THURSDAY, JULY 29, 1880

CHEMICAL DYNAMICS

Essai de Mécanique Chimique fondée sur la Thermochemie. Par M. Berthelot. Two Vols. (Paris : Dunod, Editeur, 1879.)

THE problems which the chemist attempts to solve may be broadly divided into two groups. In studying the heterogeneous distribution of molecules, the chemist finds that new relations of molecules, in other words, new substances, are produced; he must study the composition and properties of these substances. He also finds that these changes involve a consideration of the relative positions of the changing body and of other bodies, that is to say, he recognises the action of force. He must endeavour to determine the laws of action of this force. The study of the properties and composition of substances has received more attention than that of the general laws of chemical force; both methods of investigation must, however, be applied to chemical phenomena, before these can be fully explained.

The general properties of a compound may be regarded as depending chiefly on the composition of that compound, or chiefly on the function or "power of doing" of the compound. There have always been schools of chemistry which paid most attention to composition, as there have been schools which made function pre-eminent. Modern chemistry is attempting to connect both in a general scheme of classification; whilst at the same time she endeavours to learn the conditions under which chemical force is exerted, and hopes thus to elucidate general laws.

The atomic theory, which is one great outcome of the study of the composition and function of chemical substances, has of late years been merged in the wider molecular theory of matter.

This theory, assuming the existence of a grained structure in matter, proceeds to deduce, by dynamical reasoning, the amount of motion existing among these little parts of which matter is built up. The laws of Boyle and Charles are among the primary results of this deduction. But under certain conditions gases do not exactly obey these laws; hence the theory asserts that under certain conditions the molecules exert mutual action.

Another deduction from the theory is the statement usually known as Avogadro's law—"Equal volumes of gases at the same temperature and pressure contain equal numbers of molecules." This statement provides the chemist with a means for determining molecular weights. But the chemist in applying Avogadro's law is obliged to admit that in many reactions the parts of molecules really part company. He attempts to picture to himself this molecular splitting.

Let the molecule A consist of two parts, a and b, the molecule B of two parts, c and d; let these parts be in motion. Under certain conditions the stress between a and c and the stress between b and d may be greater than that between a and b, and c and d; the original molecules are decomposed, and new molecules, C and D, are formed. The stress between a and c considered from the point of view of a or c alone is a force exerted by a on c or by c on a. This force is the force of chemical affinity.

The result of the action of this force is a new configuration of the system A B; the energy of the new system, C D, will be different from that of the original system.

Chemical action, thus regarded, is a re-arrangement of parts of molecules under the influence of the force called affinity. Chemical energy is thus regarded as potential energy.

Now a chemical action between A and B will take place under certain definite conditions only, hence although the absolute value of the affinity of A for B may be a constant, the course of the change and the entire result of the change will nevertheless be largely dependent on physical conditions. No force may be exerted except at high temperatures; the change of momentum of A will depend on its position relative to B; the relative positions at which this change occurs may only be gained at high temperatures. The force exerted may be small; still if a chemical change occur at all, there must be an action between the parts of A and the parts of B.

Now let this mutual action begin, let no energy be added to the system from without, but let the system as a whole lose energy; the energy so lost may be measured in the form of heat. But more than one re-arrangement of the parts of two molecules may frequently be possible; which will be produced? A system is in equilibrium when its entropy (using the term in the Clausian sense) has reached a maximum. Hence that system whose entropy is the greatest of the entropies of the possible systems will be produced.

This is substantially Berthelot's "law of maximum work," a law which lies at the foundation of his system of thermal chemistry. But a system not marked by possessing the largest amount of entropy of all the possible systems, may nevertheless be the most stable under the experimental conditions; the stability will depend on pressure, temperature, relative masses, &c. Hence in order to determine the actual result of a chemical action, the conditions of stability, in other words, the relations to temperature, pressure, &c., of the various possible products of the reaction must be known. The necessity of this knowledge is insisted on by Berthelot. To determine, therefore, the product of a given chemical action one must measure the quantities of heat evolved in the passage of the system from the standard state to each of the possible new states, and one must know the conditions of existence and stability of each of these states This problem therefore presents both a chemical and a physical question for solution. The solution of the chemical question is much aided by a knowledge of the laws of atom-linking; but these cannot be here considered.

A measurement of the heat evolved in a chemical change evidently enables us to find the difference between the energy of the original and final chemical systems; the total heat change being independent of intermediate states through which the system may pass. So if work is done on a chemical system whereby it is caused to assume a new configuration, this work measures the energy transferred from the initial to the final system; in this case heat will be absorbed during the chemical change.

But in actual chemical reactions the action of the chemical force proper will be interfered with and complicated by physical, or secondary forces. So much is this the case, that for many years these actions were not distinguished.

One school simply measured the quantity of a substance A, which was needed to act on B to produce C; the greater the quantity of A required to act on a given weight of B, the greater was the affinity of A for B. With this school all was chemical. With Berthollet, on the contrary, all was physical; but facts have been discovered since the publication of the "Statique Chimique" which have necessitated a reconsideration of his laws.

Gradually the meaning of affinity has been made clear. The greatest contribution towards this end is undoubtedly the papers of Guldberg and Waage, whose work has been sketched by the present writer in this journal (vol. xx. p. 530). The Swedish naturalists disregard the action of secondary forces in their method of determining the ratios between the affinity coefficients of various substances.

The importance of a measurement of the change of energy accompanying the passage of a chemical system from one specified state to another; the importance, in other words, of a measurement of the heat evolved or absorbed in such a passage, is at once apparent. But this measurement—even taken along with a general knowledge of the conditions of existence of the various possible systems—does not enable us certainly to predict the result of the chemical action. If we had a complete knowledge of the mode of variation of the potential energy of a system with changes in the configuration of the system, then it *might* be possible for mathematicians to predict all possible arrangements of the system under the action of specified external forces. But having made heat measurements only, we are very far indeed from this point.

Indeed the fundamental assumption that chemical energy is wholly potential, and depends on the arrangement of the parts of a system, may be false; and even if this assumption be true we know nothing as yet of the relation between this energy and the configuration of the system.

The heat absorbed or evolved in a chemical change measures the total work done by the system in its passage from one specified state to another, but it is evident that it does not directly measure the true force of affinity. The stress between the parts of two molecules may be small, yet under certain conditions a chemical change may occur; the loss of energy in the formation of the new system may be considerable, and hence the heat evolved, considerable. Chemical affinity thus regarded is a kind of liberating force.

For the measurement of the ratios of the affinities of various systems, Guldberg and Waage's method is to be preferred to the thermal method of Berthelot. For a full consideration of chemical equilibrium Berthelot's method is altogether insufficient, although it has *largely* advanced the solution of this problem.

The method of Willard Gibbs seems the only feasible one in the present state of the chemical and mathematical sciences. In this method (see NATURE, vol. xxi. p. 516) the energy and entropy of a system are considered—the stability of a system depends on the component masses, volume, and entropy (the *magnitudes* of the system); and on the temperature, pressure, and *potential* (the *intensities* of the system).

The stability of a system is chiefly dependent, according to Berthelot, on the amount of heat evolved in the passage to the given state from an initial state, and on the general properties of the given system as compared with other possible systems. This is evidently a much cruder statement than that of Gibbs. Berthelot's principle of maximum work is indeed one among many deductions made by the method of the American professor.

Both methods lead to a recognition of chemical equilibrium as an outcome of chemical action; the conditions of the latter are considered before those of the former; chemical kinetics precedes chemical statics. The usual method of the text-books is to make chemical equilibrium all-important, and barely to mention the subject of chemical kinetics.

It is evident that the time when it will be possible to treat chemical problems by a purely dynamical method is yet distant. The method of Gibbs leads the way in bringing chemical generalisations under the domain of the principles of energy, and it does this without assumptions about the action of the parts of molecules; the method is a thermo-dynamical one.

Berthelot's method, on the other hand, is thermo-chemical; but a thermo-chemical method seems to promise the largest development in the present state of the science.

Berthelot perhaps claims too much for his method: in his great work he is not always definite in his use of such terms as "force," "affinity," "energy," "work;" nevertheless the "Essai de Mécanique chimique" is undoubtedly a great work. To Berthelot (and to Thomsen) is due the honour of having steadily pursued the thermo-chemical method for many years, and of having collected masses of most important facts; and he has now enriched chemical science by the publication of these results in a collected and systematic form, in a treatise full of original ideas and suggestive of almost unlimited topics for future work and discussion. What a field of work is opened before one in this book! To determine that this body is produced by the action of these bodies is not enough; indeed it is scarce a beginning. Chemical science has higher aims. The changes of energy which accompany changes of configuration of matter must be measured; the physical and chemical constants of all the products of a chemical change must be determined with care, the velocity of the change must be measured, and an attempt must be made to apply dynamical reasoning to the results thus obtained.

The first volume of the "Essai," entitled "Calorimétrie," begins with general remarks on thermo-chemical work, and on affinity; after laying down certain general theorems concerning chemical reactions, and illustrating the application of these in the formation of insoluble and soluble salts, the formation of series of carbon compounds, &c., a detailed account is given of experimental calorimetric methods; this is accompanied by numerous tables of specific heats, heats of combination, heats of solution, heats of formation of salts in solution, heats accompanying isomeric changes, &c. The second volume—entitled "Mécanique"—is concerned with a

study of the conditions which determine chemical changes. This general study divides itself into two branches: chemical decompositions and recompositions—included under the title of "Dynamique Chimique"; and secondly those final distributions of matter which result from reciprocal actions between simple or compound bodies, grouped together as "Statique Chimique." Would it not have been better to have entitled the general subject "Chemical Dynamics," and the branches "Chemical Kinetics" and "Chemical Statics" respectively?

It would obviously be impossible to give here even an outline of Berthelot's treatment of this immense field of work; one or two instances must suffice.

The two fundamental generalisations of the French chemist have already been mentioned. Let us turn to his treatment of the specific heats of elementary bodies and of chemical equilibrium.

Berthelot refuses to accept the law of Dulong and Petit as applied to solid elements. He says that the actually-determined specific heats of the elements vary much with temperature, and that the products of these numbers into so-called atomic weights are of very different values. He gives a list of 11 elements, the specific heats of whose *equivalents* is about 6·4; and a list of 31 for which the product of specific heat into equivalent weight is about 3·2.

This result well illustrates what will probably be regarded by most chemists as a fundamental error on the part of the author of the "Essai"; Berthelot is still to be classed among the staunch supporters of the system of notation founded on equivalents. In this country we have no such phenomenon as a great chemist who writes the formula of nitric acid AzO_5. Nevertheless Berthelot's thermal chemistry is founded on a molecular theory. He constantly speaks of molecules and of action between the parts of molecules; he also speaks of the architecture of atoms, and seems to regard the modern atomic theory as utterly opposed to such an idea.

"The kinetic energy of the molecule may be regarded as made up of two parts—that of the mass of the molecule supposed to be concentrated at its centre of mass, and that of the motions of the parts relative to the centre of mass. The first part is called the energy of translation, the second that of rotation and vibration. The sum of these is the whole energy of motion of the molecule. The pressure of the gas depends on the energy of translation alone. The specific heat depends on the rate at which the whole energy, kinetic and potential, increases as the temperature rises." (Clerk Maxwell, *Chem. Soc. Journ.*, 13, 502.)

In the present state of our knowledge of the internal motion of the parts of a molecule it is impossible to determine satisfactorily the ratio of the two parts of the energy of the molecule, and it is extremely difficult to reconcile the observed with the calculated ratios of specific heats.

Nevertheless, if we adopt the mean numbers found for the specific heats of the solid elements and multiply these into the maximum atomic weights as determined by the aid of Avogadro's law, we get a result which is too constant to be merely accidental. Taking Kopp's numbers, calculated from specific heats of compounds, for those elements which have not yet been obtained in the solid form, we find that the product of specific heat into atomic weight (*not equivalent weight*) is about 6·4 for forty-four elements, about 5·5 for ten elements, less than 5 for two elements, and is yet unknown for eight elements. Furthermore we find that the specific heats of the elements are fairly constant, provided they be determined for a temperature-interval known to be considerably below the temperature of fusion of the elements.

We seem, therefore, fully justified in accepting the law of Dulong and Petit as an empirical statement of very considerable value, although not as a final statement of the connection subsisting between the ratio of the two parts of the energy of the elementary molecules, and the relative weights of the parts of the same molecules.

In treating the subject of chemical equilibrium Berthelot first of all examines processes of chemical combinations in general, and contrasts these with processes of decomposition; he then studies those changes which are made up of two parts—a direct and reverse—and which are characterised by the attainment of a limit dependent on conditions of temperature, pressure, relative masses, &c. The chemical equilibrium thus established he divides into two kinds: equilibrium of homogeneous bodies, *i.e.*, when the original and final substances are all liquid or gaseous and capable of complete admixture during the course of the change; and equilibrium of heterogeneous bodies, *i.e.*, when some of the substances are solid and some liquid, or some liquid and some gaseous, or when all are liquid or gaseous, but are nevertheless incapable of complete admixture. Examples are given of each kind of equilibrium, and of the conditioning influence of temperature, pressure, mass of solvent, contact with other substances, relative masses of reacting bodies, chemical functions of reacting bodies, velocity of the change, &c. The phenomena of equilibrium of heterogeneous systems lead to a discussion of dissociation; this to a consideration of precipitation, and thence to an instructive chapter on the state of salts in solution, and the meaning of the terms "feeble" and "strong" as applied to acids and bases.

Although, in considering Berthelot's treatment of chemical equilibrium, one misses the bold and fascinating results obtained by Gibbs in his great paper on the "Equilibrium of Heterogeneous Substances," and the exactitude and simplicity of the beautiful theory of Guldberg and Waage, and although one cannot but much regret that he should not have written his formulæ and equations in a language more easily understood by the chemist of to-day, one must nevertheless admire the breadth of view, the felicity of illustration, and the suggestiveness of the work of the French chemist.

The publication of the "Essai" marks an important point in the advance of modern chemistry: it comes to the chemist with the message, amongst others, that his science demands more than the stereotyped so-called original investigation, in which are detailed a few properties of a number of new compounds produced by methods long ago marked out and defined; it tells him that he must revise and advance his methods, that he must try to explain his facts by appeal to principles, that he must not be afraid to strike off the beaten path into the by-ways of research, and that there is more to be hoped

for in a bold impatience than in the "Smooth diffused tranquillity of heartless pains."

