much in the same sense.

I think it possible that the word Physiography was introduced in Sweden by Linnæus as a substitute for Cosmography, the ancestor alike of the Physiography of South Kensington, and the Physical Geography of the older text-books.

HUGH ROBERT MILL.

Artificial Rain.

AFTER the magisterial words of Prof. Cleveland Abbe, as reported in your issue of December 13, 1900, it requires some courage to offer a possible instance of "artificial" rain. I was near Bolton Abbey railway station on November 26 last. The atmosphere was perfectly calm, and a thin white mist enveloped the landscape. A number of land-blasting explosions took place in some limestone quarries, perhaps a quarter of a mile away. At a very short interval after these there occurred a very little shower or sprinkling of rain, just sufficient to cause me to put up my umbrella in preparation for more. The extreme brevity of the shower, and the peculiar conditions under which it occurred, arrested my attention, and led me at once to refer it to the explosions which had just taken place.

Keighley, December 22, 1900. C. H. B. WOODD.

IN an article on artificial rain in your issue of December 13, 1900, Prof. Abbe alludes to "the popular belief that rain follows great battles," which is now often—incorrectly, as the article points out—explained by and used as an indication of some effect produced on the clouds by the explosion of the gunpowder.

It is interesting in this connection to observe that the belief about rain following battles was held many centuries before the invention of gunpowder. Plutarch, in his life of Caius Marius, writes:—"It is observed, indeed, that extraordinary rains generally fall after great battles: whether it be that some deity chooses to wash and purify the earth with water from above; or that the blood and corruption, by the moist and heavy vapours they emit, thicken the air, which is generally liable to be affected and altered by the smallest cause." (Langhorne's translation). The inference is that the belief was the result of a preconceived idea, and that the gunpowder explanation was therefore wasted on a theory which was not grounded on observation at all. M. T. TATHAM.

Northcourt, Abingdon.

PROGRESS IN METALLOGRAPHY.

THE application of micrographic analysis to the study of alloys has given to the metallurgist a new and important field of investigation, and every improvement in the established methods is worthy of attention. Some of the latest suggestions are made by M. Henri le Chatelier in the *Bulletin de la Société d'Encouragement* for September last, the most noteworthy being in connection with the final stages of polishing. It is necessary for this work that the polishing powders should be perfectly classified according to the dimensions of the particles. The method of sorting by means of levigation, described by M. Osmond, is defective, owing to the fact that the salts of lime in ordinary water cause coagulation and rapid deposition of minute particles suspended in water. Caustic lime and acids induce even more rapid settling, a fact that has proved of great commercial importance in the treatment of ore slimes by cyanide in South Africa.

To overcome this difficulty the powders are heated with nitric acid, washed thoroughly, and allowed to settle in distilled water containing 0·2 per cent. of ammonia. When treating ten grams of powder in a litre flask, nine-tenths of the liquid are siphoned off at the following intervals of time: a quarter of an hour, one hour, four hours, twenty-four hours, and eight days. The third deposit is useful in polishing hard metals such as iron, but the fifth and last deposit affords the best polishing powder. Minute care is taken to avoid any admixture of dust or dirt with these powders, which can now be bought in Paris mixed into a paste with soap, and contained in tin tubes such as are used for oil colours.

A number of materials for the manufacture of these powders have been tried. M. Le Chatelier finds that alumina prepared by calcining ammonium alum is the best, as far as speed of polishing is concerned; but oxide of chromium, obtained from the combustion of bichromate of ammonium, answers fairly well in the treatment of iron and steel, and is better than alumina for soft metals such as copper. Oxide of iron is far less advantageous than these substances, its action being very slow. The soap

FIG. 1.—Crystals of Al_2Cu.

preparations are applied in the ordinary way to discs of wood or metal covered with skin or cloth and capable of being revolved at high velocity, the whole operation of polishing proper being carried through by their aid in five minutes.

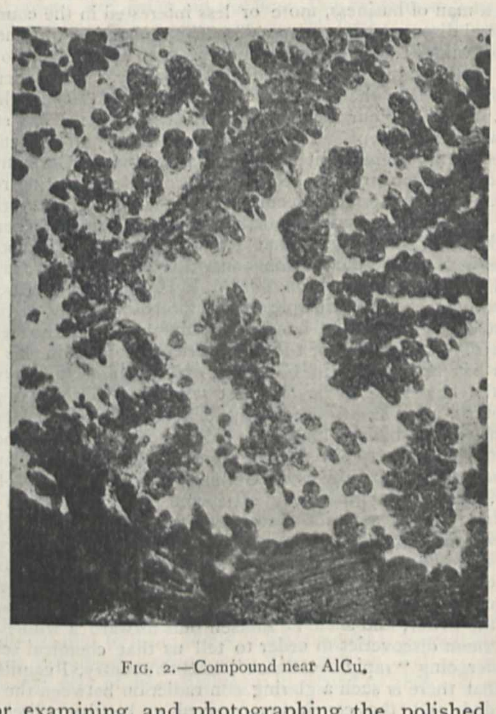

FIG. 2.—Compound near AlCu.

For examining and photographing the polished and etched specimens under the microscope, M. Le Chatelier proposes the use of monochromatic light such as that derived from an electric arc in mercury vapour, with suitable screens between the source of light and the object to be illuminated; but it appears doubtful whether enough light can be easily obtained in this way for very high magnifications.

With regard to the selection of the specimens to be examined, it is well known that much time is wasted when working out a complete series of alloys of two metals. It is necessary to prepare, polish and etch a series of specimens, many of which will present no features of interest when examined under the microscope. M. Le Chatelier proposes to shorten the search for typical alloys by melting together two superimposed layers, each consisting of a pure metal, the lighter one being on the top. If no alloys are formed of greater density than the heavier metal, and the crucible is allowed to cool undisturbed, a culot can be obtained which, on being sawn through vertically, shows a complete gradation from one pure metal to the other, passing through the whole series of alloys, which can then be studied in one specimen. In this way he prepared a number of series, the three illustrations (Figs. 1, 2 and 3) being from

FIG. 3.—Crystals of $AlCu_3$.

photographs of different parts of a single specimen showing the aluminium-copper series. Fig. 1 shows crystals of Al_2Cu; Fig. 2, crystals of a compound of undetermined composition which is not far from that expressed by the formula AlCu; Fig. 3 shows crystals of the compound $AlCu_3$. It would seem that the exact percentage of any particular part of a specimen prepared in this way must be a matter of uncertainty, but there is no doubt that, in the hands of M. Le Chatelier, the method has already yielded some interesting results.

T. K. ROSE.

SOME RECENT ADVANCES IN GENERAL GEOLOGY.

AMONG the recent researches on organic remains none are of greater geological interest and importance than those relating to the Radiolaria. The tiny siliceous structures which belong to this Order of Protozoa have long been recognised in our formations, but the part they have played in building up portions of the stony structure of the earth has not until lately been realised. The most striking evidence was that brought forward by Prof. Edgeworth David and Mr. E. F. Pittman (*Quart. Journ. Geol. Soc.*, vol. lv. p. 16, 1899). They describe a great series of siliceous limestones, jaspers and claystones, with interstratified coral limestones and plant-beds, and submarine tuffs, the whole attaining a thickness of over 9000 feet, and extending over many hundred square miles in New South Wales. In the bulk of these rocks Radiolaria are present at the rate of about one million to the cubic inch, and among the forms Dr. G. J. Hinde has recognised twenty-nine genera and fifty-three species. Taken as a whole, the deposits are fine-grained, and bear evidence of having been laid down in clear sea-water, beyond reach of any but the finest sediment. They do not indicate any very considerable depth of water; but they tell of a vast lapse of time, and of conditions which prevented the dispersal over the area of coarse detritus. What exactly were these conditions it remains for future research to discover. In this country, in Devonshire and Cornwall, the occurrence of radiolarian cherts, both of Ordovician and Carboniferous ages, has been made known through the observations of Dr. Hinde, Mr. Howard Fox and Mr. Teall. The more prominent of these rocks are found in the Lower Carboniferous formation of Coddon Hill near Barnstaple, where the chert-beds have long been known, although their organic origin was not until recently discovered. The freedom of the beds from mechanically-formed detritus has led to the supposition that these strata were deposited in deep water and at some distance from the coast, although the associated strata above and below the chert-beds do not lend support to the hypothesis. The fact is that at the present time the only extensive radiolarian deposits known to be in process of accumulation are in the deeper oceanic regions.

Radiolaria, while entirely marine, are widely distributed, and they can exist at various depths in deep and shallow seas. It may be surmised, therefore, that in shallower areas coral-reefs may have acted as barriers to the dispersal of terrestrial *débris*. Hence in our explanations of the physical conditions of the past we must be guided by the general characters of the sedimentary strata in which bands and beds of radiolarian chert occur, rather than by the evidence of the chert itself. There is, however, little doubt, from the wide distribution of these lowly forms of life, that they may prove of considerable importance in the identification of horizons, although, as might be expected from their present geographical and bathymetrical ranges, some specific types have been of long geological duration.

In the coast ranges in California, and again in Borneo, such radiolarian rocks of Jurassic, or possibly Lower Cretaceous age occur, and it is noteworthy that Dr. Rüst has remarked that "the differences in the Radiolaria from these two rock-divisions are not very striking." (See Hinde's "Description of Fossil Radiolaria from Central Borneo," 1899.)

The question whether the Wealden strata which are essentially freshwater should be grouped as Jurassic rather than Cretaceous has been raised by geologists in the New as well as in the Old World, who have argued that the Wealden plants, fishes and reptiles are Jurassic rather than Cretaceous in character. There has never been any question in this country that the Purbeck and Wealden Beds are intimately connected both stratigraphically and palæontologically, and it has been held by some geologists that locally the Wealden Beds and Lower Greensand bear also evidence of continuous deposition. The subject was lately discussed by Mr. G. W. Lamplugh (Brit. Assoc., Bradford, 1900), who points out that in Dorset, Hampshire and Surrey there is evidence of the close stratigraphical connection between Wealden and Lower Greensand, that part of the freshwater Wealden must represent true marine Lower Cretaceous beds elsewhere, and that consequently it is equally erroneous to classify the Wealden series entirely with the Jurassic system or entirely with the Cretaceous.