M. M. PATTISON MUIR

A JAPANESE ROMANCE

Chiushingura, or the Loyal League; a Japanese Romance. Translated by F. V. Dickins, B.Sc., of the Middle Temple, Barrister-at-Law. (London: Allen and Co., 1880.)

THIS book is one of great value and interest, both from a purely literary and from an anthropological point of view, and further as yielding a most instructive lesson in the meaning of Japanese pictorial art. Mr. Dickins is well qualified for the task which he has performed, being not only a practised Japanese and Chinese scholar, but a man of very wide attainments in various branches of natural science, and he has been able to supply a series of most valuable explanatory notes in the appendix of his work. It may be mentioned that he commenced his career by graduating in science and medicine at the University of London, and that after having served for some years as a surgeon in the navy he was called to the bar, and practised his profession for many years at Yokohama, where, by constant study, he became deeply versed in all that pertains to Japanese life and customs.

The present work is illustrated by the actual Japanese woodcuts with which the Japanese edition of the historical novel of which it is a translation is embellished. The woodcuts were printed in Japan by native workmen, and are now bound up with the English text. The reader is therefore able to form an exact conception of the ideas which the Japanese artist has intended to convey in the twenty-nine pictures which the work contains. It is most interesting to all who are in any way attracted by Japanese art to realise the mode in which the emotions, such as rage and despair, laughter and pain, are depicted, and to join as it were in a Japanese game of blind-man's-buff. The "Chiushingura, or Loyal League," is an historical romance which embodies the history of the forty-seven Ronin so well known from Mr. Mitford's account of it in his fascinating "Tales of Old Japan." The present romance is one of the most popular and best known in Japan, or rather was so, for its main object is to glorify "Chiushin," or loyal-heartedness, the supreme virtue of the Bushi class under the old order of things that passed away with the year 1868. Disloyalty was considered to be the meanest of crimes, rendering the person guilty of it unworthy of existence, and the Japanese self-despatch, seppuku, which occurs abundantly in the romance, was a self-inflicted atonement for this crime, and in no sense a mere ignoble suicide.

The action of the romance is laid in the fourteenth century, although the events on which it is founded really occurred at the beginning of the eighteenth, the author having been compelled to disguise barely the reality by diluting the history with a certain amount of fiction, and altering names and dates so as to evade the law which, under the Shogunate, attached severe penalties to the publication of recent or current events of a public character.

We cannot detail the plot of the story, but will give a few extracts. A highway robber after murdering an old man soliloquises thus as he kicks the body aside: "Wretched piece of work. Well, I am sorry for it. I did not do it out of any malice, but you see you had money, that killed you. No money, and you'd be alive now. Your money was your enemy. I can't help pitying you. Which prayer are you for? Namu amida butsu, or Namu miyôhô renge-kiyô? Choose one, and let all end." The prayers are Buddhist, the words being Sanskrit ones which have undergone much Japanese alteration.

The story closes with the account of the attack of the forty-seven Ronin on the castle of Maronhao, the murderer of their lord Yenya (by "murderers" being meant the persons who compelled Yenya to perform seppuku). Their mode of proceeding is very quaint. In the very heat of the attack, just as they burst into the dwelling of their victim, the leader of the expedition, in true style of a Japanese general, calmly seats himself on a camp-stool and gives his orders. The neighbours on either side are roused by the noise and send their retainers to see what is going on. "Ya ya," they cry, "what means all this uproar and confusion, clashing of weapons and hurtling of arrows? Are you attacked by rioters or by robbers, or has a fire broken out somewhere? We have been commanded to find out what is going on, and inform our masters of the cause of disturbance." The Ronin answer, "We are liegemen of Yenya Hanguwan; some forty of us banded together to revenge our lord's death upon his enemy, and are now struggling to get at him. We are not rising against the Government, still less have we any quarrel with your lords. *As to fire, strict orders have been given to be very careful*, and we beg you not to be under any apprehension on that score. We only ask you to leave us alone and not to interfere with us. If as neighbours you should think yourselves bound to assist our enemy, we shall be obliged, despite our inclination, to turn our weapons against you."

To these bold words the retainers of the noblemen shout back approvingly, "Right well done, right well done; in your place we should feel ourselves bound to act as you are acting; pray command our services." So they desert the roofs and put out their lights.

When Maronhao is at last caught he is treated with ceremonious respect, and afforded the opportunity of performing suicide in the usual manner. "We pray you pardon our violence, and beg of you that you will *present us with your head* according to the usage of our country." But Maronhao is a vile, ungentlemanly ruffian, and drawing his sword under pretence of ripping himself up, he makes a treacherous lunge at the leader of the Ronin So he is at once despatched without more ado. The head is cut off with the dagger with which Yenya committed "seppuku," and is struck at in frenzy, gnashed at, and cried over in grief and fury by the Ronin. Then it is washed, and presented on a small stand before the "ihai" (a tablet inscribed with the posthumous name of the deceased) of Yenya placed opposite to it on a similar stand. Incense is burnt before the "ihai," and a prayer is offered up to the dead Yenya "resting amid the shadows of the tall grass" (in the grave), that he will look with favour on the offering. Then all the Ronin betake themselves to his grave and perform "seppuku" themselves.

The Appendix contains an interesting account of a Japanese orchestra, many historical notes, and various information of great ethnological value. The notes throughout the book are very interesting, and some of them amusing. Thus, when the Ronin are crowding round the body of their victim they shout, "Happy are we as the Môki when he found his waif." In the note we learn that "the Môki, according to a Chinese fable, was a species of sea-tortoise with one eye in its belly. For three thousand years the monster had longed to see the light, but in vain. One day, while swimming about the surface of the sea, it came into contact with a piece of drift-wood, to which it immediately clung in such a manner that the belly was uppermost under the wood, a ragged hole in which fortunately allowed the tortoise the opportunity of at last satisfying its long-cherished desire. There is a curious note on p. 120 on an allusion in the text as follows:—"Allusion is here made to the practice of hacking at the dead bodies of criminals, by which the young Samurahi was wont to perfect himself in swordsmanship under the old order of things. Treatises exist upon this repulsive art—for an art it seems to have been considered—and one of the commonest of picture-rolls used to represent the various cuts, distinguished by special names, by practising which the aspirant could best learn on the dead subject to qualify himself for mangling the living one."

The Appendix contains a translation in verse of a popular Japanese ballad which is often sung as a kind of epithalamium, and which gives a pleasing conception of Japanese poetry. We commend the book to all our readers.

H. N. MOSELEY

OUR BOOK SHELF

Loch Etive and the Sons of Uisnach. With Illustrations. (London: Macmillan and Co.)

ALL sorts of epithets have recently been applied to Oban—the Brighton of Scotland, by those whose highest ideal of heaven is "London by the Sea"; the future Liverpool of the North, according to one of its most constant wooers, that enthusiastic Celt, Prof. Blackie; the "Charing Cross of the Highlands," a picturesque placard of one of the railway companies informs the public. But to those who have been there and know from impressive experience all the romantic beauties of island and loch and rugged coast to which the modern Argyllshire coast town is the key, no epithet however ingenious is half so expressive and beautiful as simple "Oban" itself, especially since the "Princess of Thule" has shed a glory over all the Western Islands from Stornoway southwards. But there is the glamour of a story much older than that which William Black has told so well hovering around some of the lochs and headlands in the neighbourhood of Oban. It is this old old story which is told in the anonymous volume before us, the author of which, were we at liberty to reveal his name, our readers would recognise as one occupying a very high rank in a certain department of physical science. The story is that of the early migrations of the Irish Scots to the land which for the last 800 years has borne their name. By the help of a somewhat clumsy dialogue the author takes the reader to some of the localities in and around Loch Etive mentioned in the half-legendary record which remains of these early migrations. He seeks to reproduce the stirring life of the time and localities, takes us to the spots where the Irish emigrants and their distant kinsmen came in contact, unearths the ruins of their houses and forts, and the remains of their household utensils and warlike weapons. The work has, however, wider bearings than its immediate subject, and several important points connected with the early "Aryan" migrations are discussed in a style much more in accordance with the canons of scientific investigation, and therefore of common sense, than is usual with those who are in the habit of handling such subjects. The chapter on the Celts is specially interesting; its breadth of view is admirable. The author's discussion of the question of Celt and Saxon, Aryan and non-Aryan, and in connection therewith the subject of mixture of race, is an excellent specimen of close reasoning, and we strongly commend it to the study of "Saxon" and "Celtic" enthusiasts. To those who read this work with care and with the help of a good map a new interest will be added to Oban and its vicinity, which is now rendered so accessible by the opening of the Oban Railway. The numerous illustrations will be found really helpful; and grand and musical as the names of many of the places illustrated are in themselves, they will be clothed with a lively significance to those who take the trouble to study the legends of the Sons of Uisnach.

The Birds, Fishes, and Cetacea commonly frequenting Belfast Lough. By Robert Lloyd Patterson. (London: David Bogue, 1880.)

THIS work does not purport to be a scientific treatise, but to be a record of many years' observations on the cetacea, birds, and fishes found commonly frequenting Belfast Lough. This lough is, in its way, almost classic ground to the naturalist, and in connection with the treasures to be found around its shores or in its waters, the names of Thompson, Hyndman, Templeton, Haliday, and that of the father of the author of this volume, will ever be associated. The lough is favourably situated for receiving the visits of birds, though the great and still increasing traffic through it must to some extent frighten away many a species; and in grandeur of beauty and variety of life it will not favourably compare with the fine fjord-like bays of Western Ireland. Mr. Patterson tells us that the greater portion of the matter in this volume was originally brought together in the form of papers, which were read at different times before the Belfast Natural History and Philosophical Society, which will account in great measure for their style and for their being somewhat discursive; still the volume is for the most part pleasant reading, and every now and then we come across very interesting and novel facts. In the chapter about gannets we read a good deal about their great feeding powers, and the following estimate of how many herrings the Scotch gannets eat in a year is noteworthy; it is given on the authority of Commander M'Donald, of H.M. cruiser *Vigilant*. Of the five Scotch stations where the gannet breeds, the number of birds frequenting each is put down as follows:—Ailsa Craig, 12,000; the Bass Rock, 12,000; St. Kilda, 50,000; the Stack, 50,000; Gula Sgeir, 300,000, or a total of 424,000. Each of these birds would consume at least a dozen herrings in the day if it could get them; but estimating the daily average as six to each gannet produces 928,560,000 as the quantity consumed in one year, and reckoning 800 herrings to a barrel gives us 1,160,700 barrels captured by the gannets, as against 750,000 barrels, the total take by fishermen on the west coast of Scotland for 1872. Many more such extracts might we give, but our space is limited, and our desire is to send the reader to the volume itself. Almost everywhere throughout the work the author spells the specific names with capital letters, in this overlooking both the rules and practice of men of science. Sometimes, indeed, a specific name, if after a person or place, may be thus spelled without offence, but these exceptional cases should not be made the rule. The volume is dedicated to the memory of the author's father, Robert Patterson, F.R.S.

Key to the Universe; or, a New Theory of its Mechanism. Founded upon a (1) *Continuous Orbital Propulsion, arising from the Velocity of Gravity and its Consequent Aberrations;* (2) *Resisting Ethereal Medium of Variable Density, with Mathematical Demonstrations and Tables.* By Orson Pratt, Senior. Second Edition. (Salt Lake City, Utah Territory, 1879.)

MR. ORSON PRATT'S work is not a text-book for students, but an application of dynamical principles to the system of the Universe. "The aim of the author is to vindicate the UNIVERSALITY of the law (*i.e.*, of gravitation); to rescue it from the environed limits sought to be thrown around it, and to give it that unlimited freedom of action which the distinguished name 'UNIVERSAL' so appropriately and definitely imports." Mr. Pratt states that astronomical science needs a theory which will answer as far as possible nine questions, which he propounds; the second is, "Why do planetary bodies rotate upon their respective axes? Why do they rotate from west to east, instead of the contrary direction? Is there any law governing their diurnal periods?" The ninth, "Will cometary orbits ever be converted into those of a planetary form?" "Unaided and alone, he launches his humble barque upon this great unexplored ocean, with a compass of his own invention." The discussion occupies thirteen chapters, and his investigations result "in the development of the following beautiful law: *The cube roots of the densities of the planets are as the square roots of their periods of rotation.*" Without making any long comments of our own we can say that Mr. Pratt's book gives evidence of much hard work and, it may be, of ingenious speculation, and we quote as appropriate to the work before us the following remarks of Prof. Newcomb ("Popular Astronomy," p. 233): "It is true that many ingenious people employ themselves from time to time in working out numerical relations between the distances of the planets, their masses, their times of rotation, and so on, and will probably continue to do so; because the number of such relations which can be made to come somewhere near the exact numbers is very great. This, however, does not indicate any law of nature."

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

The Recent Gas Explosion

THE explosion of the gas main in the neighbourhood of the Tottenham Court Road appears to be an example on a large scale of the phenomenon which occurs on the bursting of a eudiometer.

It is known (although I do not speak from experience) that when such an accident happens the glass gives way at the surface of the mercury in the tube, for at this point the explosion is most violent, in consequence of the gas being compressed by the explosion of that above it. When no accident takes place the flash of light is more brilliant at the surface of the mercury than in the upper part of the tube. In order to see if this fact would throw any light on the explosion of the gas main I tried a few experiments about a fortnight ago, an account of which may possess some interest. A piece of combustion tube 1·93 m. long and 13·5 mm. in diameter was closed at one end, and at 100 mm. from the open end of the tube a pair of platinum wires was sealed into the glass. The tube was filled over water with a mixture of hydrogen and oxygen obtained by the electrolysis of dilute sulphuric acid, and the mouth of the tube closed with a plug of wet cotton wool. The tube was placed on the lawn and secured to a heavy weight by a piece of string tied near the open end; a spark from an induction-coil was then passed between the wires. The explosion of the gas blew out the plug of cotton wool and bent the platinum wires against the sides of the tube, but the glass was not broken. The tube was again filled with the mixed gases and closed with a cork, which was not forced tightly into the mouth of the tube. This time the tube burst in the middle, leaving ·78 m. of the closed end and ·59 m. of the open end without damage. The cork was projected some distance, but the wires were not bent by the rush of gas; the closed end of the tube was only slightly moved from its original position by the explosion.

Another piece of similar tube, but only about ·88 m. in length, was next filled with gas and exploded in the same manner. The closed end was burst, and ·475 m. of the open end remained. In this case the cork was also projected, but the wires were not bent. The experiment being made at night, it was noticed that the flash was much more brilliant at the closed than at the open end of the tube. A third tube of the same length as the first was next tried; the cork was blown out, but the tube did not burst. It was again filled and the cork forced in tightly, but it was again projected. The third time a block of stone was placed a few millimetres in front of the cork; this prevented its projection, but the tube did not burst, being apparently of thicker glass than the previous tubes. In the last three cases the flash was brilliant in the half of the tube towards the closed end.

The explanation of the experiments seems to be, that in the two tubes that burst the pressure produced by the explosion at a distance of about three quarters of a metre from the point at which the gas was fired was sufficient to overcome the resistance of the glass; and in the case of the long tube, which burst in the middle, the release of the pressure prevented the closed end from being destroyed. If the tube had been much longer there would probably have been another place where the violence of the explosion produced by the compression of the gas would have burst the tube.

The press of work at the end of the term has prevented my carrying the experiments farther, but I intend to try the effect of an explosion in a long lead or composition pipe, when I expect to find several swellings or burstings of the metal at the points where the pressure is greatest. When the experiments have been made I hope to be allowed to communicate them to you. HERBERT MCLEOD

Cooper's Hill, July 24

The Freshwater Medusa

IN NATURE, vol. xxii. p. 241, Prof. Lankester asserts that I had in a previous number (vol. xxii. p. 218) incorrectly represented him as holding that in Limnocodium the radial canals terminate blindly, and as denying the presence of a marginal canal. In proof of my inaccuracy he makes the following statement:—

"A reference to NATURE, vol. xxii. p. 147, will show that in my first publication on the subject I gave as a character of the new genus, 'Radiating canals 4, opening into the marginal canal. Marginal or ring canal voluminous.' I made the same statement in my communication to the Royal Society on June 17, and have not since deviated from it."

I have read the article to which Prof. Lankester here refers, and which was published on the date of the reading of his paper at the Royal Society. The only allusions in it to this subject are the following:—

"RADIATING CANALS 4, terminating blindly at the margin of the disk."

"MARGINAL or RING CANAL obliterated (or, if present, of very minute size)." GEO. J. ALLMAN

Storm Effects

THE storms about this part of Surrey have been lately local and violent, and the effects produced in some instances curious. Visiting a neighbour's farm on Wednesday evening (21st), we found a field of standing wheat considerably knocked about, not as an entirety, but in patches forming, as viewed from a distance, circular spots.

Examined more closely, these all presented much the same character, viz., a few standing stalks as a centre, some prostrate stalks with their heads arranged pretty evenly in a direction forming a circle round the centre, and outside these a circular wall of stalks which had not suffered.

I send a sketch made on the spot, giving an idea of the most

perfect of these patches. The soil is a sandy loam upon the greensand, and the crop is vigorous, with strong stems, and I could not trace locally any circumstances accounting for the peculiar forms of the patches in the field, nor indicating whether it was wind or rain, or both combined, which had caused them, beyond the general evidence everywhere of heavy rainfall. They were to me suggestive of some cyclonic wind action, and may perhaps have been noticed elsewhere by some of your readers.

Guildown, Guildford, July 23 J. RAND CAPRON

The Inevitable Test for Aurora

I HAVE not long returned from abroad, and have only recently had the opportunity of perusing in NATURE (vol. xxii. pp. 76, 96, 145) the correspondence of Messrs. De La Rue and Müller, Prof. Piazzi Smyth, and Mr. Backhouse on this subject.

I do not understand Messrs. De La Rue and Müller as claiming their electric discharges to be in the nature of an actual auroral discharge, but rather that their experiments inform us inductively at what heights auroræ are to be found. This, however, doubtless assumes that the discharges in question and auroræ must have something very much in common; and Prof. Piazzi Smyth is quite to the point in remarking that unless the citron line (and, I would add, the red line) are present in the spectrum, the identity of the discharges with the aurora has not even a foundation.

The fact is, that many of the electric discharges in air and the air gases, and the circumstances attending them—we may instance the ordinary tube glow, its change from rose-tint to violet under magnetic influence, the aura-arc accompanying the spark discharge under similar conditions, the dark space between the terminal and the glow, the change of colours in a hydrogen tube, and other appearances which I have not time to capitulate—so closely resemble auroral incidents, that one is quite disappointed to find on examination no concordance in the spectra. At the most, in a vague and unsatisfactory way one or two of the blue and violet lines in the aurora spectrum have been assigned to one or other of the atmospheric gases; but as Prof. Smyth points out, the red and green giant lines of the spectrum have up to the present time found no terrestrial analogues. I have examined the air spectrum and the spectra of the component gases of air under many various conditions, but always without success so far as these lines are concerned.

I have not, however, had the opportunity of doing this in the case of direct discharges from large secondary batteries; and it would undoubtedly be a valuable addition to our knowledge of facts relating to auroræ if Messrs. De La Rue and Müller would undertake this examination, and clear up matters in that respect. With regard to the heights at which auroræ obtain, the evidence is very conflicting. Certainly they have been seen very near the earth ("Auroræ, their Characters and Spectra," pp. 37 to 40. Height of the Aurora). It is unfortunate that simultaneous observations of the auroral corona are almost entirely wanting. I think I once saw one in print, but missed it subsequently, and would be glad if any particulars could now be furnished me. Prof. Newton, by calculations based on observations of auroral arches in 28 auroræ, has assigned a height of from 33 to 281 miles, with a mean of 130 miles.

Messrs. De la Rue and Müller, I notice, deduce experimentally that at 124 miles no discharge could occur. As to whether the red or the white aurora is the nearest to the earth, my impression certainly is that the apparently low-lying auroræ have generally been the white. I may instance the aurora seen by Mr. Ladd a Margate, "a white ray," and that seen by me in the Isle of Skye in September, 1874. In Lapland, too, the auroræ seem almost universally yellow, but it can hardly be assumed that they are all thirty-seven miles high. The apparently lower position of the red tint is by no means universal, and can hardly be relied upon as evidence on the point, especially when so many auroræ are seen in which it is wanting. I have great hopes, with a spectroscope specially prepared for the purpose, of getting the photographed spectrum of an aurora.

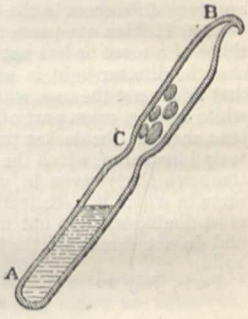
The red line is of course out of the question, but judging from experiments on gas tubes I think the green might be got, and the blue and violet I make in anticipation pretty sure of in the event of an aurora lasting some hours. The principle of the instrument is a long collimator, a single fluid prism, and a short focus-projecting lens, used with rapid dry plates.

Guildown, Guildford, July 23 J. RAND CAPRON

Experiment with Glass Tubes

I HAVE just been repeating a very beautiful experiment of Prof. Quincke's which he showed me some weeks ago in his laboratory at Heidelberg. The experiment was, I believe, described in *Poggendorff* about two years ago, but I have not seen it noticed in English papers, and a few words about it may interest your readers.

Prof. Quincke, with a view to test the porosity of glass for gases, sealed up tubes in which hydrogen and carbonic acid were generated in great quantity, and weighed them from time to time. Up to the present time, as I learned from him, no loss of weight has been detected. He obtained, however, a very curious result. As I do not know precisely how Prof. Quincke filled his tubes, let me describe what I did myself three weeks ago, remarking that I have done nothing but attempt to repeat what he showed me in Heidelberg.



I took a glass tube, A B, about 5 inches long and ¾ inch in external diameter, with good stout walls. I closed the end A, and let the glass fall in at C, keeping it still very strong, and annealing very carefully at A and C. I introduced some sulphuric acid into the part C A, carefully keeping the neck C dry, and dropped into the part B C some fragments of marble, previously washed, in order that no little particles should tumble down through the neck, C, and commence effervescing before I was ready. I then drew out the tube at B, making a small hook, by which the tube can be suspended if necessary, closed it very strongly, and annealed the extremity carefully, wrapped the tube in cotton wool, and inverted it. The sulphuric acid attacked the marble, and carbonic acid was given off no doubt in great quantity.

For the first few days there was nothing particular to be noticed. The tube was filled with a bubbling mass of liquid and white mud. Latterly, however, it has begun to show the phenomena which Prof. Quincke observed. The liquid now no longer wets the glass as it did at first, but creeps away from it, giving very much the appearance of the "tears of strong wine." Day by day this is getting more marked, and I expect that soon, as was the case in the Heidelberg tubes, the acid will roll about in the tube like so much quicksilver. Meantime it is most interesting to watch.

I believe Prof. Quincke considers that a thick layer of gas is condensed over the surface of the glass, and that it is this which gives rise to the very peculiar capillary phenomena that present themselves.

I feel bound to remark that the experiment is one that ought not to be attempted without great care and caution.

J. T. BOTTOMLEY

Physical Laboratory, University of Glasgow, July 15

On the Colours of Double Stars

IF any light whatever has its intensity increased the effect on the eye is to add to the sensation a certain yellow element which I have accurately defined by experiment (*Am. Jour. Sci.*, April, 1877, vol. xiii. p. 247). A red light brightened becomes yellower, a green light yellower, a yellowish white less white, a blue or violet light whiter. The phenomena are described at length in Prof. Rood's "Modern Chromatics." The fact that an incandescent body becomes less red and more yellow when it is heated is probably due to this physiological principle. That the incandescent body ultimately becomes white is probably owing to some not understood modification of the principle for excessively bright lights.

It follows that if two stars are of unequal brightness they will appear of different colours unless the qualities of the two lights have a peculiar relation to one another; and the brighter star will usually be the yellower. Accordingly, if we refer to Mr. Burnham's lists of binaries recently published by Prof. Holden (*Am. Jour. Sci.*, June, 1880, vol. xix. p. 467) we find that although differences of colour are so little distinguished that three-quarters of all the pairs are considered to be of the same colour, yet of the twenty-four pairs which differ in brightness by two magnitudes

or over, not one is considered to have components of the same colour. And of the forty-two pairs which are said to be of different colour all but two have more yellow in the brighter, so much so indeed that it is possible to suppose that the difference of brightness is the chief cause of the difference of colour. The two exceptions are :—

No. 23. ε *Boötis*	A. eq. Cærulea	B. eq. Cærulea
No. 42. O Σ 507	A. Blanche	B. Cendriolivatre

There is evidently some error about No. 23. Either the colours are wrong, or it is wrongly stated to have differently coloured components. In No. 42 it is difficult to say which component is more yellow. Although, then, it is certain that other causes largely affect the colours of stars, yet differences of brightness seem to have the greatest effect in producing the apparent differences in the colours of double-stars.

Prof. Holden compares the colours of bright and faint stars to those of a more or less hot incandescent body. But in the latter case the dimmer light is accompanied with redness. We know that this is not the case with the light of our own sun ; for of a white surface, upon part of which the sun shines, while the rest is in shadow, the darker part is bluer. In the same way, of the forty binaries of which the brighter component is the yellower, there are thirty-seven in which the fainter is bluer, and only three in which it is distinctly redder. It appears, therefore, that most double-stars do not differ greatly in colour from our sun, and do not shine with the strongly red light of an incandescent solid.

C. S. PEIRCE

Paris, July 20

Coffee-Disease in New Granada

THE following information about what appears to be a new disease of the coffee-tree is taken from an official letter written on April 29 last by Mr. C. Michelsen, Commissioner of Agriculture at Bogotá, to Mr. José Herrera, Vice-consul of New Granada in this city, who sent me a copy of it, requesting me to give him my opinion about the disease.

At first there appear on the leaves small spots of a light-greenish colour, which in two or three days turn brownish, and then appears on each of them a fungus *divided in three or more greenish-yellow branches*. This fungus is said to be phosphorescent at night, and *in places where it is very common a phosphoric smell is noted* (!) After some days the diseased leaves fall off; the fruits, which also are attacked by the parasite, follow very soon, and the trees are left quite bare. They form, however, new leaves after some months, but these are again attacked by the fungus.

The disease is reported to be more frequent in damp places than in dry ones, its ravages being greatest in plantations where the trees are planted rather close. The fungus has also attacked the shade trees, especially the *guamos* (*Inga* sp.).

Though the description is far from being satisfactory, I think it is pretty clear that the fungus is not the *Hemileia vastatrix* of Ceylonese celebrity. However it bears a great resemblance to it, so that I recommended to employ fumigations with sulphur under the kind of large umbrella proposed by Mr. George Wall (NATURE, vol. xix. p. 423). The unusually rainy weather in the last year has very likely much to do with the spread of the disease, which at the same time is a new proof of the eminently fatal consequences resulting from close planting.

I have asked for dried specimens of diseased leaves, in order to submit them for examination to a competent mycologist.

Carácas, June 26 A. ERNST

Toughened Glass

PROBABLY the accident mentioned by Mr. Noble Taylor is not exceptional, as a similar one happened to a member of my own family. She was about to take a seidlitz-powder, and had poured the contents of the blue paper into a tumbler of toughened glass half filled with cold water, and was stirring it gently to make the powder dissolve, when the tumbler flew into pieces with a sharp report. There was no fire or lamp in the room at the time. Some of the fragments flew to a distance of three or four feet. The bottom of the tumbler was not altogether fractured, but cracked into a number of little squares, which could be separated readily.

T. B. SPRAGUE

Edinburgh, July 20

THE same accident occurred to me a few nights ago as happened to your correspondent, and I cannot help thinking that the spoon had most to do with the phenomenon.

In a hot room I had just finished what is usually called a "lemon squash," *i.e.*, the juice of a lemon and a little white sugar, with a bottle of soda-water, a lump of ice being put into the mixture. I was talking at the time, and so held the empty glass with a spoon in it in my hand for a second or two, when suddenly it went off in my hand into thousands of pieces, none larger than an inch or so.

I picked up one of the largest and thickest pieces, and found it to be so thoroughly disintegrated that I broke it up with my fingers into about a hundred small pieces, and might have done more. This disintegration seems to be a natural property of toughened glass when broken, but I never before saw a case of its breaking up without being struck. I do not think that usually such occurrences are dangerous, on account of the entire destruction of the fabric.

J. C. J.

Large Hailstones

ON Tuesday, July 13, at 2.30 p.m., hail began to fall heavily in this neighbourhood. A thunderstorm was at the time approaching rapidly from the north-east. I was struck with the extraordinary size of the stones, and going into the open air I collected six—the first that came to hand—in an accurately-tared glass, and weighed rapidly. The six stones weighed 5·766 grams. The average weight for each stone was therefore ·961 gram. or 14·8 grains. A pane of glass in a skylight window had a hole driven through it by one hail-stone.