If the planes of division between our formations are more often than not ill-defined, so also are those between the main systems. Between our Palæozoic and Mesozoic strata there has never been a very well-marked boundary, for some authorities have placed the Permian with the older division and some with the newer.

The tendency of recent investigations in the midland areas is to show that a considerable series of red beds which have been regarded as Permian are truly portions of the Coal-measures, while it is evident that the Magnesian Limestone series is stratigraphically united more closely with the Triassic strata. In Britain the main mass of the Permian (Magnesian Limestone series, &c.) lies unquestionably with great discordance on various subdivisions of the denuded Carboniferous and Devonian rocks. Abroad in many areas, in India, Australia and elsewhere, there appear connecting links in strata grouped as Permo-Carboniferous; but it is a question whether the original Permian is anything more than a provincial set of strata, unentitled to rank with a system (see C. R. Keyes, *Journ. Geol.*, Chicago, vol. vii. p. 337, 1899).

As the history of the successive strata in different countries becomes better understood, so it becomes possible more closely to parallel the life-epochs which are represented in the rocks. Such life-epochs do not of course correspond with the sedimentary changes which are recorded by the rocks themselves, and hence a double system of grouping becomes needful. In our own country this has been long apparent, and the successive groups of strata which are so well established in the Ordovician and Silurian systems of Wales, the Lake District and the Southern Uplands of Scotland require distinct stratigraphical terms, while the life-history and the correlation of the subdivisions are indicated by the zonal groupings based on zoological evidence. The representation on maps and in sections of the main stratigraphical groups, or geological formations, is essential in order to show the physical structure of a country, not only in reference to economic questions, but also in regard to the influence on the present scenery of the rocks and the movements to which they have been subjected. Different types of landscape and the evolution of river systems are engaging a good deal of attention, notably in the United States; and the study has led to the introduction of a large number of terms which are rather difficult to remember, but the more important are explained in Mr. J. E. Marr's "Scientific Study of Scenery."

Increasing attention is given to the great movements which have affected the rocks especially in mountain regions. The pioneering work of Heim in Alpine regions has been utilised and developed in the most brilliant manner by Lapworth and Rothpletz and many others. The old ideas of reversed faults have been, so to speak, magnified into great earth movements, whereby huge masses of country have been overfolded, fractured, and overthrust, the older being pushed over the newer. On a small scale such overthrusts were long ago recognised in some coal-fields by the name of overlap faults, and the displacement was measured by yards—now it is sometimes reckoned by miles. Moreover, not only in Highland regions where the secret inferred by Nicol was unravelled by Lapworth have these mighty overthrusts been made manifest, but on a comparatively small but by no means unimportant scale they have been traced out and pictured in the Cretaceous rocks of the Isle of Purbeck by Mr. A. Strahan. The same observer has drawn attention to other overthrusts in the great Coal-field of South Wales.

All sorts of complicated structures due to cross-folding and faulting, to successive horizontal displacements and twisting, have been produced in mountain regions; and Dr. Ogilvie Gordon has dealt exhaustively with the subject in a paper on the torsion-structure of the Dolomites (*Quart. Journ. Geol. Soc.*, vol. lv. p. 560). To quote one sentence from her paper will, perhaps, be enough to give an idea of the puzzles she has attempted to solve: "Anticlines have been twisted round synclines, and the rocks in the synclines have themselves been twisted and distorted, buckled up and depressed, overthrust and faulted normally, cross-faulted and cleaved, to an extent that has not hitherto been realised." We may add that the subject of torsion-structure has been examined mathematically by Mr. J. Buchanan (*Phil. Mag.*, vol. l. p. 261).

The evidence of great folds and flexures, accompanied by overthrust faults, has lately been brought more fully to light in the Malvern region by Prof. T. T. Groom, while in the Lake District the field labours of Mr. J. E. Marr and Mr. A. Harker, as recently expounded (*Proc. Geol. Assoc.*, vol. xvi. August 1900), indicate that the country has there been affected, not only by overthrust faulting, but by more or less horizontal displacement, termed "lag" faults, whereby lower and older strata have been moved more rapidly than newer overlying strata, which consequently have lagged behind. Other faults, called "tears," are described, where, during these movements, rents have occurred in the shifting masses of strata without occasioning much vertical displacement.

In very many cases along fault-planes there has been produced a kind of breccia due to the effects of displacement, but more striking results of such action have lately been made known in the production of conglomerates. In such cases the effects of earth-movements have not only fractured, but actually worn away, the edges of the shattered rocks. In the Isle of Man, where the Manx slates have undergone acute folding followed by intense shearing, the shear-cleavage has cut and displaced bands of grit and has actually rounded the fragments so as to produce what Mr. Lamplugh has termed a crush-conglomerate. His observations have borne good fruit elsewhere. Mr. C. A. Matley has described crush-breccias and crush-conglomerates in Anglesey, where they occur "along zones of powerful crushing, especially in areas where the soft, fine-grained, slaty rocks alternate with tougher and more brittle strata, such as grits and quartzites" (*Quart. Journ. Geol. Soc.*, vol. lv. p. 657), and Prof. Groom has dealt with the crush-breccias of the Malvern Range (*ibid.*, p. 151).

It has long been felt that some revolution in palæontological nomenclature is needed, and, fortunately, the matter has been taken up boldly and effectively by Dr. Arthur W. Rowe.[1] In old times new species were named from fossils obtained from formations without reference to their special horizons. Some were founded on the evidence of but one or two specimens, and it has not unfrequently happened that "varieties" have been found which preceded in time the type species. Of late years, when increasing attention has been given to careful collecting, there has been a tendency to "make every prominent form a species, on the plea that every minute variation must be ticketed and pigeon-holed." In this way very many of the old land-marks have been removed, the study and identification of species have passed beyond the comprehension of any but the specialist, and the value of his labours to others has been more and more reduced or obscured. Dr. Rowe has now for some years devoted the leisure of a busy life to a careful collection of *Micrasters* from successive stages or zones in the Middle and Upper Chalk. He finds that by examining the facies of the genus in each horizon, passage-forms prove to be the rule, while sharply-defined and typical species are the exception. He has been able to trace an unbroken continuity in

[1] *Quart. Journ. Geol. Soc.*, vol. lv. p. 494.

the evolution of *Micraster*, so that in successive stages of the Chalk he finds variations in the structure of the tests, variations indeed which "are so marked that one can tell by their aid from what zone a *Micraster* is derived." As passage-forms and mutations form the bulk of the genus, it is necessary to mass certain obviously allied forms into groups which will admit of the zoological continuity being exemplified and the zonal peculiarities noted. This is the plan adopted by Dr. Rowe, and it certainly appears most philosophical to take a series of specimens rather than an individual as the foundation for a zonal specific type; and to group rather than to try and separate so many forms. It is satisfactory to learn that the detailed zoological work carried out by Dr. Rowe bears witness to the great value of the palæontological zones which were broadly marked out in the chalk of this country nearly twenty-five years ago by Dr. Charles Barrois.

There is no doubt that the careful collecting of fossils from definite horizons, and from horizons in definite sequence, is of the utmost importance in advancing palæontological knowledge. Such work, as a rule, requires prolonged labour, otherwise the conclusions are worse than useless. Now, by close research, it is possible to trace out the successive modifications that occur in stratigraphic sequence, and this has been attempted with the Graptolites, and with several groups of Mollusca and Brachiopoda, as well as with Echinodermata. Even in so variable a group as the Oysters, it is affirmed by Messrs. R. T. Hill and T. W. Vaughan (*Bulletin* U.S. Geol. Survey, No. 151) that these organic remains possess very distinct specific characters, have definite geologic horizons and are of the greatest value in stratigraphic work. Their value, moreover, may be not merely scientific, but also of some benefit to humanity. Instances have occurred in Texas where, by the aid of these fossils, brought up from great depths in diamond-drill cores, cities upon the point of abandoning the attempt to procure artesian water have been warranted in drilling a few feet farther, and with success.

Views on the duration of geological time have occupied a considerable amount of letterpress during the past fifty years, and during the past few years the subject has been discussed by Mr. G. K. Gilbert, Mr. J. G. Goodchild, Sir A. Geikie, Prof. J. Joly, and Prof. W. J. Sollas.

Mr. Gilbert would look to the influence of precessional changes and to the periodic modification of the climatic conditions of the two hemispheres. Contrasted phases of climate would thus occur every 10,500 years, and such changes should be looked for in the strata. Indications of moist or dry climates, of the increase or decrease of glaciers, and of the local fluctuations of sea-level as affecting the character and extent of strata are the indices to which he would appeal.

Prof. Joly, arguing from the amount of sodium at present contained in the waters of the ocean and the amount annually supplied by rivers, claims that a period of between eighty and ninety millions of years has elapsed since the land first became exposed to denuding agencies. Sodium, as stated by Prof. Joly, is the only dissolved substance of which the ocean has retained substantially the whole amount committed to it by the solvent denudation of geological time.

Prof. Eug. Dubois, dealing with the circulation of carbonate of lime, believes that the real lapse of time since the formation of a solid crust and the appearance of life upon the globe may be more than one thousand million years.

Mr. J. G. Goodchild in 1897 also argued that the more trustworthy data relating to the time of formation of marine strata were furnished by deposits of organico-chemical origin. He concluded that over seven hundred million years would be required since the commencement of the Cambrian period.

Although the conclusions arrived at by investigators are widely at variance, it is not improbable that some trustworthy data may in time be gained by the different methods of research advocated by Gilbert and by Joly. As lately remarked by Sir A. Geikie, progress in geology will be best made by the adoption of more precise methods of research and by a hearty co-operation among geologists in all parts of the world; and Prof. Sollas well observed in his address at Bradford that "our science has become evolutional, and in the transformation has grown more comprehensive." The work of the palæontologist must be supported by very detailed local field-work, work which at present is very much in its infancy. Such work will help in the grand story of "the science of the earth," a story whose materials can only be gathered together by the patient local toiler; while he or she may well be content to see the results worked up by those who by training and opportunity are able to take a comprehensive view of the earth as a whole.

H. B. W.

LORD ARMSTRONG, F.R.S.

THE death of Lord Armstrong on Thursday last, in his ninety-first year, will be regretted in the world of engineering and applied science. To the general public he was best known as a manufacturer of munitions of war, but engineers will remember him more for his developments of hydraulic machinery, and in science his name will be associated with the discussion of the duration of our coal fields, and the development, and discharge phenomena, of statical electricity.