GEORGE PATERSON

Borax Works, Old Swan, Liverpool, July 14

CHATEL, JERSEY.—Please send exact address.

PAUL BROCA

THE sudden death of the eminent French anthropologist, Dr. Paul Broca, which we announced a fortnight since, is an irreparable loss to science, and for the French medical and anthropological schools particularly.

Prof. Broca, born in 1824 at Ste. Foy la Grande (Gironde), was a senator, vice-president of the Academy of Medicine, officer of the Legion of Honour, and member of several learned societies. Since 1846, the year in which he was promoted Aide d'anatomie, till 1880, when he died as a professor of surgery, during nearly thirty-four years the life of Dr. Broca has been an uninterrupted consecration to science. A rapid review of his scientific work, especially of what he did for anthropology, will show how indefatigable was his zeal, how well his life has been spent.

Broca's publications on various subjects in anatomy, surgery, and anthropology are innumerable, especially his contributions to the last-mentioned subject. One has only to open the numerous volumes of the *Bulletins* of the Paris Anthropological Society, of the *Mémoires* and the *Revue d'Anthropologie* and other scientific journals, to get an idea of Broca's immense activity. In 1856 he published his famous "Traité des Anévrismes," which, with his "Traité des Tumeurs," published in 1866, constitute his principal medical works. The former opened a new era in the treatment of these affections; in the latter Broca expounded the historical evolution of the knowledge of tumours and their treatment in so able a manner that it has hitherto not been surpassed.

In 1861 Broca made his remarkable discovery of the seat of articulate language at the third frontal convolution of the left side of the brain. Moreover in later years Broca devoted himself to the study of the brains of man and animals, greatly contributing to our knowledge on that subject. The *Revue d'Anthropologie* contains many of the results of these studies; for instance, "Sur la Topographie cranio-cérébrale," "Étude sur le Cerveau du Gorille," "Anatomie comparée des Circonvolutions cérébrales," "Localisations cérébrales," &c.

His treatise "Des Phenomènes d'Hybridité dans le Genre humain" appeared in 1858 and 1859, and in 1864 was translated into English.

Among the great number of memoirs may further be mentioned: "L'Intelligence des Animaux et le Règne humain," "La prétendue Degénerescence de la Population française," a brilliant plea for the French nation, "L'Ordre des Primates: Parallele anatomique de l'Homme et des Singes," "Recherches sur l'Indice Nasal," "Étude sur la Constitution des Vertèbres caudales chez les Primates sans Queue," "Les Troglodytes de la Vézère," "La Race Celtique ancienne et moderne," "Étude sur les Propriétés hygrométriques des Crânes," "Sur l'Origine et la Répartition de la Langue basque," "Recherches sur l'Indice orbitaire," "Sur l'Angle orbito-occipital."

The practical results of a good deal of Dr. Broca's anthropological researches are found in his "Instructions," forming two separate volumes; one, for the anthropological study of the living, appeared for the first time in 1864, and has been re-edited several times since; the other, particularly on craniology and craniometry, was published in 1875. Another valuable memoir is that on the "Indices de Largeur de l'Omoplate chez l'Homme, les Singes et dans la Série des Mammifères," in which he opened up new views on the comparative anatomy of races and mammals. One of Dr. Broca's last works was his important study on the "Variations craniométriques et de leur Influence sur les Moyennes," &c.

The greatest glory of Broca is perhaps the foundation of the Anthropological Society of Paris in 1859. The perseverance and talent of the founder surmounted all the difficulties and troubles of every kind which threatened in the beginning the existence of the society, which now, after nearly one-and-twenty years, is flourishing as one of the first learned societies in Europe. During these long years Broca was the soul of the anthropological movement in France; nay, we may say that his influence extended far beyond his own country, and that the study of man in other civilised countries has been followed after his method. In reality Broca was at the same time the founder of a new and excellent anthropological school: his method of anthropometry, &c., as expounded in the "Instructions" above-mentioned, is now followed by the great majority of anthropologists. But this was not enough for the indefatigable zeal of the eminent scholar; in 1872 he commenced to publish the *Revue d'Anthropologie*, one of the best organs on the science of man. Many of his own works have been published in it.

Broca's last and greatest work was the foundation in 1876 of the now celebrated École d'Anthropologie in Paris, with a first-rate museum, laboratories, library, and a complete course of anthropological lessons given by more than half-a-dozen professors, among whom are de Mortillet, Bertillon, and Topinard. Broca himself taught the comparative anatomy of the Primates.

The laboratories above-mentioned belong at the same time to the École pratique des Hautes Études since 1878.

Broca, the scholar, philosopher, and statesman, died on the field of honour, in the midst of his work, in the vigour of life. Though dead, his work will never perish; man dies, but science remains. His illustrious example will continue to enlighten the path of those who follow the imperishable footprints he has left.

H. F. C. TEN KATE

THE WOOLWICH GUNS

A PETITION signed by several men well known in the field of mechanical science and presented to the House of Commons last week contains many points to which it is important that public attention should be directed. The memorialists state their belief that the system of heavy ordnance now in use and known as the Woolwich system is inefficient and dangerous, that, considering the increasing dependence of the nation for food supply upon its command of the sea, it is evidently unsafe to neglect any of the opportunities which the mechanical skill and manufacturing resources of the country afford for securing the best weapons of offence and defence for our fleet and our army; "that, having regard to the advances constantly being made by private manufacturers in this and other countries, and to the ordnance actually in use or in course of construction for the other Powers of Europe and America, your petitioners look with dismay upon the defects of the English heavy guns, and they are of opinion that these defects seriously endanger our naval supremacy and our national safety." Further the petitioners maintain that it is not right that the heads of the manufacturing department, which is in competition with outside manufacturers, should be the official advisers of her Majesty's Government as regards new inventions, and that the defects in our present system of ordnance arise and are likely to continue from the absence of independent criticism, and in consequence of the technical advisers of the Government being the same persons as those who either are or have been in charge of the manufactories responsible for these defects; that there are in existence several systems of ordnance superior to the Woolwich system, and that it is of national importance that private establishments for the production of arms of all kinds should be encouraged and should not be crushed by giving a virtual monopoly to the Government establishments, but that the private trade and the Government factories should rather serve as reserves to one another.

The principal issues thus raised may be very shortly stated. If we want the best guns, can they be obtained better from a Government manufactory carefully fenced round by official jealousy, or can a better article be procured by open competition amongst private manufacturers? Is it impossible for the technical advisers of the Government to select from the enormous mass of inventions and improvements offered to them those of real value? And further, do they, or would they make this selection if it were in their power? It has often been objected that the great quantity of suggestions and friendly advice constantly being received renders it quite impossible to treat them with adequate discrimination; but if the officials intrusted with this work were only possessed of a thorough scientific knowledge of mechanical principles, we believe that nine-tenths of the worthless schemes could be at once rejected, so inevitably does the mark of the circle-squarer appear in his work to one who knows where to look for it.

Respecting the remaining 10 per cent. of inventions and improvements, it would probably require somewhat greater practical judgment to decide which were worth further investigation; but while we do not for a moment suggest that the whole of these should be examined and tested at the expense of the tax-payer, it is at least not too much to expect that an obviously good design should not be rejected with an official reply. Inventors are probably the most persevering of all men, and, fortunately for the cause of progress, though not perhaps for their own advantage, they have a greater belief than any one else in the results they hope to obtain; but it is hardly to be expected that they will bestow their whole powers of persuasion on the authorities of their own country when they plainly see a more open field abroad.

For instance, there can be little doubt that the Whitehead torpedo might have been a secret exclusively the property of this country if the inventor had been afforded a fair investigation; again, it would be interesting to know whether the Russian Government required as much persuasion to induce them to adopt the Moncrieff hydro-pneumatic gun-carriage as has been expended in bringing it as far as the "experimental" stage in our own service.

That many inventors have had a short innings at the

hands of the War Department is to be plainly seen in the collections of what are merely regarded as useless eccentricities at Woolwich and Shoeburyness, but it is very improbable that most of the lessons to be learnt from these have ever been appreciated by those who were responsible for their rejection. Has it not taken twenty years for the system invented by Robert Mallet of building up a massive piece of ordnance capable of being taken to pieces to facilitate transport, to at length bring forth the present seven-pounder screw gun, which can be carried in halves on the backs of mules? It would be interesting to know whether any private firm in this country, if they had received the order, could have manufactured and proved a train of siege guns on similar principles, and capable of as easy transport as the modern field gun, and which would have considerably facilitated Gen. Stewart's advance to Cabul.

It can of course be urged with some show of reason that, considering the enormous supply of most patterns of guns and the vast quantity of ammunition required throughout the Empire, great inconvenience would result from too great a multiplicity of designs; but to continue the manufacture of an inferior pattern for this reason when a better one is procurable appears to us only to make the evil greater when the former has to be finally abandoned as obsolete. Thus we suppose it must have been obvious to a great many persons for the last five years that the days of heavy muzzle-loading guns for the navy were numbered, from the difficulty or impossibility of giving sufficient length of bore for the consumption of large charges of powder while still enabling the gun to be fought in a turret. All possible ingenuity was then expended on shortening the recoil and on mechanical systems of loading in a confined space, with results that might have been incalculably disastrous had this country been involved in war previous to the terrible accident on board the *Thunderer*; all this too while we believe a suitable pattern of breech-loader was in the hands of a private firm and had been tendered by them for adoption by the War Department. If it could be shown that a Government factory could alone turn out guns of the best manufacture, superior to anything that could be produced by private establishments, the logical sequence would be that armour plates and marine engines and the ships themselves should all be provided in the same way.

The effect of a Government monopoly on the foreign trade of a manufacturer is too well known to require demonstration; but if the encouragement of private establishments for the production of all kinds of arms and warlike stores should result, as it doubtless would, in a larger trade with foreign powers in these manufactures, while we should profit by their custom in time of peace, they would not only find themselves in the event of war with this country cut off from their supply of fresh arms and ammunition, but the whole of our own increased production would be available for national defence.

If such an inquiry as is sought for in this petition be instituted by the present Government, conducted not only by officers of the army and navy, but also under independent scientific advice, we believe that numerous articles of belief and revered principles of construction will be shown to have been long exploded and will have to be at once abandoned. We shall then probably find the Woolwich system of rifling with increasing pitch and studded projectiles giving place to the poly-groove of uniform pitch with rotation by gas-check which has been under consideration for years, and is yet scarcely recognised; we may even take a hint from the Chinese Government, who, by applying to Sir William Armstrong's firm, have for more than a year been in possession of four more powerful guns than any afloat in our most recent ironclads; we should perhaps find that a system of breech-loading is ready for adoption solving most of the difficulties of turret and casemate defence, and that a trustworthy type of hammered steel is ready at hand to be substituted for the welded coils of wrought iron at present in use.

If it should be found that our Government establishments have been suffering from a slow process of crystallisation, they might be resuscitated by being placed in keen competition with private firms whose very existence depends on their unceasing activity, or at the least it would be ascertained whether in a critical time the country would have to depend entirely on the Royal Gun Factory, or whether some of the old firms who in former years fought so hard for a share in the work have not forgotten their skill.

LIVING ON WATER

HOW long a man can live on water alone is now the subject of an experiment in New York. A Dr. Tanner from Minnesota is devoting himself to this trial. Tanner declares that he can live for forty days without food, and is proving, or trying to prove, the truth of the hypothesis on his own unfortunate person. He is reported to have got through twenty-eight days of his endeavour, and still to be alive and comparatively well. On the twentieth day his pulse was 76, his temperature 98·405, and his actual weight 132 lbs. On the twenty-eighth day his weight was 130 lbs. He lost 27½ lbs. in the first nineteen days during which he fasted, and then ceased to waste at the same rate. The latest report we have of him states that he is cheerful, active, and, notwithstanding abundant medical opinion to the contrary, confident that he should continue to the end of the time named for the experiment. Of food of the solid kind he touches none; of drink he partakes of water and nothing else; water and air will, he maintains, sustain him, and that notwithstanding exertions from riding and other exercises. Dr. Tanner is not original in this mode of attempt upon his own life. In the *Transactions* of the Albany Institute for 1830 Dr. McNaughton reported the history of a man named Reuben Kelsey, who on July 2, 1829, declined eating altogether, assigning as a reason "that when it was the will of the Almighty that he should eat he would be furnished with an appetite." McNaughton's account of this man is singularly interesting. We have not room for all the details, but it may be told in brief that Kelsey continued to live for *fifty-three* days; that he went out of doors and walked about during the greater part of the time, and that he was able to sit up in bed until the last day of his life. During the first three weeks of his abstinence he fell away very fast, but afterwards did not seem to waste so sensibly. Towards the close of his days the colour of his flesh was blue, and at last blackish. His skin was cold, and he complained of chilliness. His general appearance was so ghastly that children were afraid of him. Of this he himself seemed to be aware, for it was not uncommon to observe him covering his face when strangers were passing by. At the time of his death Mr. Kelsey was twenty-seven years of age. The writer of this notice once attended a gentleman, who, for a nearly similar reason as that assigned by Mr. Kelsey, abstained from all food, except water, for even a longer period, viz., fifty-five days. In this instance the wasting was most observed in the first three weeks of the fasting. From this it will be gathered that Dr. Tanner may live to the full extent of forty days on water without being suspected of having been the subject of a miracle. It is against the success of his experiment that he should be exposed to an amount of excitement and vexation that must reduce greatly the vital power, but for all that he may possibly survive the ordeal. The grand question is how he will cry back again. The facts of these examples, painful as they are, are not without their use. They indicate that water being admitted into the body, life may go on for periods

far beyond any that might be expected, and they expose altogether the fallacy about the value of alcohol when with large quantities of water it has been administered as a supposed life-sustaining food.

B. W. R.

WATERFOWL[1]

ONE of the principal objects of these lectures being the illustration of the animals exhibited in the Society's Gardens, I have selected for my address to you this day the subject of "Waterfowl," by which I mean the *Anseres*, or family *Anatidæ*, of naturalists, commonly known as ducks, geese, and swans. Three familiar species of domestic birds, the names of which I have just cited, belong to this family, and have been known to us since the times of the Romans, and a fourth, the Muscovy duck, has been added to the series since the discovery of America. Besides these four domestic species nearly all waterfowl show great aptitude for semi-domestication. When pinioned and put in small ponds, and supplied with food and shelter, most of them will thrive, and many of them will breed in captivity.

The acquisition of waterfowl has long been a subject of special interest to this Society. In 1830, in the first list of our animals ever published, I find thirty species of waterfowl included, amongst which are the Orinoco goose, Mandarin duck, and the Cercopsis goose. In 1844 I find twenty-six species included in the catalogue of the animals then living in the Gardens. About that time the thirteenth Earl of Derby, then president of this Society, was the great patron of waterfowl, and, by means of collectors and agents in all parts of the world, brought together in his celebrated menagerie at Knowsley one of the finest collection of these birds ever made. At the disposal of the Knowsley menagerie by auction in 1851, examples of 51 different species of waterfowl were sold, many of which had been bred in the Knowsley Gardens.

Since that period the Zoological Society, having become the possessor of some of the choicest specimens sold at Knowsley, has taken up the subject of waterfowl with increased vigour, and has succeeded in adding considerably to the list of introduced species. During the past twenty years there have been exhibited in the Society's Gardens examples of 86 species of this group of birds, and at the present time the collection consists of not less than 270 individuals, referable to 53 different species, forming, as we believe, the finest living series of these birds now in existence. The zoological gardens of Amsterdam, Antwerp, and Berlin, and the Jardin d'Acclimatation of Paris have also excellent collections of waterfowl, and have succeeded in breeding some species which have obstinately refused to avail themselves of the inducements we have offered them in these Gardens. But in extent and variety I believe our series remains pre-eminent.

The total number of species of the family Anatidæ at present recognised by naturalists is about 175; of these some 94, or more than half, have been at various times represented by specimens held in captivity either in our Gardens or elsewhere, and of the species thus exhibited no less than 50 have paired and produced young.

Of the nine groups or sub-families into which, as will be seen by the Table, the Anatidæ are divisible, the *Anatinæ* or geese, swans, and river-ducks show the greatest aptitude for this kind of semi-domestication. The sea-ducks, lake-ducks, torrent-ducks, and mergansers are much more wild in their nature, and do not thrive nearly so well in confinement. Of the 31 known species of sea-ducks (*Fuligulinæ*) but 13 are known to have been exhibited in zoological gardens, and of these only 5 have reproduced in captivity. None of the lake-ducks (*Erismaturinæ*) or torrent-ducks (*Merganettinæ*) have ever been introduced alive, and none of the Mergansers (*Merginæ*) have been bred in captivity,

Table of Water-fowl

	Species Known.	Exhibited.	Bred.
1. Anseranatinæ	1	1	—
2. Cercopsinæ	1	1	1
3. Anserinæ	38	25	14
4. Cygninæ	10	8	5
5. Anatinæ	75	43	25
6. Fuligulinæ	31	13	5
7. Erismaturinæ	9	—	—
8. Merganettinæ	3	—	—
9. Merginæ	6	3	—
	174	94	50

although examples of three species of the last-named group have been occasionally exhibited.

Of the geese (*Anserinæ*), on the other hand, which number some 38 known species, no less than 25 have been introduced at various times, and of these 14 have reproduced in captivity. Amongst these one of the best introductions effected by the Society is that of the Magellanic or upland goose, of which examples were first received in 1857, presented by Capt. Thomas Moore, at that time Governor of the Falkland Islands, in which settlement, as we know from no less an authority than that of Mr. Darwin, the upland goose is a familiar species. The upland goose commenced to breed with us in 1863, and has continued to do so with tolerable regularity ever since; it has also hybridised in this country with the closely-allied form from Chili, which has been called *Bernicla dispar*, and of which many examples have been received by the Society in recent years.

Besides the upland goose, the allied ruddy-headed and ashy-headed geese of Antarctic America have been acquired and successfully bred. The ruddy-headed goose has unfortunately been lost, and requires reintroduction, but its ashy-headed brother remains a denizen both of these Gardens and also of similar establishments on the Continent.

Passing on to the swans, we find that a still greater degree of success has been obtained in the acclimatisation of these birds. Ten species of swans are recognised by naturalists, of which eight have been introduced into zoological gardens and five have been bred in captivity. Besides the common tame swan which is upon every piece of water, the ponds of our Gardens contain at the present time examples of the hooper, Bewick's swan, trumpeter swan, black swan, and black-necked swan, and but a short time ago we had also examples of the beautiful Coscoroba swan of Antarctic America, remarkable for its coral-red bill. Of all these the most engaging is perhaps the black-necked swan, originally obtained by the late Lord Derby from Chili, and first acquired by this Society at the dispersal of the Knowsley collection in 1851. A pair of these birds first bred with us in 1857, and the species has continued to do so with more or less regularity ever since that date.

The river-ducks (*Anatinæ*), which succeed the swans in the natural series, are the most numerous group of the family. Of the seventy-five known species of river ducks forty-three have been introduced into captivity, and twenty-five have been successfully bred. Of these I will call particular attention to two which have been recently added to the list of introduced species, and are charming representatives of the group.

The rosy-billed duck of South America was first introduced by this Society from Chili in 1867, but only, unfortunately, in the shape of a single male. In 1870, however, we obtained examples of both sexes from the same locality, which began to breed with us in 1873. Since then young ones have been hatched nearly every

[1] Abstract of a "Davis Lecture" given before the Zoological Society of London, July 8, 1880, by P. L. Sclater, F.R.S., Secretary to the Society.

year in the Society's Gardens, and we have been able to supply many of the gardens and collections on the Continent with pairs of this fine species.

Another successful introduction, from a very different quarter of the globe, has been the paradise duck of New Zealand. The so-called paradise duck belongs to the genus *Tadorna*, or shield-drake, and is remarkable, as I believe we were first certainly able to ascertain from our living specimens, for the black head of the male being replaced by a brilliant white in the female. What is still more remarkable however is that in this bird the young in both sexes, contrary to what usually obtains amongst the whole class of birds, have the plumage of the male parent, the female birds putting on the white head only after the first moult. The paradise duck was first obtained by the Society in 1863, when specimens of both sexes were presented to us by Mr. J. G. Tetley; the species first bred in the Gardens in May, 1865, and, assisted by the arrival of subsequent specimens, has continued to do so ever since, so that we have been able to supply many of our friends and correspondents on the Continent with examples of this duck, which may now be considered as firmly established in the gardens of Europe. Amongst other fresh-water ducks which have been successfully acclimatised in the same way within recent years I should also notice the Chiloe widgeon and the Chilian pintail, of Antarctic America, the spotted-billed duck of India, and the Brazilian teal, all of which have of late years bred freely in the Society's Gardens.

I will conclude with a few remarks upon the geographical distribution of the Anatidæ.

In treating of this part of the subject I find it impos-

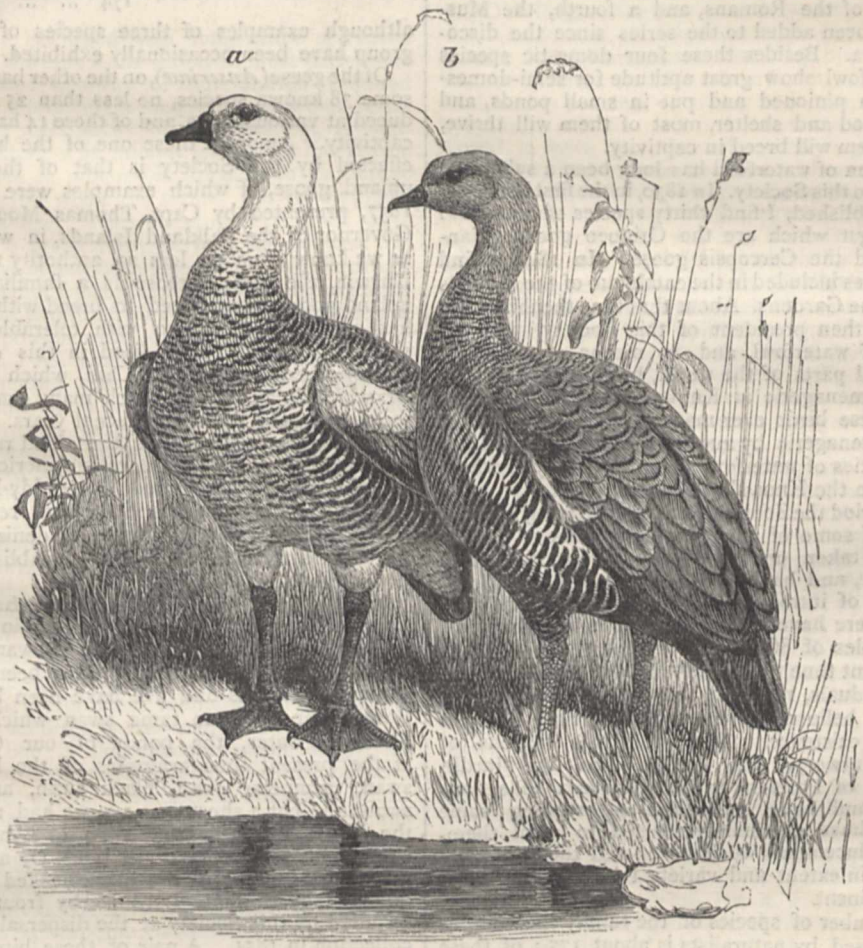


FIG. 1.—Upland Goose.

sible to separate conveniently the Palæarctic and Nearctic species, or those of the northern parts of the Old and New World. So many of the high northern species are circumpolar or common to both continents, and so many other of the Palæarctic species have closely allied (in some cases barely separable) representatives in the Nearctic area, that it is much more natural to unite these categories into one group as "Arctic Anatidæ." Adding to this the other four generally recognised divisions, we shall find the Anatidæ come out, somewhat as follows, in five great geographical groups:—

I. ARCTIC ANATIDÆ.—The Arctic Anatidæ are by far the most numerous of all the five groups, these birds with their thick covering of feathers, and aquatic habits, being naturally adapted to cold and wintry climates. Out of the 38 known species of geese 20, out of the 10 known swans 7, and of the 31 known sea-ducks not less than 26 belong to this category. Of the whole number of 174 generally recognised species of Anatidæ, 77 may, I think, be best set down as Arctic, although some of them, such as *Tadorna rutila*, *Fuligula rufina*, and *Marmaronetta angustirostris*, cannot be strictly so termed, as they inhabit only the temperate portions of the Palæarctic region. Very many of the Palæarctic species also, as will be noted below, go far south in winter and intrude far into the Æthiopian, Indian, and Neotropical regions.

II. ÆTHIOPIAN ANATIDÆ.—Under this head I place only those species that live all the year round, and breed within the Æthiopian region. These are about twenty-two in number.

Amongst these are two generic forms not found elsewhere, *Plectropterus* and *Thalassornis*. Of the nine Anatidæ hitherto registered as met with in Madagascar two species only are peculiar to the island, *Anas melleri* and *A. bernieri*, the remaining seven being also found in Africa.

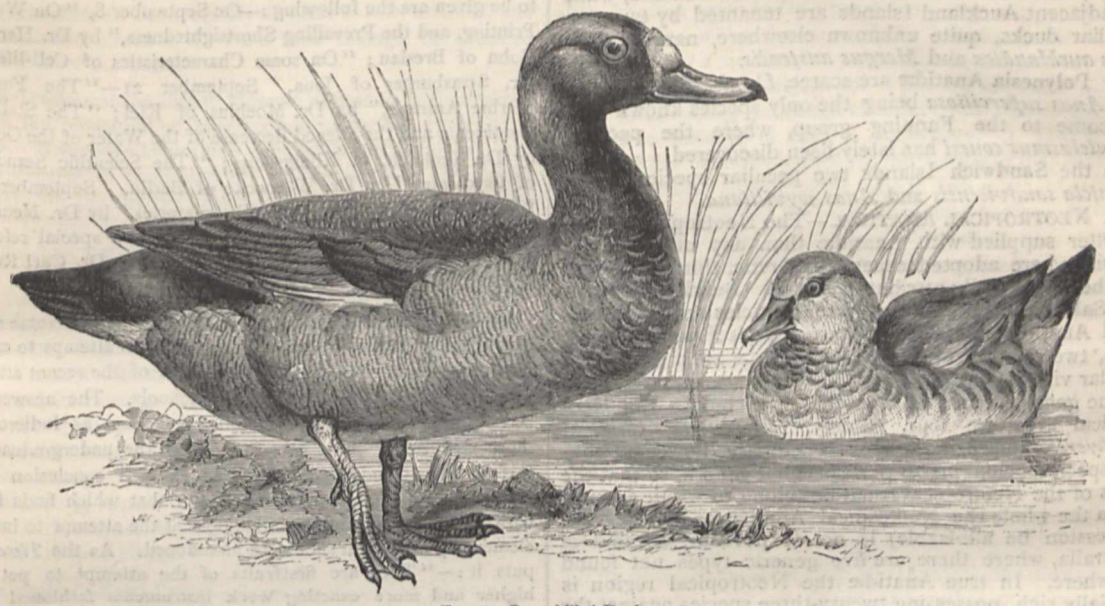


FIG. 2.—Rosy-billed Duck.

In winter, as will be seen by Heuglin's recent works, many of the Palearctic Anatidæ penetrate into Eastern Africa.

III. INDIAN ANATIDÆ.—In this category again I include only species that are permanent inhabitants of some parts of the region. They are not numerous, consisting only of twelve species.

Amongst these there is only one peculiar generic form, *Rhodonessa*.

In winter, however, a host of immigrants from the north invade the Indian region. Jerdon gives us accounts of upwards of twenty northern ducks and geese which are found in various parts of the Indian peninsula in the cold weather.