William George Armstrong was born at Newcastle-upon-Tyne in 1810, and educated at a school at Bishop Auckland. He adopted the law as a profession, and became a partner in a firm of solicitors; but a strong bent for scientific pursuits led him to study mechanics with more interest than law and eventually diverted him into another career. Early in life he began investigations of electrical subjects, which resulted in the invention of the hydro-electric machine familiar to all readers of text-books of electricity. The circumstances which suggested this novel electrical machine are well known. The workmen at a colliery near Newcastle had observed that when steam was blowing off from the high-pressure boiler, a smart shock was received if the safety valve was touched, and sparks could be seen. An investigation of the phenomena showed Mr. Armstrong that the boiler was insulated on a dry seating, and the friction of the water particles against the sides of the orifice through which it was escaping caused a development of electricity. On this discovery he based the construction of his hydro-electric machine, which at that time formed the most powerful means of generating frictional electricity. It consisted essentially of an insulated boiler, from which steam at high pressure was allowed to escape through nozzles of peculiar construction. For this he was elected a Fellow of the Royal Society in 1846, while still comparatively a young man.

Another electrical research for which Lord Armstrong will be remembered was concerned with electric movement in air and water, and it culminated in the publication of an elaborate volume on the subject in 1897. In this work a striking experiment, performed with the hydro-electric machine half a century earlier, was made the starting-point of a valuable research on the nature of electric discharges. Two glasses of distilled water were placed near together, and a thread of cotton, which was coiled up in the one, had its free end placed so as to dip in the other. On negatively electrifying the glass of water in which the cotton was coiled, and the other glass positively, the thread crept out of its glass into the other, while a stream of water passed in the opposite direction. This and other evidence led Lord Armstrong to conclude that an electric current consists of a negative stream flowing in one direction surrounded by a sheath of positive stream flowing in the opposite direction. The theory presents difficulties which have not been overcome, but neglecting it altogether, the photographs published to illustrate it are the most remarkable examples of electric discharges ever produced.

To Lord Armstrong the world is indebted for the development of the hydraulic machinery which to-day plays so important a part in the business of our docks and large railway stations. He first invented the hydraulic crane, and, between 1845 and 1850, the accumulator by which an artificial head of water is substituted for the natural head. By this invention hydraulic machinery was rendered available in almost every situation. Being very convenient where power is required at intervals and for short periods, it has come into extensive use for working cranes and hoists, opening and shutting dock gates, turning capstans, raising lifts, &c., and in many cases has procured important economies, both as regards time and money, at harbours and railway stations where large amounts of traffic have to be dealt with. In the Navy, again, its applications are almost infinite in number. In awarding the Albert Medal to Lord Armstrong in 1873, the Society of Arts recognised the benefits which have accrued to manufactures through his development of the hydraulic transmission of power.

For the manufacture of hydraulic machinery the Elswick Engine Works was founded, and there, in 1854, was constructed the first rifled ordnance gun that bears the name of Armstrong. Its trials were so satisfactory as regards range and accuracy that it was soon adopted by the Government, and Armstrong was appointed engineer of rifled ordnance, being made C.B. and receiving the honour of knighthood. Under his supervision some 3500 of these guns were turned out between 1859 and 1863, and England became the possessor of the best armament then in existence.

In 1863, Sir William Armstrong resigned his official appointment, and rejoined the Elswick Manufacturing Company, and in the same year he was president of the meeting of the British Association at Newcastle-upon-Tyne. In that capacity he drew attention to the gradual lessening of our supply of coal, and the prospects of exhaustion of our coalfields. The discussion suggested by this address led to the appointment of a Royal Commission to inquire into all the circumstances connected with the national coal supply, and he was nominated a member of it. The better utilisation of natural forces was a subject to which he again called attention in his presidential address to the mechanical science section of the Association at York in 1881, when he commented upon the wastefulness of the steam engine, and discussed the question whether its difficulties might be avoided by resorting to electrical methods of obtaining energy.

Lord Armstrong received many honours. Cambridge made him a LL.D. in 1862 and Oxford a D.C.L. in 1870. He was president of the Institution of Civil Engineers in 1882, and he more than once served the same office in the Institution of Mechanical Engineers. An original member of the Iron and Steel Institute, he was in 1891 awarded the Bessemer Medal by that body, and the large number of foreign decorations which were bestowed upon him attested the reputation which his work won for him abroad. His presidency of the Newcastle Literary and Philosophical Society was the occasion for several noteworthy addresses, and he wrote a number of articles, pamphlets and short treatises on scientific subjects. His public spirit and philanthropy are justly appreciated in Newcastle. A lecture hall for the Literary and Philosophical Society, an operating theatre for the Infirmary, thousands of pounds towards the restoration of a fine old steeple, other thousands to the Children's Hospital, three-quarters of a 20,000*l*. bridge across Benton Valley, 10,000*l*. to the Natural History Museum, a Mechanics' Institute, and schools for the Elswick men, a banqueting hall, public parks—these were among his gifts to the city.

For these works, as for his contributions to the progress of science and industry, his name stands high among the great men of the century.

WILLIAM POLE, F.R.S.

MR. WILLIAM POLE, F.R.S., whose death occurred on December 30, at the age of eighty-six, was distinguished both as an engineer and as a musician. He was born in Birmingham in 1814, and, after following the profession of engineering for some years, was appointed professor of civil engineering in Elphinstone College, Bombay. In 1847 he returned to London, devoting his chief attention to the mechanical branch of his profession, and soon became a recognised authority on engineering matters Between 1859 and 1867 he was professor of civil engineering at University College, London, and lecturer at the Royal Engineer Establishment, Chatham. He served on the Council of the Institution of Civil Engineers from 1871 to 1875, in which year he was appointed honorary secretary.

Mr. Pole's services to the Government in carrying out scientific work of various kinds were very important. In 1861–1864 he was a member of the committee on iron armour, and from that year till 1885 he was almost constantly employed by the Government in one of its departments, bringing the knowledge of an expert to bear on questions differing so widely as the comparative merits of the Whitworth and Armstrong systems of artillery and the gas and water arrangements of the metropolis. He acted as secretary to four Government commissions of inquiry—namely, from 1865 to 1867 to the Royal Commission on Railways, from 1867 to 1869 to the Royal Commission on Water Supply, from 1882 to 1884 to the Royal Commission appointed to inquire into the pollution of the Thames, and in 1885 to a committee on the science museums at South Kensington. From 1871 to 1883 he was consulting engineer for the Imperial railways of Japan, and on his retirement the Mikado decorated him with the Imperial Order of the Rising Sun.

In June, 1861, Mr. Pole was elected a Fellow of the Royal Society of London, and was vice-president in 1876 and 1889. He was elected into the Royal Society of Edinburgh in 1877, and into the Athenæum Club as a man of "distinguished eminence in science," in 1864. He published in 1844 a quarto treatise on the steam engine; in 1848 a translation of a German work on the same subject; in 1864 and 1870 "Scientific Chapters in the Lives of Robert Stephenson and I. K. Brunel"; in 1872 a treatise on iron; in 1877 he wrote the life of Sir William Fairbairn, and in 1888 that of Sir William Siemens. He was also the author of a well-known scientific work on the game of whist, and contributed a number of papers to scientific journals and periodical literature.

Mr. Pole was skilled both in the theory and practice of music. He took the Oxford degree of Bachelor in 1860, and in 1867 that of Doctor of Music. He also held for some years the office of examiner in music at the University of London. He was the author of "The Philosophy of Music," "The Story of Mozart's Requiem," and other compositions.

NOTES.

SCIENCE is represented in the list of New Year's honours by Sir William Turner, F.R.S., professor of anatomy in the University of Edinburgh, who has been made a K.C.B. Other names familiar in various branches of the scientific world are:—Dr. Thomas Barlow, physician extraordinary to the Queen, and Dr. W. S. Church, who have each received the dignity of a baronetcy; Mr. Hiram Maxim, the well-known inventor, has been knighted; Mr. F. Victor Dickins, Registrar to the University of London, and Lieut.-Colonel G. T. Plunkett, director of the Department of Science and Art, Dublin, have been appointed to the Order of the Bath (C.B.); and Captain F. E. Younghusband, known for his journeys in China and India, has been granted the Kaiser-i-Hind medal.

THE *Times* of Tuesday, December 25, contains an article on the dispute between the London United Tramways Company and the managers of Kew Observatory. It is written very much from the point of view of the Tramways Company, and contains several misstatements to which Prof. Rücker calls attention in a subsequent letter. The question, as Prof. Rücker rightly points out, is not whether it is possible to obtain "perfect" insulation, but whether the insulation, which every one knows can be obtained, should not be insisted upon when the interests of so valuable an institution as Kew Observatory may be preserved by doing so. The engineers of the Tramways Company originally proposed to limit the maximum potential difference between the rails and earth to one-fifth of a volt, a condition which was accepted by Kew, but they have since found that, by the system they proposed to adopt, they are unable to keep within this limit. There are, however, other systems which could be used, and it rests with the Board of Trade to decide whether some other system should be adopted or not. It is to be hoped that the final decision will enforce everything being done that can be done to prevent interference with the very important magnetic work carried on at Kew, or, if protection is considered impossible, that adequate compensation will be insisted upon. Quite apart from the particular point at issue, it is an anachronism which ought to be remedied as quickly as possible that electrical engineers should be allowed to let their waste current flow into the soil. The evils of the system are apparent in many instances already; they will become intolerable when electric traction is developed on a large scale in London.