IV.—AUSTRALIAN ANATIDÆ.—As we advance farther south the Anatidæ commence to increase again. Instead of only twelve native species we find the number in the Australian region running up to twenty-nine. The greater

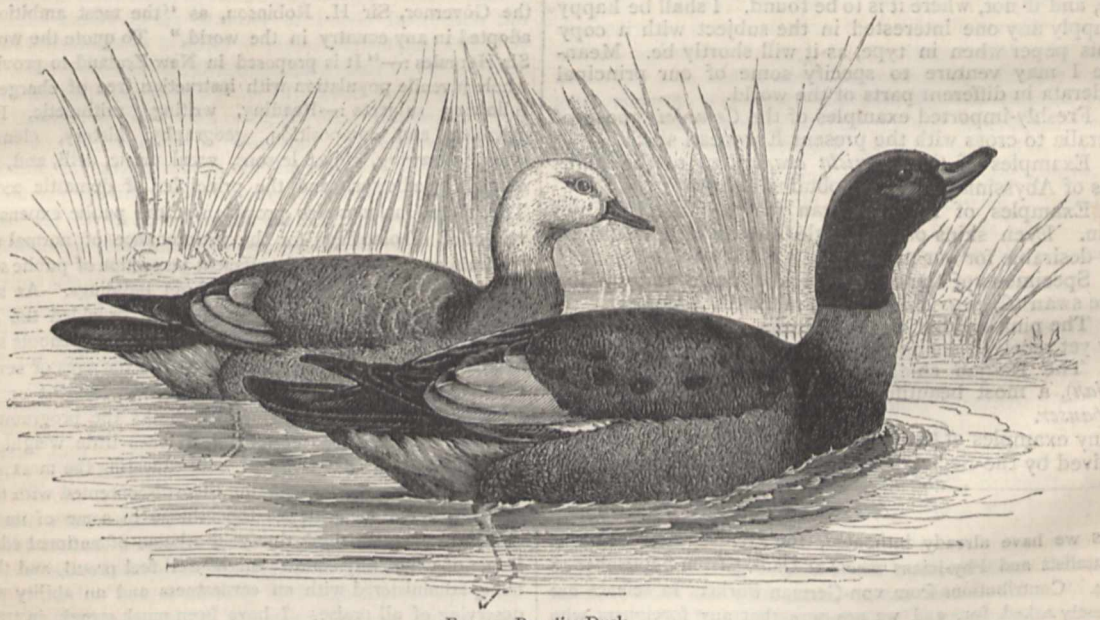


FIG. 3.—Paradise Duck.

number of these are found in Australia itself, that great continent, although so dry and arid, being well supplied with waterfowl.

Among these there are no less than five generic monotypic types peculiar to Australia, namely, *Anseranas*, *Cereopsis*, *Stictonetta*, *Malacorhynchus*, and *Biziura*.

Proceeding to the outlying parts of the Australian region, we find New Zealand also well provided with Anatidæ, nine species being comprehended by Dr. Buller in his lately-published work on the birds of New Zealand, while the adjacent Auckland Islands are tenanted by two very peculiar ducks, quite unknown elsewhere, namely *Nesonetta aucklandica* and *Mergus australis*.

In Polynesia Anatidæ are scarce, *Dendrocygna vagans* and *Anas superciliosa* being the only species known until we come to the Fanning group, where the peculiar *Chaulelasmus couesi* has lately been discovered.

In the Sandwich Islands two peculiar species occur, *Bernicla sandvicensis* and *Anas wyvilliana*.

V. NEOTROPICAL ANATIDÆ.—The Neotropical region is better supplied with Anatidæ than any other of the divisions here adopted except the Arctic, thirty-nine species being specially attributable to it. Besides these, as Mr. Salvin and I have shown in our articles on the Neotropical Anatidæ published in the Society's *Proceedings* for 1876,[1] twenty-three of the Arctic Anatidæ are more or less regular visitants to it during the winter season.

The generic types of Anatidæ restricted to the Neotropical area are four, namely, *Heteronetta*, *Cairina*, *Tachyeres*, and *Merganetta*. There are, however, only six species belonging to these peculiar genera, so that the mass of the Neotropical Anatidæ belong to Arctic forms.

On the whole the Neotropical Anatifauna (if such an expression be allowable) is not so peculiar, as that of Australia, where there are five generic types not found elsewhere. In true Anatidæ the Neotropical region is specially rich, possessing twenty-three species against the Arctic eighteen.

In *Fuligulinæ*, on the other hand, it is very poor, having only one species against the Arctic twenty-six.

In concluding my lecture I would venture to urge those who have friends and correspondents abroad, or who are so fortunate as to travel themselves, not to let any opportunity pass of adding to the Society's living collection of Waterfowl. In a paper recently read before the Zoological Society I have given a complete list of the known species of these beautiful birds, and an exact account of the introduction of each species that has been obtained alive, and if not, where it is to be found. I shall be happy to supply any one interested in the subject with a copy of this paper when in type, as it will shortly be. Meanwhile I may venture to specify some of our principal desiderata in different parts of the world.

1. Freshly-imported examples of the *Cereopsis* goose of Australia to cross with the present European stock.

2. Examples of the *Bernicla cyanoptera* of the highlands of Abyssinia, never yet obtained alive.

3. Examples of David's swan (*Cygnus davidi*) from Pekin. Even skins of this little known bird would be very desirable for our museums.

4. Specimens of the canvas-backed duck and smaller white swan (*Cygnus americanus*) of North America.

5. The pink-headed duck of India, of which we have only yet received a single pair in 1874.

6. The Radjah shieldrake of Queensland (*Tadorna radjah*), a most beautiful species allied to our *Tadorna vulpanser*.

Any examples of these species would be most gratefully received by the Society for their living collection.

NOTES

As we have already intimated, the German Association of Naturalists and Physicians meets at Danzig from September 18 to 24. Contributions from non-German workers in science are earnestly asked for, and we are sure that any foreigners who desire to be present at the meeting will receive a hearty welcome. Applications for quarters should be made before September 10 to Herr L. Biber, Brodbänkengasse 13, Danzig. Besides the usual excursions, concerts, and other social gatherings which the Germans know how to manage so well, there will be plenty of work in the twenty-three sections. Among the public lectures to be given are the following:—On September 8, "On Writing, Printing, and the Prevailing Shortsightedness," by Dr. Hermann Cohn of Breslau; "On some Characteristics of Cell-life," by Dr. Strasburger of Jena. September 21—"The Food of Marine Animals," by Dr. Moebius of Kiel; "The Statics of Continents and the alleged decrease of the Water of the Ocean," by Dr. Jentzsch, of Königsberg; "The Scientific Standpoint of Psychiatry," by Dr. Wernecke of Berlin. September 24—"Polar Expeditions or Polar Observatories," by Dr. Neumayer of Hamburg; "Foreign Domestic Birds, with special reference to the scientific results of their Breeding," by Dr. Carl Russ of Steglitz.

MUCH capital is being made out of the reports of some of the inspectors in the new Education Report, who attempt to enliven their pages by giving some of the results of the recent attempts at higher education in elementary schools. The answers are certainly ludicrous enough sometimes, almost as ludicrous as those said to be given occasionally by the undergraduates of Oxford and Cambridge. But the rational conclusion to be drawn from this state of things is not that which finds favour with Lord Norton and his friends, that the attempt to improve elementary education should be abandoned. As the *Times* well puts it:—"They are firstfruits of the attempt to put to a higher and more exacting work instruments fashioned for a lower and a simpler one. All such results are at first necessarily imperfect, and nothing is easier than to make them appear ridiculous. The true remedy, however, is not to reject the instruments, but to adapt them, or give them the means of adapting themselves, to the higher function." If science is to be taught in elementary schools, let it be taught in a proper manner by properly trained men.

EVIDENTLY the Government of New Zealand have no fear of over-educating the people. From the *Colonies* we learn that the New Zealand system of education has been characterised by the Governor, Sir H. Robinson, as "the most ambitious yet adopted in any country in the world." To quote the words of Sir Hercules:—"It is proposed in New Zealand to provide the whole juvenile population with instruction free of charge in the following subjects:—Reading, writing, arithmetic, English grammar and composition, geography, history, elementary science, drawing, object lessons, vocal music, drill, and, in case of girls, needlework and the principles of domestic economy. The scheme includes also provision at the public expense for a system of scholarships, for the maintenance of normal schools for training teachers, for the efficient inspection of public schools, and for the erection of suitable school buildings. As soon as sufficient school accommodation has been provided the Education Act contemplates that attendance at public schools shall be made compulsory on all children between the ages of seven and thirteen who may not be otherwise under efficient or regular instruction." While Sir Hercules thinks the programme may be too varied and too costly, he attaches little weight to the objection that there is a risk of over-educating the masses above their occupations and so making them discontented with their lot in life. While he criticises the scheme in some of its details, still he says:—"I think that your scheme of national education is one of which any country might well feel proud, and that it is being administered with an earnestness and an ability which is deserving of all praise. I have been much struck, in travelling about the country, with the deep interest which is universally taken in this most important question, and with the determination which pervades the whole community that the blessings of education shall for the future be placed within the reach of all.

[1] Revision of the Neotropical Anatidæ, *Proc. Zool. Soc.*, 1876, p. 358.

With such a healthy, vigorous motive power, supervised and directed with so much intelligence, any defects in the driving gear of the machinery will soon be detected and corrected, until the object which all have equally at heart is fully attained, and New Zealand is placed in the front rank amongst the educated communities of the world."

THE Trustees of the British Museum appear to be determined to earn the reputation of hopeless incapacity for appreciating science. Everybody knows how completely successful has been the experiment of furnishing the reading-room of the British Museum with the electric light, and what an impetus this has given to the use of the British Museum Library. A few days ago a question was asked in the House of Commons by Mr. D. Grant, whether the Trustees were prepared to make arrangements for lighting the building so that the scientific collections and other portions of it might remain open to the public until 10 p.m. The answer returned by Mr. Walpole on behalf of the Trustees was unsatisfactory enough. The use of gas would be deleterious to sculptures and books; and experience would not "justify" a more extended use of the electric light in the exhibition-rooms and long galleries. The body of Trustees, though they may be admirable custodians of the national library, appear to have the most limited and provincial notions with respect to the scientific collections which are committed to their charge.

THE ways of official French science are somewhat inscrutable. Some months ago we notified our readers that the *prix Volta*, instituted by Napoleon, had been awarded to Graham Bell for the articulating telephone. It appears that this award was made in accordance with the report of a commission appointed in 1876, of which M. Dumas was president and M. Becquerel secretary, the Commission being unanimous in their award. In their report they also mentioned with high approval the names of M. Gramme, the inventor of the Gramme machines, M. Gaston Planté, whose researches on secondary batteries, &c., are now so well known, and Dr. Onimus, who has done much to advance our knowledge of electro-physiology. But in passing through the hands of the Minister of Public Instruction this report was manipulated in order to please the national vanity by lifting up the claims of M. Gramme above those of MM. Planté and Onimus, and eventually a grant of 70,000 francs was voted by the Chamber, 50,000 francs being the prize awarded to Prof. Bell, and 20,000 francs to M. Gramme. No one will grudge M. Gramme his prize, though we cannot help thinking that this secondary award will give rise to invidious comparisons of claims, for M. Gramme is not the first nor yet the last in the field amongst electrical engineers and inventors.

THE fund established by the Birmingham Philosophical Society for the endowment of scientific research now amounts to 820*l.*, which will be invested, the interest only to be used. The subscription list amounts to over 80*l.* a year. A donation of 25*l.* has been received from Mr. Charles Darwin, who, in a letter received from him by Mr. Lawson Tait, a member of the council of the Society, says:—"I saw something in the newspapers about the fund, and admire greatly the noble spirit of Birmingham."

WE have often referred to the enterprise of the Midland Union of Natural History Societies, and now they have gone in for the encouragement, if not the endowment, of original research. The Council, at the last annual meeting at Northampton, submitted for consideration a proposal to the effect that an annual prize should be provided for the purpose of recognising and encouraging original research by members of the societies in the Union. After careful consideration by the committee at a meeting held at Birmingham on July 15, the following scheme was adopted:—1. That a prize (by permission of Mr. Ch. Darwin, F.R.S., to be called "The Darwin Prize") of the value of 10*l.*, to include a gold or bronze "Darwin Medal," at the option of the successful candidate, be given annually for a paper indicating original research upon a subject within the scope of the societies in the Union, contributed by a member for publication in the journal of the Union. 2. That the subjects for "The Darwin Prize" for the three years ensuing be limited as under:—In 1881 to Geology, in 1882 to Biology, in 1883 to Archæology. 3. That a committee of five, annually elected for the purpose by the Committee of Management, adjudicate the prize to such paper, of sufficient merit, on the subject of the year, contributed as aforesaid to the journal of the Union (the *Midland Naturalist*), either actually published or sent in for publication during the twelve months preceding March 31 of that year, and declare the adjudication at the annual meeting. 4. That right be reserved for the adjudicators to withhold the prize if in their opinion no contribution has been sent in of sufficient merit. The scheme is a happy one, and might with great advantage be adopted by other groups of societies all over the kingdom. Mr. Darwin, in giving permission for the use of his name in connection with the medal, says: "It is particularly pleasing to me to have my name connected, in however indirect a manner, with a scheme for advancing science—the study of which has been my chief source of happiness throughout life."

THE death is announced of M. Lissajous, the discoverer of the well-known Lissajous figures, and author of a number of elegant and valuable scientific memoirs. M. Lissajous, who was Professor of Physics at Toulouse, was one of the founders of the Société Française de Physique.

A COMMITTEE has been formed to erect a statue to the late Dr. Broca by public subscription.

WE have received the following details with reference to the career of the late Mr. W. A. Lloyd:—Born in Wales, he early developed a taste for study, and in his early years went deeply into such subjects as archæology, numismatics, and heraldry. In 1852 he turned his mind to natural history, especially as regards marine life. The first really successful marine aquarium was that at Hamburg, which was wholly devised by him, and in which the circulating principle was the great element of success. In 1870 he was engaged by the Crystal Palace Company to construct and superintend the fine aquarium there, which, although not large, is probably one of the best existing. His reputation spread, and he was consulted for almost every new aquarium that was projected. Besides his practical knowledge of the aquarium, he was a man of very considerable culture, and contributed largely to the literature of the subject. At the time of his death he was engaged on a work comprising all his life-long experience, which unfortunately he has not completed. His death, at the age of fifty-six (July 13), was the result of effusion of blood on the brain, and took place at his study table, where he was at work. Mr. Lloyd was connected with aquaria at Paris, Vienna, Dresden, Frankfort, Naples, New York, San Francisco, Melbourne, Adelaide, Calcutta, Rhyl, Yarmouth, Tynemouth, Nottingham, Morecambe, Edinburgh, Westminster, Southport, Rothesay, Aston, and possessed the only medals (gold, silver, and bronze) ever awarded for aquaria.

THE Committee of Council of the British Medical Association have awarded the gold medal of the Association to William Farr, C.B., M.D., F.R.S., D.C.L., "as an expression of their high appreciation of his long, unwearied, and successful labours in behalf of statistical and sanitary science; as a recognition of the light he has thrown upon many physiological and pathological problems; and on account of the extraordinary services

his work has rendered to the advancement of the health of the nation." The presentation will be made in the Senate House, Cambridge, on Thursday, August 12, at half-past twelve in the afternoon.

THE French Parliament has voted a sum of 300,000 francs for purchasing from the City of Paris the grounds which had been rented for a nominal sum to M. Leverrier by the Municipal Council, and had been already annexed by the great astronomer to the Observatory. The reason for this resolution is the impending erection of a new monument, which, according to the provision of the French law, cannot be built except on ground the freehold of which belongs to the Government.