AT the fourth International Zoological Congress, held at Cambridge in 1898, it was decided that the fifth Congress, in 1901, should be held in Germany; the selection of the town and president being left to the German Zoological Society, acting in conjunction with the Permanent Committee of the Zoological Congress at Paris. Announcement has now been made that the meeting place will be Berlin, on Aug. 12–16, and the president Prof. K. Moebius, director of the zoological collection of the Natural History Museum, with Prof. F. E. Schulze, director of the Zoological Institute, as vice-president. The secretaries of the Congress will be Herr P. Matschie, Dr. M. Meissner and Dr. R. Hartmeyer. The treasurers will be Herr H. Schalow and Herr Otto Stutzbach. Arrangements as to meetings and papers will be in charge of Prof. L. H. Plate, apartments and receptions will be under the care of Dr. L. Heck, and the lighter pleasures of the meeting will be managed by Dr. O. Jaekel. The meetings will be held in the Natural History Museum and neighbouring rooms of the University. Among the subjects to be brought before the Congress are the following:—Fossil remains of man, Prof. Branco (Berlin); vitalism and mechanism, Prof. Bütschli (Heidelberg); theories of fertilisation, Prof. Yves Delage (Paris); the psychological attributes of ants, Prof. A. Forel (Morges); the malarial problem from a zoological point of view, Prof. Grassi (Rome); mimicry and natural selection, Prof. E. B. Poulton (Oxford). After the conclusion of the Congress an excursion will be made to Hamburg for the purpose of visiting the Natural History Museum and Zoological Garden there, and also to Heligoland. Communications concerning the Congress should be made to the president, 43, Invalidenstrasse, Berlin, N. 4. Admission to the Congress will be free to all zoologists and all friends of zoology.

IN connection with the remeasurement of the Peru arc of meridian by a French Commission, M. F. Gonnessiat, of the Lyons Observatory, has been appointed director of the Observatory at Quito for a period of five years.

THE committee of the U.S. House of Representatives in charge of the Bill to substitute, in 1903, the metric system of weights and measures for the common system in use, has reported in favour of the change, and there is reason to believe that the Bill will become a law.

IT has been found necessary to postpone the opening of the Exhibition of Modern Illustration in the Indian Section (Imperial Institute Road) of the Victoria and Albert Museum, from January 7 until January 14. The Exhibition will be open free every day, and will remain open about three months.

AT the annual meeting of the Geographical Association on January 9, at the College of Preceptors, Mr. Douglas W. Freshfield, president of the Association, will show a series of lantern slides illustrating his recent journey in the Sikhim and Nepalese Himalaya.

WE are informed that the inaugural meeting of the Birmingham Local Section of the Institution of Electrical Engineers will be held in the buildings of the Birmingham University at 8 p.m., on Wednesday, January 23. Dr. Oliver Lodge, the chairman of the Section, will then deliver his address. The president and secretary of the Institution have accepted an invitation to be present.

WE learn from *Science* that Mr. D. O. Mills, of New York, has promised the University of California about 24,000 dollars, to defray the expenses of a two years' astronomical expedition from the Lick Observatory to South America or Australia, with the object of studying, under good conditions, the movements of stars in the line of sight.

THE monthly record of anthropological science, which has just appeared under the title of *Man*, ought to prove an excellent recruiting agent for the Anthropological Institute, under the direction of which it is published. The first number contains several articles and reviews on anthropology understood in its widest sense, and provides all who are interested in the study of man with a *précis* of important contributions to various branches of the science. A coloured picture of a Buddhist wheel of life from Japan forms a frontispiece, and is described by Mr. N. W. Thomas.

THE death of Major Serpa Pinto, the African explorer, is announced from Lisbon. He was leader of an expedition organised by the Lisbon Geographical Society and the Geographical Commission of the Ministry of Marine, for the purpose of exploring the hydrographical conditions between the basin of the Congo and that of the Zambesi, and generally to explore the whole region between the provinces of Angola and Mozambique. The expedition started from Benguella in November, 1877, and reached Durban in 1879. Little new country was opened up by the journey, as Africa had previously been crossed by Livingstone and other explorers. His contributions to a knowledge of the hydrography of the country between the coast and the Kwando were, however, of importance, and he was able to describe the large tableland that characterises a considerable part of this region. The expedition was well supplied with scientific instruments, with which numerous observations that have been serviceable to the cartographer and the meteorologist were taken. The Royal Geographical Society awarded him their Founder's Medal for this journey. His travels from Mozambique in 1884, and into the Shiré country in 1889, were of political importance, but have no scientific value.

SIR HARRY JOHNSTON has sent to the Royal Geographical Society an account of his recent journeys in the Uganda Protectorate, and it is here abridged from the *Times*. He succeeded in making very interesting natural history collections in that part of the Congo Forest which stretches from the basin of the Ituri River to the vicinity of the Semliki. Many photographs were taken of the dwarfs, male and female, of their dances, implements and dwellings. Anthropological measurements were also made by Mr. Doggett, the collector accompanying the Special Commissioner's expedition. Other dwarfs were subsequently examined from the Mboga district, which is that outlying portion of the Uganda Protectorate which lies to the north-west of the Semliki River. It was found that (as other travellers relate) the dwarfs were of two types—black-skinned, with a good deal of stiff, curling black hair about the body, and red or yellow-skinned, with a tendency to redness in the hair of the head and yellowish-grey in the hair growing on the body. Some of the dwarfs, especially when young, have quite hairy bodies, and their women not infrequently have incipient whiskers. These Congo dwarfs no longer speak an original language of their own, but talk, in a slightly corrupted form, the language of the taller negroes in whose vicinity they dwell. Amongst physical features which specially distinguish them from their neighbours is the large size and flatness of the nose. This organ has scarcely any bridge, and the wings of the nose are very large. The dwarfs also have a very long upper lip, which is scarcely, if at all, erected. In many other points they exhibit ape-like features, but their intelligence is, as a rule, well developed, and though hideously ugly and often very ape-like in appearance, they are usually of a winning and cheerful disposition, while their dances are so frolicsome and gay and full of pretty movements as to distinguish them markedly in that respect from the average negro.

SIR H. JOHNSTON has ascertained that there exists in these Congo forests a remarkable species of horse or zebra not hitherto known or described. According to his observations, the gorilla as well as the chimpanzee exists in these Congo forests between the Ituri and the Aruwimi. He hopes to send home a specimen of the chimpanzee which is found in the western part of the Uganda Protectorate. Sir H. Johnston devoted three weeks to examining the upper part of Mount Ruwenzori. He and two of his companions ascended to a higher point, seemingly, than has yet been reached by any explorer. Beyond an altitude of 14,800 feet a succession of sheer walls of rock was found, the ascent of which was extremely difficult. Snow was found lying as low as 13,000 feet, and permanent snow was reached at 13,500 feet. A large botanical collection was made, and photographs were taken of the more remarkable forms of vegetation, which include two species of giant lobelia, a tree-heath grown to 50 feet, and the tree groundsel which was discovered by Sir H. Johnston in 1884 on the upper parts of Kilima-Njaro. Collections in zoology made on the mountain in this vicinity will probably result in at least one new species of monkey, a new hyrax, a new antelope, and a number of birds, reptiles and insects new to science.

DURING the past week this country has been visited by a series of severe storms, which have caused much damage to both life and property. On the morning of Thursday, December 27, the Daily Weather Report issued by the Meteorological Office showed that a "V" shaped depression lay over St. George's Channel, the distribution of barometric pressure being of a complex character, with high readings over both the north and south of Europe. During the day the depression moved eastwards across England, but was followed very closely by a new and much deeper disturbance. The centre of this storm passed across the northern parts of Ireland and England on December 27 and 28, and on the morning of the 29th the centre lay over Denmark, having travelled during some part of its course at about 23 miles an hour, while the velocity of the wind in the vortex reached over 80 miles an hour; at Greenwich the pressure anemometer registered 27 lbs. on the square foot in the afternoon of December 28. A further disturbance moved along our south coasts on the 30th and 31st, and occasioned northerly gales over a large part of England, during which some heavy falls of rain, amounting to 1—3 inches, were recorded in several parts of the country, resulting in disastrous floods.

THE report of the Meteorological Council for the year ending March 31, 1900, has recently been presented to Parliament. The principal changes during the year have been the appointment of Mr. W. N. Shaw as secretary, in succession to Mr. Scott, retired, and the appointment of Captain Campbell Hepworth, R.N.R., as marine superintendent, in place of Lieut. Baillie, deceased. The appendices contain (1) regulations for superannuation allowances to the established clerks, (2) correspondence referring to the continuation with the National Physical Laboratory of the relations hitherto subsisting between the Meteorological Office and Kew Observatory, and (3) further correspondence with H.M. Treasury and the Scottish Meteorological Society relating to the maintenance of the Ben Nevis observatories. A comparison of the evening weather forecasts (which appear in the morning newspapers) shows that the percentage of complete and partial success during the year amounted to 82. The success of the storm-warning telegrams issued to the sea coasts was even more gratifying, amounting to 91 per cent., while the warnings not justified by subsequent weather were only 4·8 per cent. The report contains an account of anemometer experiments made at Holyhead, and a note upon investigations in atmospheric electricity.

MANY years ago, a paper was published by H. Arons, dealing with the symmetry of crystals as deduced from their elastic potentials, in which it was shown that if a crystal possessed two planes of symmetry, then either the angle between the planes is 45°, 60°, or 90°, or every plane through their intersection is a plane of symmetry. In the *Atti dei Lincei*, ix., 10, Signor C. Viola now discusses the various forms of crystalline symmetry with reference to the so-called "law of rationality of the indices," and raises objections to this law. From considerations partly based on observation, partly on the theory of elasticity, Signor Viola gives a proof of the theorem that there are thirty-two different possible kinds of crystalline symmetry.

A METHOD of crystallising substances from albuminous solutions without the formation of a crust on the surface is described by Herr A. Wróblewski in the *Bulletin* of the Cracow Academy, viii., 1900. The method consists in confining the solution to be crystallised in a tube with a parchment bottom, and depends on the fact that evaporation takes place through the parchment although the surface exposed to the air shows no signs of moisture from the transpiration of the liquid. The apparatus which the author describes has enabled him to obtain crystals of albuminous substances of greater purity than those resulting from the use of Hoffmeister's method, and, moreover, it suggests several interesting experiments connected with osmotic phenomena.

IN his address on the future of anatomical teaching, delivered before the Middlesex Hospital Medical Society on October 18, and published in the December number of the Middlesex Hospital *Journal*, Prof. Alexander Macalister urges that much of the matter in our anatomical text-books might advantageously be omitted from what is taught to the over-burdened student. The essential thing for the future practitioner to learn is the position of the working parts of the human frame which affect his practice. In the case of the shoulder-girdle, for instance, he must know the precise shape of the articular surfaces, their extent of motion, where they are covered with muscle, and where the capsule is thinnest. But the minute description of the ligaments do not concern him. Neither need he know the relations of minute arteries in other parts of the body, or be taught the homology of, say, the human pterygoid bones. Not that what used to be called transcendental anatomy is decried by the professor. On the contrary, the importance of its study is extolled; but the ordinary medical student has not the time for it.

WE have received a paper by Messrs. D. S. Jordan and J. O. Snyder on fishes recently collected in Japan by Mr. Otaki and the U.S. steamer *Albatross*, published in the *Proceedings* of the U.S. Museum (vol. xxiii., pp. 335–380). Fourteen new species are described, several of which are referred to new generic types.

In the section of the *Papers* from the Harriman Alaska Expedition devoted to Diptera, Mr. D. W. Coquillet describes a considerable number of new forms, among them being a new genus —Ornithodes—of Tipulidæ. This most remarkable discovery is, however, the existence in Alaska of a species of Telmatogeton, a genus previously known only from St. Paul's Island in the Indian Ocean.

THE issue of the *Notes* from the Leyden Museum for January and April last (published in July and received a few days ago) opens with a communication from Mr. M. C. Piepers, in which the views advanced by him at the Cambridge Zoological Congress in regard to the evolution of colour in butterflies are defended against the criticisms of Miss Newbigin and others. The author urges that none save those who have made the morphology of the Lepidoptera their special study are capable of fully appreciating, much less of criticising, his views.

A SECOND article in the same issue, by Dr. F. A. Jentink, describes a remarkably coloured stoat in the Leyden Museum. After describing the gradual change from the brown summer to the white winter coat in the species and *vice versâ*, the author goes on to say that the example in question is striped in such a curiously symmetrical manner that it might well be regarded at first sight as representing an unknown species. The brown of the upper parts is locally interrupted by narrow bands of longer white hairs, which appear to be the remnants of the winter coat; and there are patches of white elsewhere—notably a ring dividing the black tip of the tail from the brown of the remainder of that appendage. The specimen was killed in Holland during the spring of 1869.

THE Geological Survey of Canada has published a useful general index to the reports of progress, 1863 to 1884. Since 1884 the successive annual reports have been separately indexed, but it is intended at a later date to prepare a general index to them. The volume before us, which contains full references to subjects, localities and authors, has been compiled by Mr. D. B. Dowling.

CRAGS of weathered granite in the Black Hills of South Dakota are described and pictured by Mr. E. O. Hovey (*Bull.* Geol. Soc. Amer., vol. xi). The granite is intrusive in the mica-schists of the region, but the schists have suffered most from erosion, so that the granite, which is intersected by numerous joints, stands up in places in sharp pyramidal and needle-like forms.

THE latest addition to Prof. Penck's *Geographische Abhandlungen* is a pamphlet on the three lakes of the Reschen-Scheideck, by Prof. Johann Müllner. The positions of the lakes, their supply areas, depths, surface levels, rainfall conditions and ice-covering, are dealt with in separate chapters, and besides the interest of its results the investigation forms another excellent example of the adequacy of the geomorphometric methods employed by the geographers of the Vienna school.

THE third number of the current volume of the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* is devoted to a review of the present state of knowledge of the geographical distribution of plants and animals, by Dr. Arnold Jacobi. The special problem dealt with is the position and form of biogeographical regions, and the bases on which such regions must be defined. A general map of animal distribution and special maps showing the distribution of the jay and the bullfinch accompany the paper.

THE November number of *La Géographie* contains the first part of a paper on the geography of the coast-region of the Landes, by M. Hautreux, well known for his work on the oceanography of the Bay of Biscay. M. Hautreux here discusses the wind records from a number of coast stations, with special reference to their influence on ocean currents and on the formation and movement of sand dunes. We note with satisfaction, from an announcement also in *La Géographie*, that the efforts of M. Hautreux during the last twenty years have borne fruit in the establishment of a "Société d'Océanographie du Golfe de Gascogne," to which we wish every success.

WE have received a copy of an official pamphlet on the currents of the Gulf of St. Lawrence, practically an abstract of the reports on surveys of tides and currents for the seasons 1894, 1895 and 1896. The information is arranged in a form likely to be specially useful to navigators; the surface currents in each locality are minutely described, and the causes of the general circulation in the Gulf are dealt with separately. One of the most important facts brought to light by the work of the survey is that no confirmation is forthcoming of the supposition that a current enters the Gulf by Belle Isle Strait and leaves it by Cabot Strait. The current flowing out by Cabot Strait apparently consists partly of water from the St. Lawrence and partly of water entering Cabot Strait itself on the eastern side.

THE November number of *Petermann's Mitteilungen* contains the third and last instalment of an important paper by Dr. L. Frobenius on the "Kulturformen" of Oceania. Dividing the region into four parts, in the west "Indonesia" or Farther India, in the south-east Australia, east Melanesia, and north-east Mikronesia, the author points out that there are three main lines extending from the first of these eastwards, a southern axis towards Australia, a central axis just skirting Australia, and a northern axis through the Mikronesian archipelago. To the civilisation of the southern axis the name "nigritic" is given, to that of the central axis "vormalaysian," and to that of the northern "malayo-asiatic." The paper is illustrated by an elaborate series of maps.

PROMPTITUDE of publication is now the distinguishing characteristic of the *Journal* of the Chemical Society. The January number of the journal contains the Rammelsberg Memorial Lecture (pp. 43) delivered by Prof. H. A. Miers, F.R.S., on December 13.

THE third volume of Prof. G. O. Sars's detailed "Account of the Crustacea of Norway" has been published by the Bergen Museum. It treats of the Cumacean group of Crustacea, which is but imperfectly known; and it will be of service, not only for the determination of Norwegian species, but also for the future investigation of the Cumacean fauna of other countries.

DURING January, the following popular science lectures will be delivered at the Royal Victoria Hall, Waterloo Road:—January 8, History of the Solar System, Mr. F. Womack; January 15, Sea Coasts of Britain, Prof. H. G. Seeley, F.R.S.; January 22, Waves and Oscillations Mr. F. W. Porter; January 29, Niagara Water Power Installation, Prof. Capper.

THE Bath Natural History and Antiquarian Field Club has sent us a copy of its *Proceedings* (vol. ix. No. 3), containing among other contributions, a reduced copy of an old map of the Parish of Walcot, made in 1740. Then the parish was a little country village, now it is a great suburb of Bath. The notes on this map, by the Rev. C. W. Shickle, are of sufficient interest to make one wish they had been more extensive.

WE have received the November number of the *Victorian Naturalist*, the journal and magazine of the Field Naturalists' Club of Victoria. It is illustrated by some good views of the Basalt columns of Sydenham, and contains a variety of notes on local natural history.

IN the last number of the *Berichte der Deutschen Chemischen Gesellschaft* (33, 3307) Herr E. Buchner describes new experiments the results of which must be regarded as strong evidence in favour of the view that the active agent in fermentation processes is of enzymic character. Quantities of yeast were dried in vacuo at temperatures from 35°–100° C, and then heated for several hours in a current of hydrogen at 100° and then at 110° C. After this treatment the yeast has no fermenting power, as was conclusively proved by observations of its action on wort, the observations extending over a period of three weeks. The sterile yeast was then ground up into a paste with sand, kieselguhr and 10 per cent. aqueous solution of glycerin, and the mass subjected to strong hydraulic pressure. The liquid pressed out from the paste was found to have strong fermenting action. In spite of the sterilisation and the loss involved in the extraction with aqueous glycerine, the fermenting power was found to be one-quarter to one-half that of the original yeast. These experiments do not conform to the hypothesis set up by the opponents of the enzyme theory, that the fermenting power of press yeast is due to living protoplasm, for the latter is certainly no longer present in the yeast after its subjection to the sterilising process described. The specific action of the enzyme zymase is therefore not dependent on the presence of the living cell, and in this respect zymase is perfectly analogous to the active enzyme of urea fermentation isolated by Miquel.

THE additions to the Zoological Society's Gardens during the past week include a Derbian Zonure (*Zonurus giganteus*) from South Africa, presented by Major J. W. Jerome; three Bengal Monitors (*Varanus bengalensis*), a Conical Eryx (*Eryx conicus*), an Indian Eryx (*Eryx johni*) from India, deposited; two Bar-tailed Pheasants (*Phasianus reevesi*) from North China, twelve European Tree Frogs (*Hyla arborea*), European, purchased.

OUR ASTRONOMICAL COLUMN.

HELIOMETER MEASURES OF *h* AND χ PERSEI.—The great care taken and accuracy obtained by Prof. Wilhelm Schur in his observations with the fine Repsold heliometer of the Göttingen Observatory, make one regard the publications of the "Astronomische Mittheilungen von der Königlichen Sternwarte" as so many standard illustrations of heliometer reductions. The sixth part of this publication deals with the two bright star clusters, *h* and χ, in the constellation of Perseus. Both of these clusters have been measured before, the first by Krüger with the Bonn heliometer, by Bredichin with the micrometer, and by Karl Oertel with the large München refractor; and the latter by Vogel with the Leipzig 8-inch refractor, Pihl with the micrometer, and by Lohse and Bronsky and Stebnitzky from photographs. Prof. Schur compares his results with all these previous measures.

For his triangulation, Prof. Schur has used fifteen of the brighter stars in the two clusters; no less than 61 different distances have been measured, each distance having been determined on three, but generally more occasions. We must, however, simply restrict ourselves to the result of the whole investigation, which has led Prof. Schur to give the following final places for the stars he has employed; the consecutive alphabetical letters in the first column refer to the notation he has adopted in the chart of the region accompanying this publication. In the following summary the secular variation and proper motions have been omitted, and Kr. in the fourth column refers to Krüger's magnitudes:—

Positions of 15 *Stars in the Clusters h and* χ *Persei for the Epoch* 1893.75, *and Equinox* 1890.0.