THE first of the great annual Congresses, that of the Archæological Institute, commenced proceedings at Lincoln on Tuesday.

THE summer meeting of the Institution of Mechanical Engineers will be held at Barrow-in-Furness from Tuesday to Friday next week. A number of technical papers will be read, and several interesting excursions have been arranged for.

SIR W. HARCOURT stated in the House of Commons on Thursday that the Commissioners on Explosions in Coal Mines hoped to make their report at the end of the present or beginning of next year.

THE first annual meeting in connection with the Parkes Museum of Hygiene was held at the Mansion House on Tuesday, when a number of eminent medical men were present. The Museum has so expanded that a building specially designed for it has become necessary. It has attracted a considerable number of visitors, and during the past winter a series of demonstrations have been given by members of the executive committee. The various speakers testified to the great educational value of such a museum, and the absolute necessity for all classes to know something about sanitary science.

THE Council of Public Hygiene of Paris, on the proposition of M. Pasteur, has decided to erect two establishments, one at each end of Paris, intended for the disinfection by steam of all furniture or clothing contaminated by individuals attacked by any contagious diseases.

AN official despatch from Manila of the 20th inst., giving some additional particulars of the earthquake, states that the first shock lasted seventy seconds, and that nine of the native inhabitants were killed and eleven others injured. A second shock, lasting forty seconds, occurred at four o'clock in the afternoon. At Leguno and Rabacan some of the public buildings were also thrown down. The earth opened in several places, and jets of boiling water and showers of ashes were ejected from the fissures. Another shock is stated to have occurred on the evening of the 24th. Other accounts received state that the period of seismic disturbance commenced on the 13th inst., and that repeated shocks have occurred since then, those of the 13th and 20th inst. being the most violent. The cathedral and the barracks at Manila have fallen in, and the troops are now encamped outside the city. Almost all the volcanoes of the island of Luzon are in full activity.

A SHARP shock of earthquake occurred at Naples at 3.30 on Sunday morning, preceded by lighter shocks at regular intervals, beginning at 9.30 the previous night. The principal shock was undulatory from east to west, lasting five seconds, and was sufficiently strong to awake all the inhabitants of Portici. Vesuvius shows increased activity. Several new fissures have opened, sending lava streams eastwards.

THE Epping Forest and County of Essex Naturalists' Field Club held a meeting at Ilford last Saturday for the purpose of visiting the well-known pits which have yielded such a rich harvest of Post-glacial mammals, &c. A well-preserved jaw of *Bos primigenius* was exhumed in the presence of the members. The zoology of the period and the geology of the district were respectively treated of by Sir Antonio Brady and Mr. Henry Walker, the conductors for the occasion. After spending some time in the pits the meeting adjourned for tea to the "Angel Inn." The president announced that as the result of the Field Meeting at the ancient earthworks in Epping Forest (already noticed in these columns) it was decided, in accordance with a suggestion made by Major-General Pitt-Rivers, to apply for permission to excavate in one or both of the camps, and to start a fund for this purpose. As the period of these camps was quite unknown, this would be the only method of arriving at any definite conclusion concerning them. A discussion upon the results of the afternoon's excursion then took place. Sir Antonio Brady brought for exhibition a large number of specimens from his valuable collection of Palæolithic and Neolithic remains; and remarks of great scientific interest were made by Mr. A. R. Wallace, Mr. Worthington Smith, &c. The Club appears to be in a flourishing condition, as it already numbers over 200 members.

M. GAUTHIER VILLARS is publishing, at the expense of the Laplace family, a new edition of the works of the illustrious astronomer. The reason of this republication is very singular. The widow of the Marquis de Laplace bequeathed a certain sum of money to the Academy in order to deliver every year a copy of the works of her husband to the youth who obtains the first rank in the leaving examinations at the Polytechnic School. But latterly it has become almost impossible to find these volumes in the trade. M. Gauthier Villars and executors *in perpetuo* are obliged to deliver gratis a copy every year to the Academy.

PROF. CHURCH was lecturing last week at the Cirencester Agricultural College on "Some Recent Advances in Agricultural Chemistry."

A FRENCH journal states that the first astronomical instruments intended for a great astronomical observatory, to be established at the Trocadéro, have been recently mounted on the first terrace of the east tower of the palace.

ON August 8 the pupils of all the schools of the Arts et Métiers of France meet at Liancourt to celebrate the 100th anniversary of the foundation by the Duc de la Rochefoucault-Liancourt of the first establishment of this kind at his private residence. There are four of these useful schools—Aix, Angers, Chalons, and Cluses—in existence in France, and one in Algeria, of very recent creation, at Delhys. It is said that each of the two provinces of Oran and Constantine will establish, at their own expense, a similar institution.

THE President of the Republic has conferred a knighthood in the Legion of Honour on M. Serrin, the inventor of the first regulator which could be used in lighthouses; and on M. Gariel, the general secretary of the French Association for the Advancement of Science, who will lecture on Radiant Matter at Rheims in the forthcoming session.

"TASMANIAN Friends and Foes, Feathered, Furred, and Finned," is the title of a work, illustrated by woodcuts and coloured plates, upon the Natural History of Tasmania, to be issued this autumn by Messrs. Marcus Ward and Co. The volume is from the pen of Mrs. L. A. Meredith, the author of several well-known works upon this colony, and gives in a popular style accounts of the kangaroos, bandicoots, wombats, and other marsupials, the birds and fishes. Several of the species described the author believes to be new to science, and the marvellous intelligence displayed by some of these lowly-

classified mammals when kept by the author as household pets will be both new and interesting to English readers.

THE additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. Fred Peake, F.Z.S.; a Great Eagle Owl (*Bubo maximus*) from Nyland, South Finland, presented by Mr. Lindsay von Julin; two Ocellated Turkeys (*Meleagris ocellata*) from Yucatan, Mexico, presented by Mr. W. E. Sibeth; a Crimson-crowned Weaver Bird (*Euplectes flammiceps*), two Red-backed Pelicans (*Pelecanus rufescens*) from West Africa, two Common Blue Birds (*Sialia wilsonii*) from North America, two Great Eagle Owls (*Bubo maximus*) from India, five Four-rayed Snakes (*Elaphis quater-radiatus*), a Black-spotted Snake (*Elaphis dione*), a Lacertine Snake (*Cælopeltis lacertina*), four Dahl's Snakes (*Zamenis dahli*), thirteen Vivacious Snakes (*Tachymenis vivax*), a Four-lined Snake (*Coluber quadrilineatus—var. leopardinus*), South European, deposited; five Australian Wild Ducks (*Anas superciliosa*), three Garganey Teal (*Querquedula circia*), three Common Teal (*Querquedula crecca*), two Horned Tragopans (*Ceriornis satyra*), a Peacock Pheasant (*Polyplectron chinquis*) a Bronze-winged Pigeon (*Phaps chalcoptera*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

FAYE'S COMET.—The following ephemeris of this comet is for Berlin midnight, and is calculated from elements accurately perturbed to the approaching perihelion passage, which were communicated by Dr. Axel Möller to the Academy of Sciences at Stockholm in September, 1878:—

	R.A. h. m. s.	Decl. N. ° ′	Log. dist. from Earth.
Aug. 1 ...	23 16 14 ...	10 35·5 ...	0·1859
3 ...	— 16 16 ...	10 40·3 ...	0·1784
5 ...	— 16 12 ...	10 44·3 ...	0·1709
7 ...	— 16 3 ...	10 47·2 ...	0·1635
9 ...	— 15 48 ...	10 49·2 ...	0·1562
11 ...	— 15 28 ...	10 50·2 ...	0·1490
13 ...	— 15 3 ...	10 50·1 ...	0·1419
15 ...	— 14 33 ...	10 48·9 ...	0·1349
17 ...	— 13 57 ...	10 46·6 ...	0·1280
19 ...	— 13 17 ...	10 43·2 ...	0·1213
21 ...	— 12 31 ...	10 38·6 ...	0·1147
23 ...	— 11 42 ...	10 32·8 ...	0·1083
25 ...	— 10 47 ...	10 25·8 ...	0·1021
27 ...	— 9 49 ...	10 17·5 ...	0·0961
29 ...	— 8 47 ...	10 8·0 ...	0·0903
31 ...	23 7 41 ...	9 57·3 ...	0·0847

The theoretical intensity of light at the end of the month will be twice as great as at the beginning, when it somewhat exceeds that corresponding to the last observation at Pulkowa in March, 1866. At the return in 1873 the comet was observed on four nights only at Marseilles and at Clinton, New York; the admirable calculations of Dr. Axel Möller gave positions which exhibited hardly appreciable differences from the observations. In the present year it will be nearest to the earth on October 3 (distance = 1·09), and perhaps most favourably circumstanced for observation during the last ten days of the same month, though at no time does the intensity of light exceed its value on October 16, 1858, when the comet was last observed at that appearance with the 10-inch Berlin refractor. The perihelion passage does not take place until January 22, 1881, and although Dr. Axel Möller's ephemeris does not extend beyond the end of the present year, it appears possible that the comet may be observed till quite the end of next February, when its place will still be commanded on a dark sky-ground, or perhaps later; indeed, on April 26, when the comet sets three hours after the sun, its intensity of light is equal to that at the last observation at Pulkowa in 1844.

THE OBSERVATORY, CHICAGO.—The "Annual Report of the Board of Directors of the Chicago Astronomical Society, together with the Report of the Director of the Dearborn Observatory," dated May 13, 1880, is before us. During the preceding year the Observatory had been in charge of Prof. G. W. Hough, formerly of the Dudley Observatory, Albany, Prof. Colbert and Mr. S. W. Burnham taking part in the regular work with the 18½-inch Alvan-Clark refractor. Mr. Burnham's attention, as in previous years, was chiefly directed to the measurement of double stars, including the more interesting binary systems and objects beyond the scope of smaller instruments. A series of observations of the planet Jupiter was commenced on August 27, 1879, and continued on every fine night till February 11. With a magnifying power of 638 the disk was measured on eight nights by Prof. Hough, and six by Prof. Colbert, the resulting values for ellipticity being respectively 1-16·23 and 1-16·73, sensibly smaller than Struve's value, though not differing much from other more recent determinations. The measures further showed "the figure of Jupiter's disk to be a true geometrical spheroid." The belt system during the opposition of 1879 is indicated by the following numbers, the equatorial diameter at the planet's mean distance being 38″·70, and the polar diameter 36″·32.

No. 1 ...	+ 1″·10		
,, 2 ...	+ 9·78		
,, 3 ...	+ 5·98		
,, 4 ...	+ 2·59	N. edge of equat. belt.	
,, — ...	− 3·18	S. edge of equat. belt.	
No. 5 ...	− 5″·83		
,, — ...	− 6·94	Red spot.	
,, 6 ...	− 9·83		
,, 7 ...	−13·84		

An examination of which shows that the belts were symmetrically arranged on either side of the equator, the large red spot coinciding nearly with belt (5). Prof. Hough remarks that the faint belts are not seen with small instruments, in which there is merely a darkening towards the poles. The middle of the great equatorial belt was subject to gradual change in its appearance between September 1 and November 1. At first it was made up essentially of three separate belts, approximately of equal width; gradually it formed in two nearly equal portions with a rift extending through a large part of the planet's circumference. The colour of the equatorial belt was reddish-brown—brick colour.

The red spot was studied from September 3 to February 10. Its colour was similar to that of the equatorial belt, but brighter, and appeared sensibly the same when only partially on the disk as when on the centre. The mean value of its length at the centre of the disk was 12″·73, and its breadth 3″·56, for Jupiter's mean distance; the length appeared to vary to the extent of two seconds, and the breadth about the same amount, but owing to the irregular outline of the object it was difficult to decide whether actual change took place, or whether the discordances in the measures were due to indifferent vision. By observations extending from September 25 to February 10 the time of sidereal rotation was found by Prof. Colbert to be 9h. 55m. 34·2s. The diameters of the satellites were measured on three nights with the following results for the planet's mean distance:—

I. 1″·114 ... II. 0″·980 ... III. 1″·778 ... IV. 1″·457

Prof. Hough states that the two interior satellites of Uranus reported by the Washington observers to be "the most difficult well-known objects in the heavens" can be "readily seen and measured under ordinary atmospheric conditions" with the Chicago refractor: micrometrical observations of *Ariel* were obtained on four nights, *Umbriel* appears to have been measured on one night only, but the weather was unusually adverse to this class of observations.

PHYSICAL NOTES

A SINGULAR phenomenon was seen (according to the *New York World*) recently off the coast of Florida by the officers of the brigantine *Fortunate*. Shortly after dark two columns of fire appeared, seemingly a mile away. They were fifty yards apart and about 500 feet high, arching towards one another at the top, but without meeting. They were of a dull red colour, without sparks; but the arching portions emitted tremulous rays or streamers of light like those of the aurora. They were visible all night, but faded at daybreak. The weather was fine, not a cloud being seen all night. The following day there was a gale of wind accompanied by thunder, but no rain. It is not stated in what quarter of the heavens the appearance was seen. Could it have been an *aurora?*

M. MARCEL DEPREZ, the ingenious inventor of many pieces of electrical apparatus, has just brought out a new electric motor, in which a piston of soft iron is attracted up and down in a hollow cylindrical electro-magnetic coil with a motion like that of an

ordinary steam-engine piston. This principle is not new, having been employed by Page, Bourbouze, and Du Moncel in the construction of electro-motors. The novel point however about the motor of M. Deprez is that the magnetism of the soft iron core is never either reversed or interrupted. This was the weak point of the earlier machines, but it has been obviated in the new form by the device of dividing the solenoidal coil into sections like the separate coils of the ring-armature of the Gramme machine, the current being thus transmitted first to one part of the cylindrical coil and then to another. The commutator which distributes the current successively to the various sections is worked by an excentric on the shaft of the fly-wheel in the ordinary way, but the "lead" does not require to be so much as a quarter of a revolution.