	B.D.	Mag.		R.A.	Precession	Declination.	Precession.
	+ 56°	B.D	Kr	h. m. s.	s.	° ′ ″	″
a	471	6·6	6·7	2 9 10·477	+4·1533	+56 32 35·06	+16·952
b	479	8·9	8·9	9 34·736	·1409	23 11·21	·933
c	498	8·6	8 6	10 40·779	·1628	30 0·98	·880
d	500	8·5	8·5	10 44·886	·1715	41 54·73	·877
e	530	6 7	6·4	11 30·237	·1756	39 37·93	·842
f	543	8 0	8 2	12 11 145	·1870	48 38·09	·809
g	545	8·5	8·6	12 31·519	·1803	35 29·12	·793
h	547	8 2	7·2	12 45·113	·1775	29 10·59	·782
i	555	8·8	8·4	13 26·604	·1773	21 35·55	·749
k	567	8·4	8·3	14 7·833	·1841	24 1·19	·716
l	568	6·7	6 6	14 9·189	·1985	44 17·45	·715
m	593	7·0	7·0	15 12·596	·2127	53 2·12	·663
n	595	8·5	8 3	15 24·027	·2060	41 47·75	·654
o	598	8·4	8 6	15 38·363	·1930	21 6·48	·642
p	603	9·2		2 17 4·986	+4·2120	+56 32 54·63	+16·572

This triangulation will form a fine groundwork for future photographs of the fainter stars in this region, for the constants for the reduction of the plates can be determined by the heliometer positions of the brighter stars. The great value of heliometer measures as forerunners of the photographic plate is a point that cannot be overlooked when dealing with star clusters, nebulæ immersed in stars, or *vice versâ*.

ANNUAIRE POUR 1901 BUREAU DES LONGITUDES.—This useful annual, issued under the direction of MM. Janssen, Cornu and Lœwy, is compiled in similar manner to previous issues. A complete calendar, with the usual solar and lunar data, lists of celestial phenomena for the year, comprising occultations, eclipses, maxima and minima of variable stars, elements and ephemerides of the planets, shooting stars, &c., occupy some three hundred pages. An important notice is issued stating that all the times given in the volume are expressed in *civil mean time*, reckoned from 0h. to 24h., commencing at midnight.

A lengthy appendix is occupied by a dissertation on the electrical transmission of power, by M. Cornu, and other articles are contributed by M. Poincaré (Revision of the Meridian Arc of Quito); M. Lœwy (Astronomical Conference at Paris); M. Bassot (Foundation of the Metric System); M. B. de la Grye (International Geodesy), and M. Janssen (Work at the Observatory on Mont Blanc).

CATALOGUE OF STARS.—The sixth volume of the publications of the Hamburg Observatory consists of the reduced places of stars between 80° and 81° north declination, determined with the Repsold meridian circle of 10·8 cm. aperture and 1·62 metres focus. The stars are arranged in 69 zones, an index being furnished to show the various zones containing each object.

NEW MINOR PLANETS.—A telegram through Laffan's Agency from New York, dated January 1, says:—Mr. W. R. Brooks has discovered by means of photographs three new planets within one degree of Eros. The brightest is somewhat brighter than Eros.

SPAIN AND GREENWICH TIME.—After midnight of the 31st of December last, Spain began the new century by adopting officially throughout the country Greenwich time, the hours being numbered one to twenty-four.

THE USE OF BLAST-FURNACE GASES IN GAS ENGINES.

DURING the past year all the difficulties in the use of blast-furnace gases have successfully been overcome, and it is interesting to consider the rapid progress that has been made in this important development of metallurgical practice. The question was first taken up by Mr. B. H. Thwaite in 1894, and a 15 horse-power engine, worked by blast-furnace gas purified by his apparatus, was set to work at Wishaw, in Scotland, in February 1895. Since that date numerous small motors have been in operation in this country using purified blast-furnace gas driving machinery and dynamos. In the development of large motors and in their adaptation to blowing engines Belgium has taken the lead. In May 1898, Mr. A. Greiner, of the Cockerill Company, described a 200 horse-power engine in successful use at his works. The results attained stimulated experiment in Germany and in Luxemburg. The Cockerill Company, however, continued to take the initiative by starting, on November 2, 1899, the largest gas engine ever built. On May 9, 1900, Mr. Greiner described the engine to the Iron and Steel Institute, and gave the results of six months' working. This was the first gas engine to run the blowing engine of its own furnace. Results of tests of this gas engine, by Prof. Hubert, of Liége, are given in an appendix to an exhaustive paper on power gas and large gas engines, read by Mr. H. A. Humphrey before the Institution of Mechanical Engineers on December 14, 1900. The engine was designed by Mr. Delamare-Deboutteville, and built by the Cockerill Company. It is a single cylinder 600 horse-power engine, working on the Otto cycle, and direct coupled to a double-acting blowing cylinder. The large engine and blower shown by the Cockerill Company at the Paris Exhibition was a duplicate of the one under discussion. It was rated at 700 horse-power on blast-furnace gas, at 800 horse-power on producer gas, and at 1000 horse-power on illuminating gas. In an exhaustive paper on the subject, published by Prof. Joseph W. Richards in the current number of the *Journal* of the Franklin Institute of Philadelphia, the following list of blast-furnace gas engines now in operation is given:—

	No.	Horse-power.
Seraing, Belgium	4	500
Differdingen, Luxemburg	4	500
Hoerde, Westphalia	2	600
	2	1000
Friedenshütte, Silesia	2	200
	2	300
Oberhausen	1	600
Dudelingen	2	600
	2	1000
Kneutingen	2	500
Roechling	1	200
	2	600
Ruhrort	1	500
Barrow, England	—	1000
Toula, near Moscow	3	600
	3	200
Island of Elba	—	1000

The Cockerill Company is now constructing, for the Roechling Ironworks in Lorraine, three 1200 horse-power gas engines. They are double-cylinder tandem engines directly attached by a tail rod to the blowing cylinder. The Cockerill Company and Mr. Delamare-Deboutteville have now decided to build engines of 2500 horse-power. They will have two tandem cylinders on each side of the dynamo, giving four cylinders per engine. They are designed for a central electric station.

In view of the remarkable results already attained, there can be no doubt that during the next few years the design and erection of large central power-stations for the generation and distribution of electric energy in bulk will be one of the most important problems with which engineers will have to deal. The new stations will be larger than any now existing, and every possible effort will be made to reach an unprecedented degree of economy in the production of power. Mr. Humphrey's paper strongly urges the claims of the gas engine to rank as a rival of the steam engine for large power units. The results of a trial of a 400 horse-power Crossley gas engine carried out by Mr. Humphrey are certainly most satisfactory, whilst its capability for continuous work has been shown at Messrs. Brunner, Mond and Co.'s works at Winnington, Cheshire, where it is used for their electrolytic plant. The employment of gas engines in large central station work is, however, still very limited, for out of the total of seven central stations where gas motors are used, the largest has only an aggregate of 650 horse-power, whilst the largest unit is of only 200 horse-power. The use of the waste gases from blast furnaces renders it possible to have a supply of cheap fuel. This result can also, according to Mr. Humphrey, be attained by the use of a Mond producer plant, which is suitable for converting cheap bituminous fuels into suitable gas for gas engines, and at the same time permits of the recovery of the ammonia from the coal as a by-product.

The great industrial revolution which is imminent in the economical utilisation of blast-furnace gases is best shown by the careful calculations made by Prof. Richards of the results that would be attained by the application of this improvement to American blast-furnace practice. As an illustration of average practice, he takes the figures from a blast-furnace plant in Eastern Pennsylvania, which is making in three furnaces 2600 tons of pig iron per week. The composition of the gas by volume is as follows:—

CO_2	CO	H	N
9	27	1·8	62·8

The pig iron produced daily is 370 tons; the fuel used per 100 kilograms of pig iron, 100·0 kilograms; carbon in fuel, 82·9 kilograms: carbon in flux, 4·6 kilograms; carbon in the iron, 3·1 kilograms; efficiency of stoves, 60 per cent.; efficiency of boilers and engines, 4·5 per cent.; pressure of blast, 1·3 kilogrammes per square centimetre (20 lbs. per square inch); and temperature of blast 555° C.

With these conditions, the calculations are as follows:—

Calorific power of gas per cubic metre, 873 calories; volume of gas per 100 kilograms of pig iron, 434·7 cubic metres; calorific effect of gas per 100 kilogrammes of iron, 379,490 calories; heat required to heat blast per 100 kilograms of iron, 90,500 calories; indicated horse-power of engines for blast, 950 horse-power; indicated horse-power of engines for hoist, pumps, &c., per 100 tons of iron daily, 65 horse-power.

From these calculations the following conclusions are arrived at:—

		Calories.
Calorific effect of gases per 100 kg. of pig iron		379,490
Lost (10 per cent.)	37,950	
For heating blast	90,500	
		128,450
Surplus for burning develops		251,040
Surplus per 100 tons of pig iron daily		251,000,000

The horse-power at 100 per cent. efficiency would be 16,400; horse-power with steam at 4½ per cent. efficiency, 738; deficit of steam power per 100 tons of iron daily, 277 horse-power; horse-power with gas engines at 30 per cent. efficiency, 4920; surplus power with gas engines per 100 tons daily, 3900 horse-power; deficit of steam power per 370 tons daily, 1025 horse-power; surplus of gas engine power per 370 tons daily, 14,400 horse-power.

It is an actual fact that at the works considered by Prof. Richards the three blast furnaces are charged with 800 horse-power, furnished to them by the boiler plants fired by coal. It is also a fact that nearly 10,000 horse-power is raised for the rest of the plant by coal-fired boilers, and that all of this could be supplied by gas engines utilising the blast-furnace gases. The saving in the coal bill alone would amount to at least 30,000*l*. in one year. The gas-engine plant to accomplish this would cost 100,000*l*. These calculations, based on average practice, bring out very clearly the great saving of power possible by the economical utilisation of blast-furnace gases.

PRIZES PROPOSED BY THE PARIS ACADEMY OF SCIENCES FOR 1901.

THE following prizes are offered by the Paris Academy of Sciences for the year 1901:—

In Geometry, the Francœur Prize (1000 fr.), for discoveries or works useful to the progress of the mathematical sciences, pure or applied; the Poncelet Prize (2000 fr.), with similar conditions; and in Mechanics, the Extraordinary Prize of 6000 francs, for progress tending to increase the efficiency of the French naval forces; the Montyon Prize (700 fr.); the Plumey

Prize (2500 fr.), for improvements in steam engines or any other invention which contributes to the progress of steam navigation; and the Fourneyron Prize (500 fr.), for a theoretical or experimental study of steam turbines.

In Astronomy, the Lalande Prize (540 fr.), for the best work tending to the advancement of astronomy; the Valz Prize (460 fr.), for the most interesting observation during the current year. In Physics, a La Caze Prize (10,000 fr.); the Gaston Planté Prize (3000 fr.), for a discovery, invention or important work in the field of electricity; and the Kastner-Boursault Prize (2000 fr.), for the best work on the applications of electricity in the arts, industry and commerce. In Statistics, a Montyon Prize (500 fr.). In Chemistry, the Jecker Prize, and a La Caze Prize (each of 10,000 fr.), for researches in chemistry. In Mineralogy and Geology, the Delesse Prize (1400 fr.). In Physical Geography, the Gay Prize (2500 fr.), for a study of the distribution of alpine plants in the mountains of the Old World. In Botany, the Bordin Prize (3000 fr.), for a study of the influence of external conditions upon the protoplasm and nucleus in plants; the Desmazières Prize (1600 fr.), for a study of cryptogams; the Montagne Prizes (1000 fr. and 500 fr.), for researches on the anatomy, physiology, description, or development of the lower cryptogams; the Thoré Prize (200 fr.), for the best work on the cellular cryptogams of Europe; the De la Fons Melicocq Prize (900 fr.), for botanical work done in the north of France. In Anatomy and Zoology, the Grand Prize of the Physical Sciences (3000 fr.), for a biological study of the soft water Nematods; the Savigny Prize (1300 fr.), for the assistance of young travelling zoologists.

In Medicine and Surgery, a Montyon Prize; the Barbier Prize (2000 fr.), for a discovery in surgery, medicine or pharmacy of service in the art of healing; the Breant Prize (100,000 fr.), for a specific cure for Asiatic cholera; the Godard Prize (1000 fr.), for work on the anatomy, physiology and pathology of the genito-urinary organs; the Bellion Prize (1400 fr.); the Mège Prize; the Lallemand Prize (1800 fr.), for the encouragement of work on the nervous system; and the Baron Larrey Prize (1000 fr.), for the best work on military medicine, surgery or hygiene. In Physiology, the Pourat Prize (1400 fr.), for experimental work on the cooling due to muscular contraction; a Montyon Prize (750 fr.), and the Philipeaux Prize (890 fr.), for work in experimental physiology; and a La Caze Prize (10,000 fr.).

Among the general prizes offered are the Arago and Lavoisier Medals, the Montyon Prize for unhealthy trades, the Wilde Prize (4000 fr.), the Cahours Prize (3000 fr.), the Tchihatchef Prize (3000 fr.). for Asiatic exploration, the Petit d'Ormoy Prizes (10,000 fr. each), for work in the mathematical or physical sciences, the Leconte Prize (50,000 fr.), for a new and capital discovery in mathematics, physics, chemistry, natural history or medical science, the Jean Reynaud Prize (10,000 fr.), the Saintour Prize (3000 fr.), the Gegner Prize (3800 fr.), the Trémont Prize (1100 fr.), and the Laplace and Rivot Prizes.

Of these prizes, the Lalande, La Caze, Delesse, Desmazières, Leconte and Tchihatchef are expressly stated as being open without distinction of nationality.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. C. T. R. Wilson, F.R.S., Fellow of Sidney Sussex College, has been appointed University Lecturer in Experimental Physics, in succession to Prof. Wilberforce, now of Liverpool. The appointment of Mr. H. Herbert Smith as Gilbey Lecturer in Agriculture has been confirmed by the Senate.

The following awards in Natural Science have been made at the combined examination for entrance scholarships held by ten of the colleges in December, 1900:—

Clare College.—£60, Leather, Bridlington School; £50, Pears, Clifton College; £40, Byatt, Charterhouse; Johnson Exhibition, Jordan, Bedford School.

Trinity Hall.—£40, Hopkins, St. Paul's, and Potts, Kingswood School.

Trinity College.—£80, Chittock, Harrow; £75, Bulleid, Exeter School; £50, Bray, Harrow; Sizarship, Mottram, St. Olave's; £50, Darwin, Marlborough; £40, Browning, Westminster, Chase, Oundle School, and Hodgson, Bedford rammar School.

Pembroke College.—£40, Straus, Harrow.

Gonville and Caius College.—£60, Whitehead, Battersea Grammar School; £70 (Salomons Engineering Scholarship), Brinton, Cheltenham College; £30, Coxon, Shrewsbury School.

King's College,—£80, Spens, Rugby.

Jesus College.—£60, Crawford, Nottingham High School.

Christ's College.—£60, Radice, Bedford Grammar School; £40, Bygrave, Giggleswick School; £30, Dobell, Cheltenham College.

St. John's College.—£60, McDonnell, St. Paul's; £40, Jolly, Framlingham School.

Emmanuel College.—£60, Taylor, King Edward's School, Birmingham; £40, Watkins, Shrewsbury School.

THE ninth jubilee of Glasgow University will be celebrated on June 12-14.

FOR many years a large proportion of the national food supply has been dependent on the preservation of meat and fruit in transport and storage by means of artificial cold, so that the subject of refrigeration is one of great and growing importance to the public. Within the last two years a more special interest has been exhibited in this and kindred subjects by the cheaper and more convenient production of liquid air, the proposed applications of it, and the remarkable scientific discoveries to which it has led. Those of the public who wish for authoritative guidance and clear ideas on the whole subject of refrigeration will shortly have an opportunity of obtaining them placed within their reach. The Technical Education Board of the London County Council, acting in conjunction with the Council of University College, London, have arranged for a series of lectures on the artificial production of cold to be delivered in the chemical theatre of the college in Gower Street by Dr. W. Hampson. The lectures will begin on January 18, at 5.30 p.m., and will be illustrated by experiments. Those who wish to attend, or to obtain a syllabus of the lectures, should apply to the secretary of the college. Young engineers, and others who are engaged in practical work in connection with refrigerating machinery or cold storage, and who have not had the advantage of a systematic training in the physical sciences, should find this a useful opportunity of learning to understand better the connection between their work and the scientific principles involved in it.

THE case of Regina *versus* Cockerton is likely to have a profound effect on our national education. As readers of NATURE may remember, a district auditor, dealing with the accounts of the London School Board, disallowed certain sums paid out of the rates for the teaching of science and art in elementary schools according to the rules of the South Kensington "Directory," as distinguished from those contained in the "Code" of the Education Department. These disallowances were brought before Mr. Justice Wills and Mr. Justice Kennedy in the Queen's Bench Division with a view to having them quashed. But the Court has upheld the view taken by the auditor. The London School Board has been non-suited all along the line. To quote Mr. Justice Wills: "It is not within the power of the Board to provide, at the expense of the ratepayers, science and art schools or classes in day schools; . . . science and art classes in evening continuation schools are as much beyond the scope of rate-aided education as in day schools; but that in both such educational work may be carried on by the School Board provided the whole of the funds required for it are furnished from sources other than contributions from the rates." There is little likelihood that the matter will be allowed to rest here; it is bound to go ultimately to the House of Lords. But, whatever may be found to be the present state of the law, one thing the case makes transparently clear, and that is the chaotic condition of English education. As the *Times* said the other day, "by showing up the existing confusion and to some extent aggravating it, the judgment may perhaps hasten some comprehensive scheme for classifying education in a rational way."

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, December 13, 1900.—"Additional Notes on Boulders and other Rock Specimens from the Newlands Diamond Mines, Griqualand West." By Prof. T. G. Bonney, F.R.S.

Shortly before the outbreak of the war in South Africa, a parcel of specimens from the Newlands Mine, West Griqualand, was sent to Mr. C. Trubenbach, managing director in London, who forwarded them to the author for examination. They consisted of (1) boulders, (2) the diamantiferous rock (blue ground), (3) country rock. (1) One angular specimen, a felsite or porphyrite, with fluxion structure, might be only a fragment of a dyke or a flow; the other eight were more or less water-worn. All were holocrystalline igneous rocks, two being saxonites, two varieties of lherzolite, with a few garnets, one an enstatite-eulysite, one an eclogite like those described last year, but without any diamonds, one a hornblendic gabbro, exhibiting an interesting micropegmatitic structure with felspar and pyroxene, and one a diorite. (2) The blue ground presented a general resemblance to that from the De Beers mines—the so-called kimberlite—but its matrix contained a much larger amount of a minute, secondary brown mica. This matrix had been analysed by Mr. C. James at University College, with the result that the CO_2 and H_2O only amounted to 13·55 per cent., the magnesia being 12·14, and the other constituents showing that serpentine could not, at most, form more than about 25 per cent. of the rock. This, then, was yet another proof that the so-called kimberlite could not be an altered peridotite, but was really, as the writer contended, a breccia of rather variable composition. No diamonds were observed this year in the boulders described, but Mr. Trubenbach had obtained another specimen of a pyrope enclosing a small but well-formed diamond. (3) The country-rock. Of this the writer had examined, among others, a variety called "bastard blue" by the miners, which had occurred above the ordinary "blue" and was supposed by them to be related to it. This, however, was not the case. It was a mudstone containing little pebbles of diabase and, more rarely, of a microgranite and a subcrystalline limestone. It was, however, interesting as showing the existence of basic igneous rocks of Triassic or pre-Triassic age. Besides that, and the additional evidence as to the nature of the blue ground, this investigation brought the number of species or strongly-marked varieties of holocrystalline rocks which occur as boulders more or less waterworn up to seven at the very least. The author was of opinion that the most enthusiastic advocate of concretionary action would now be obliged to admit that the specimens, two of which, described in his last paper, had contained diamonds, were rock fragments which had been shaped by the action of water.

Mathematical Society, December 13, 1900.—Dr. Hobson, F.R.S., President, in the chair.—Mr. Basset, F.R.S., spoke on the real points of inflexion of a curve.—Miss Barwell read a paper entitled, "On the conformal representation of polygons on a half plane."—Prof. Elliott, F.R.S., communicated his own paper, "The syzygetic theory of orthogonal Binariants," and gave an account of a paper by Mr. A. L. Dixon entitled "An addition theorem for hyperelliptic functions."—The following papers were communicated by their titles: On some properties of groups of odd order, ii., Prof. Burnside, F.R.S.—On discriminants and envelopes of surfaces, Mr. R. W. Hudson.—Note on the inflexions of curves with double points, Mr. H. W. Richmond.

Zoological Society, December 18, 1900.—Dr. A. Günther, F.R.S., Vice-President, in the chair.—The Secretary exhibited, on behalf of Major A. St. Hill Gibbons, the skull and horns of a white rhinoceros (*Rhinoceros simus?*) from the White Nile, and the mounted heads of two species of Topi antelopes, which had been procured by Major Gibbons during his recent journey through Africa from south to north.—The Secretary also exhibited, on behalf of Sir Harry Johnston, K.C.B., some pieces of skin of an apparently new species of zebra which had been ascertained to inhabit the forest on the banks of the Semleki River near the borders of the Uganda Protectorate.—A communication was read from Capt. Stanley S. Flower, containing an account of the animals he had obtained or observed during Sir William Garstin's expedition to the White Nile. Amongst these were examples of several rare species of antelopes, such as the white-eared kob (*Cobus leucotis*) and Mrs. Gray's kob (*Cobus maria*), and numerous specimens of the shoe-bill or whale-headed stork (*Balaeniceps rex*).—A communication was also read from Mr. W. Malcolm Thomson containing an account of a large branchiate polynoid (*Lepidonotus giganteus* Kirk) from New Zealand.—A communication from Mr. H. M. Kyle (of St. Andrews, N.B.), contained a description of a new genus and species of flat-fishes from New Zealand, under the name *Apsetta thompsoni*.—Dr. A. G. Butler contributed a paper on the butterflies lately collected, and presented to the British Museum, by Lord Delamere. The specimens had been obtained chiefly near Mount Kenya, in British East Africa, and had been referred by the author to seventy-nine species, which were enumerated in the paper.—Prof. D'Arcy W. Thompson, C.B., exhibited and described a large specimen of a cuttle-fish (*Ancistroteuthis robusta* Steenstrup) from Unalaska. The generic position of this cuttle-fish had previously been uncertain, owing to the absence of knowledge of the tentacular club. This was now described for the first time, and confirmed Steenstrup's provisional identification.—Mr. F. E. Beddard, F.R.S., described a new species of earthworm under the name of *Amyntas alexandri*. The specimen had been sent to him from Kew Gardens, whither it had been imported from the neighbourhood of Calcutta.

PARIS.

Academy of Sciences, December 24, 1900.—M. Maurice Lévy in the chair.—Formulæ and tables for calculating the times and heights of high and low water, the heights from hour to hour being known, by M. E. Guyou. The heights for three consecutive hours being known, a very simple formula is given for calculating the time of high water.—On the origin of chemical combination and the combination of silver with oxygen, by M. Berthelot. Silver foil, heated with oxygen in sealed tubes at varying temperatures, is slightly attacked, some argentous oxide being formed and the silver becoming different in appearance. This action commences at a temperature of about 200° if the time of heating is very prolonged, and becomes very appreciable at 500°–550° C. If the oxygen is replaced by steam or carbon dioxide the silver is absolutely unchanged.—Silver and carbon monoxide, by M. Berthelot. Silver foil, after four hours heating with dry carbon monoxide at 500°–550°, becomes changed in appearance, and some three to four per cent. of the gas disappears, carbon being deposited and carbon dioxide produced.—Hydrogen and silver, by M. Berthelot. Hydrogen, heated with silver at 550° in a sealed tube, behaves differently from nitrogen, steam or carbon dioxide, as the metal alters considerably in appearance. It is possible that a compound is formed analogous to sodium hydride.—On the theorem of Hugoniot and some analogous theorems, by M. P. Duhem.—The first sign of life, by M. Augustus D. Waller. Following up some researches on the last sign of life, it results that if a *blaze* is the last sign it should also be the first. Some experiments with hens' eggs confirm this view.—On congruences of which the two focal pencils are cyclic, by M. C. Guichard.—The homographic compass, realising by articulations general plane homography, by M. G. Kœnigs.—On Neumann's method of the arithmetical mean, by M. W. Stekloff.—On a series relating to a theory of a linear differential equation of the second order, by M. A. Liapounoff.—On the theta functions of three variables, by M. M. Krause.—The theorem of vortices in thermodynamics, by M. Jougnet.—Permanent modifications of metallic wires and their electrical resistance, by M. H. Chevallier. The same wire is submitted to a series of heatings, which are alternately fixed and oscillating, and the variations of resistance measured. It was found that the permanent variations of resistance are greater when the temperature is oscillating than when it is fixed.—On the electromotive force of magnetisation, by M. René Paillot. It has been shown by M. Hurmuzescu that in a battery formed of two electrodes of iron, one of which is magnetised, the latter becomes positive with respect to the non-magnetised one. These experiments have now been extended to much stronger fields, 30,000 units, and it is found that for a given specimen of iron and acid the electromotive force of magnetisation tends always to a fixed limit.—The luminescence of a rarefied gas round metallic wires communicating with one of the poles of an induction coil, by M. J. Borgmann.—An apparatus allowing several physiological applications of the light produced by an incandescent lamp, by MM. Foveau de Courmelles and G. Trouvé. An application of parabolic mirrors.—On the liquefaction of gaseous mixtures. The isotherms of a mixture, by M. F. Caubet. A discussion of results obtained with mixtures of carbon dioxide and sulphurous acid, and of carbon dioxide with methyl chloride.—A contribution to the study of rarefied gases, by M. Albert Colson.—Influence of pressure on the phenomena of chemical equilibrium, by M. O. Boudouard. A description of some experiments upon the formation of carbon monoxide from carbon dioxide and charcoal.—On the selenides of copper, by M. Fonzes-Diacon. Some new methods of preparing copper selenide, CuSe.—On some chlorobromides of thallium, by M V. Thomas.—The action of reducing agents upon the two isomeric nitrodimethylacrylic esters, by MM. L. Bouveault and A. Wahl. Of the various substances tried, the only one giving a good yield of the corresponding amido-body was aluminium amalgam, several derivatives of which are described.—On tannase, by M. A. Fernbach. The tannase was prepared by the action of *Aspergillus Niger*, and then rendered sterile by filtration through porcelain.—Tannase, a diastase capable of hydrolysing gallotannic acid, by M. Henri Pottevin.—On the glycolysis of different sugars, by M. P. Portière. Of the sugars examined, the only ones which underwent glycolysis in the presence of the blood of the dog or the rabbit were galactose, lævulose and maltose.—Study of uranium nitrate, by M. Œchsner de Coninck. Densities of aqueous and alcoholic solutions of uranium nitrate, together with some solubilities in some other liquids.—Reaction of *p*-diazobenzene sulphonate of sodium upon the cystinate of iron existing in contaminated waters, by M. H. Causse. A reply to the criticisms of M. Molinié.—On the chemical transformations which take place during the evolution of the bud, by M. G. André. From the point of view of the distribution of the mineral material and organic substances, the evolution of the bud is comparable with the germination of the seed.—On some derivatives of methylnonyl-ketone, by M. H. Carette.—On the relations between the chemical constitution of the sexual products and that of solutions capable of determining parthenogenesis, by MM. Yves Delage and Marcel Delage. The theory advanced by Loeb as to the influence of magnesium salts in development requires a difference in the proportion of magnesium salts in the male and female. An experimental study shows that this is not the case, and hence that the proposed theory is inexact.—Germinative cells: male ovules and the cells of Sertoli, by M. Gustave Loisel.—On the signification of the basilar granulations of cilia, by M. P. Vignon.—The physiological relations of intermittent albuminuria, by M. A. Charrin.—Phagocytosis of the Eberth bacillus, by MM. O. F. Mayet and J. Bertrand. The authors have been able to clearly demonstrate the absorption of the Eberth bacillus by the white blood corpuscles.—Cytometric and caryometric researches on the motor nervous cells after the section of their cylindraxis, by M. G. Marinesco.—Remarks on the experiments of Mlle. Barthelet on telegony, by M. Edouard Rogez.—Remarks on the same subject, by M. Giard.—On the parasitism of *Fusarium roseum* and allied species, by M. Louis Mangin.—On the cytology of the Gastromycetes, by M. René Maire.—Variations of structure in a green algæ, *Stichococcus bacillaris*, under the influence of the medium, by MM. L. Matruchot and M. Molliard.—On the development of etiolated plants afterwards turned green by light, by M. H. Ricome.—Effects of annular decortication in some herbaceous plants, by M. Lucien Daniel.—On the age of the granitic *massif* of Cauterets and Néouvielle (High Pyrenees) and of part of the ancient neighbouring formations, by M. A. Bresson.—On the upper Cretacean at Mozambique, by M. Paul Choffat.—The ice caps of the Antarctic regions, by M. Henri Arctowski.—Barometer variations and the synodic revolution, by M. A. Poincaré.—Atmospheric electricity according to observations at the Eiffel Tower and at the central meteorological office, by M. A. B. Chauveau.—On the determination of the density of sea-water, by M. J. Thoulet.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 3.

RÖNTGEN SOCIETY, at 8.—Continental Progress in Practical Radiography and Apparatus: A. W. Isenthal.

FRIDAY, JANUARY 4.

GEOLOGISTS' ASSOCIATION, at 8.—The Geology of Swanage—Chapman's Pool to Punfield Cove (Kimeridge Clay to Upper Greensand): Horace W. Monckton.

MONDAY, JANUARY 7.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—The Early Manufacture of Sulphuric and Nitric Acids: Oscar Guttmann.—Note on the So-called "Heat Test" for Explosives: W. Cullen.

VICTORIA INSTITUTE, at 4.30.—Hornets: Rev. F. A. Walker.

TUESDAY, JANUARY 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Glasgow Bridge: B. H. Blyth. Railway Bridge over the Fitzroy River, at Rockhampton, Queensland: W. J. Doak.—The Niagara Falls and Clifton Steel Arch Bridge: L. L Buck.—Monthly Ballot for new members.

WEDNESDAY, JANUARY 9.

GEOLOGICAL SOCIETY, at 8.—The Geology of South-Central Ceylon: John Parkinson.—Note on the Occurrence of Corundum as a Contact-Mineral at Pont Paul, near Morlaix (Finistère): A. K. Coomára-Swámy.

THURSDAY, JANUARY 10.

MATHEMATICAL SOCIETY, at 5.30.—On the Singularities of Quartic Curves: A. B. Basset, F.R.S.—On Streaming Motions past Cylindrical Boundaries: Prof. Love, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Capacity in Alternate Current Working: W. M. Mordey.——*And, if time permit*: The Use of Aluminium as an Electrical Conductor, with New Observations upon the Durability of Aluminium and other Metals under Atmospheric Exposure: John B. C. Kershaw.

FRIDAY, JANUARY 11.

ROYAL ASTRONOMICAL SOCIETY, at 8.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Geodesy: Wilfrid Airy.

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