THE phenomena of explosion of bombs by freezing of water (once studied by Major Williams at Quebec) have been further elucidated by Prof. Hagenbach of Bâle (*Archives des Sciences*, June 15), who exposed, last winter, two iron bombs 15 ctm. exterior diameter and 2·2 ctm. thickness, filled with water and closed by screw stoppers, at temperatures descending to $-20°$. One bomb, placed out early in the afternoon, burst next morning about 7; the other, exposed about 10 a.m., exploded about 9 p.m. In the latter case the stopper was violently projected to a distance and could nowhere be found (the spotless snow around would have soon revealed its position, if anywhere near). Some parts of the screw thread were detached; there were several fissures round the orifice, and a cylinder of striated ice was forced out, having an irregular top and a curious upward-curved filament of ice attached, narrowing from 9 mm. to 3 mm. diameter, and flattened on its upper concave surface. It is thought a little water in suspension got out by the first opening in the screw, flowed down the bomb, and froze; its freezing provoked crystallisation of the whole mass, and the stopper was expelled, the ice following and lifting the attached frozen vein. A little later some water within the expelled cylinder probably froze and burst the top of this cylinder into four pieces, which twisted like petals, causing the filament to turn upwards. The other case was perhaps even more curious. The stopper was not thrown out, but the bomb burst, a triangular piece next the stopper being raised. A round filament curving downwards was here found attached to the protruded ice, and it had some sixteen enlargements or nodes, equidistant 7 mm. The initial jet of water had probably come out with high velocity and straight course, and been solidified, afterwards curving down by the action of gravity. The nodes were doubtless due to the vibratory motion observed in liquid veins.

IN a recent paper to the Vienna Academy (June 10), Prof. Reitlinger and Dr. Wächter throw some new light on the nature of "electrical ring-figures." They consider these to arise from two causes not clearly perceived before; first, a disruption of the metal, with projection of solid, fused, and vaporised particles from it by positive electric potential alone; and second, an electro-chemical decomposition of aqueous vapour present in the atmosphere in which the figures are produced, between point and plate. To the first-named cause is due the *disruption disk* (*Aufreissungscheibe*) in the centre of positive or mixed figures, and appearing oxidised in air, but metal-bright in hydrogen (it affords a new mode of distinguishing positive electricity from negative). With a strong spark (from a Ruhmkorff strengthened with a Leyden jar) the authors got *dispersion and condensation rings* round the disk, presenting various metallic colourings in dry hydrogen. To the second cause (electro-chemical decomposition of water-vapour) are attributed the various-coloured *oxide rings*, giving the ring-figures observed by Priestley, Nobili, Grove, Riess, &c., and Peterin's *bright disks*. The former occur where positive, the latter where negative, electricity passes from the plate into the air. Thus all the ring-figures observed consist of four "form-elements," viz. (1) central disruption-disks; (2) oxide rings; (3) bright disks; and (4) dispersion and condensation rings. It is further found that all these kinds can be altered in form by a magnet.

ACCORDING to the dynamical theory of gases it is probable that the exponent characterising the relation of the coefficient of diffusion to the absolute temperature is higher by unity than in the case of coefficients of internal friction. This has been fully confirmed by experiments of Herr v. Obermayer (*Wien. Akad. Anz.*, May 7), which give, for permanent gases, approximately $1\frac{3}{4}$, for coercible 2 (the lower exponents being $\frac{3}{4}$ and 1). The experiments extended over too few gas-mixtures to determine how the exponent is affected when a coercible and a permanent gas diffuse into each other.

DON EDUARDO LOZANO of Teruel, Spain, has lately published a modest little volume of ninety pages, entitled "Estudios Fisicos," in which some of the more recent advances in physical science are explained in an easy and popular form. Amongst the topics are the blue of the sky, the mechanical equivalent of heat, atmospheric electricity, &c. It is interesting to observe such signs of a revival of interest in the physical sciences in Spain. It is somewhat of a novelty to find the names of Mayer, Hirn, Wells, Dove, and Tyndall in a Spanish treatise; and we draw a good augury from this sign that these names have already penetrated into a country where science has unfortunately been so long at a low ebb.

A BUNSEN burner of modified form has been contrived by M. Terquem which promises to be well adapted for spectrum work and for producing monochromatic light. Instead of the usual two lateral apertures to admit air, the air is allowed to penetrate between the foot of the lamp and the base of the vertical tube, which is for this purpose raised 6 or 7 millims. above the solid foot. The top of the tube is divided into four by a couple of vertical partitions, so that instead of the usual central cone in the flame there are four cones. It is claimed for this flame that it is more solid, and that the temperatures throughout the different parts of the flame are more nearly equal than in the usual Bunsen burner. To procure monochromatic light it suffices to place a small fused bead of sodic chloride between the four central cones of flame.

FOLLOWING out his recent discovery that the prolonged action of the actinic rays upon a sensitised photographic plate produces a reversal of effects, M. Janssen has obtained some interesting results. He has by direct exposure taken a positive photograph of the sun 10 centims. in diameter, showing the spots in their usual dusky tints. He has, after exposures varying from one hour to three hours, obtained perfect positives of landscapes. A view of the park of Meudon thus photographed shows the sun as a white round spot upon a dark sky. Moreover, from such positives other positives can be printed by prolonged exposure; and it is now possible to obtain negative prints of negatives by the same simple expedient. M. Janssen promises at an early date a complete and searching memoir on the whole subject of photography in relation to the different rays of the spectrum.

AN electrical stone-breaker is the latest American invention. A dynamo-electric machine furnishes the power to an electro-magnetic chopper capable of delivering from 1,000 to 2,000 blows per minute. Stone-breaking requires the exertion of very great forces through very small distances, in fact precisely the kind of work for which electro-magnetic machines on a large scale might be expected to be successful, if only the cost of generating the electricity were not so serious.

IN a recent valuable paper on the thermal and optical behaviour of gases under the influence of electric discharges (*Wied. Ann.*, No. 6), Herr E. Wiedemann first studies the thermal phenomena in the case of discharges of the influence-machine, and indicates a different behaviour of the positive and the negative electricity. He then describes an experimental attempt at numerical determination of the quantities which produce a change of the band-spectrum of hydrogen into the line-spectrum. He further investigates the nature of the discharge from the negative electrode in greatly rarefied space. Then he discusses the applicability of other electrical sources, inductoria, large galvanic batteries, and Leyden jars, to spectrum-analytical researches, also the continuous and discontinuous discharges in gases. The paper concludes with theoretical considerations as to the phenomena of discharge in gases and the nature of spectra.

THE known abnormal variation of density of mixtures of acetic acid and water suggested to Herr v. Reiss (*Wied. Ann.*, No. 6) a means of ascertaining whether there were any perceptible relation between the densities and specific heats. He finds that, unlike solid bodies, those mixtures show in general, with increase of density, a proportional increase of specific heat.

AN example of anomalous dispersion by a glowing vapour, viz., that of sodium, has been recently observed by Herr Kundt (*Wied. Ann.*, No. 6). He was preparing for a lecture the well-known experiment of reversal of the sodium line, and per-

ceived that when the absorbent sodium-vapour was very dense and the dark line very broad a peculiar bend outwards appeared in the spectrum at the ends, and on opposite sides, of the line. The cone of sodium vapour in the Bunsen flame acts as a prism with upward horizontal refracting edges. If glowing sodium vapour give dispersion, this cone should give, with horizontal rays passing through it, a vertical (though necessarily impure) spectrum; and if the rays have also passed through a glass prism with horizontal refracting angle, a spectrum of the form above described should be got. From the position, the refractive index of the vapour is greatest for those rays which are most deflected downwards. In agreement with the author's researches on solid bodies and liquids, the refractive index increases greatly as you approach the band from the red side, is less on the green side than on the other, and then quickly increases again. If an actual prism of glowing sodium vapour could be produced, one might observe, even with little thickness of vapour, indications of anomalous dispersion in the narrow absorption lines. Herr Kundt's attempts, however, to change the cone-shaped flame, by means of lateral plates of glass or mica, to a prismatic one, led to nothing.

In a recent paper on the theory of inconstant galvanic elements (*Wied. Ann.*, No. 6) Herr Exner contends that the so-called galvanic polarisation in elements has no existence. The distinction between a Daniell and a Smee element is merely quantitative, not qualitative. What does he mean?

GEOGRAPHICAL NOTES

We understand that a letter was received in London last Saturday from a member of one of the Belgian Expeditions in Central Africa, stating that he had met Mr. Thomson, with the African Exploration Fund's Expedition, on May 18, at a place some ten days' march from Simba's, so that the party had evidently found it necessary to return to the coast by the caravan route to Bagamoyo or Saadani instead of following the original plan of coming out at Kilwa. It is probable that the change of route was necessitated by civil wars among the native tribes. Mr. Thomson has thus had an opportunity, not contemplated at the outset, of passing through a considerable tract of unknown country between the south-east of Lake Tanganyika and Unyanyembe, and it is satisfactory to know that in so doing he has been able to visit Lake Hikwa and settle its proper position, which has been a puzzle to geographers for some time. In a map accompanying the account of Mr. H. B. Cotterill's journey with the late Capt. Elton northwards from the head of Lake Nyassa, this lake is placed with dotted lines in a position which is probably a good deal too much to the south and east of its true locality. The letter above referred to added that Mr. Thomson was in excellent health, and that he claimed to have traversed 2,000 miles of unknown country in the twelve months he had then been on the march. A telegram from H.M.'s Consul-General at Zanzibar, dated July 17, announces the safe return of Mr. Thomson and his party.

Mr. Alfred Rabaud, president of the Marseilles Geographical Society, has just published (Marseilles: Barlatier-Prissat) a *brochure* entitled "L'Abbé Debaise et sa Mission géographique et scientifique dans l'Afrique centrale," which is accompanied by a photograph of the deceased traveller.

Prof. R. J. Veth, president of the Dutch Geographical Society, has just issued in Italian (Turin: Guido Cora), "Notizia de Selajar et Isole Adiacenti," which is illustrated by an original map of Selajar and other islands of the Celebes group, together with a note by Signor Cora.

The *Travailleur*, with the French Government Expedition for the exploration of the Bay of Biscay, left Bayonne on July 17, having on board MM. Milne-Edwards, father and son, Vaillant, of the Natural History Museum; Fischer, assistant naturalist; Marion of Marseilles, Fohn, Perin, and the English naturalists, Dr. Gwyn Jeffreys and the Rev. Mr. Norman. The results of the expedition may be described at the Swansea meeting of the British Association.

NEW SCHEME FOR DIRECTING BALLOONS

M. Gabriel Yon, one of the directors of the great Giffard captive balloon, and Mr. E. A. Pearse of Bristol, have each published a pamphlet on the direction of aërostats. The balloon of each inventor is to be elongated according to the principles of the experiments tried by Giffard in 1852 and by Dupuy de Lome in 1871. The propeller is to be moved by a gas-engine in the Pearse balloon, and by a steam-engine in the Yon balloon. M. Yon proposes to use the gas of the balloon as fuel, but only in proportion to loss of weight produced either by uncondensed steam or by consumption of petroleum.

Nothing can be said to be really impracticable in the Pearse scheme, although Mr. Pearse lacks the aëronautical training which distinguishes M. Yon, an aëronaut who ascended with M. Giffard in 1854, and has witnessed all his experiments. The only essential difference between M. Giffard's scheme and the new system is the place given to the fan, which M. Giffard attaches to the car. Practice will only decide whether the alteration projected is an improvement or otherwise. The reason alleged for the change is the bringing of the fan nearer to the centre of resistance. But it obliges the aëronaut to give to his fans a very small diameter, which requires an immense number of rotations in a second, and consequently represents a loss of power.

The calculations appear to have been made with care by M. Yon and Mr. Pearse. A trial would be greatly desirable, although it is impossible to suppose that the aërial carriage of Mr. Pearse or the directing balloon of M. Yon can possibly bring aëronauts to the North Pole for their inaugural trip, they may be instrumental in eliciting useful facts. We may add to the peculiarities of M. Yon's scheme that he uses a small globe inclosed in the lower part of the aërostat called a compensation sphere, and connected by a pipe with a ventilator, for keeping intact the form of his aërial machine. Mr. Pearse does not appear to be convinced of the urgent necessity of abstaining in any aërial construction from every complication which can be avoided at any cost, and he suggests the adoption of some accessory organs which, although designed to help aëronauts, would tax too much the lifting power or the attention of the aërial sailor. Mr. Pearse supposes that he will be able to navigate the air with an excess of weight, and does not pay attention to the intensity of motive power required to counteract gravitation even in a partial manner. He should certainly take advantage of the pamphlet written by his French competitor, who deals mostly with facts belonging to the public, and on which nobody can, in the present state of science, raise any claim as being his own property.

Both these pamphlets are greatly in advance of similar productions, and are creditable to their writers. Mr. Pearse's pamphlet has been only published for private publication. M. Yon's is printed with a number of plates representing many details; but a directing balloon is so complex a matter that this part of the publication can hardly be said to be complete.

Having been the builder of M. Dupuy de Lome's balloon and one of his crew, M. Yon may be said to have witnessed all the great aëronautical constructions of the age. Next to M. Henry Giffard, of whom he claims to be the pupil, he is the most completely qualified aëronaut to work out the solution of the great problem to which a recent success in photography has given unexpectedly in some respects a practical result.

W. De Fonvielle

EXPERIMENTS WITH THE WIRE TELEPHONE, CHIEFLY ON STRONGLY MAGNETIC METALS

By a wire telephone is meant an instrument like that described in Nature, vol. xxii. p. 168. In most of the experiments mentioned below, the mercury cups there figured were dispensed with, as they are unnecessary when stout wires are used. A small ear-piece with a ferrotype plate was also used instead of the drum-head, whose special purpose was to reproduce music so as to be audible at a distance. For hearing close at hand the ferrotype plate is much superior; indeed with the drum many of the sounds alluded to below could not be heard.

So far as I can see yet, the most probable cause of the sound in the wire telephone, when fine wires of ordinary weakly magnetic metals are used, seems to be variation of the longitudinal tension arising from the variation of the heating effect of the current. It is of course quite possible that there may be a lengthening of the wire due to the passage of the current over and above that arising from the heat developed, although such an effect can scarcely be said to be certainly established by experiment as yet.

Besides this cause three others were traced in the course of my experiments: Electrostatic action, external magnetic action, and internal magnetic action.

The following experiment was made with a very fine palladium silver wire, about 13 cm. long, as sounder. I connected the violin and microphone with four Bunsen's cells in circuit with the primary of a small induction coil (resistance of primary ·27, resistance of secondary 44), while the wire telephone was put in circuit with the secondary. With this arrangement the music was reproduced quite audibly, although the quality of the notes was "wiry." This small coil had a movable core, consisting of a bundle of iron wires, and the sound was louder with than without the core.

I next tried a more powerful induction-coil (resistance of primary ·3, secondary 320), all the other arrangements being unaltered. The music could then be just heard, but no more.

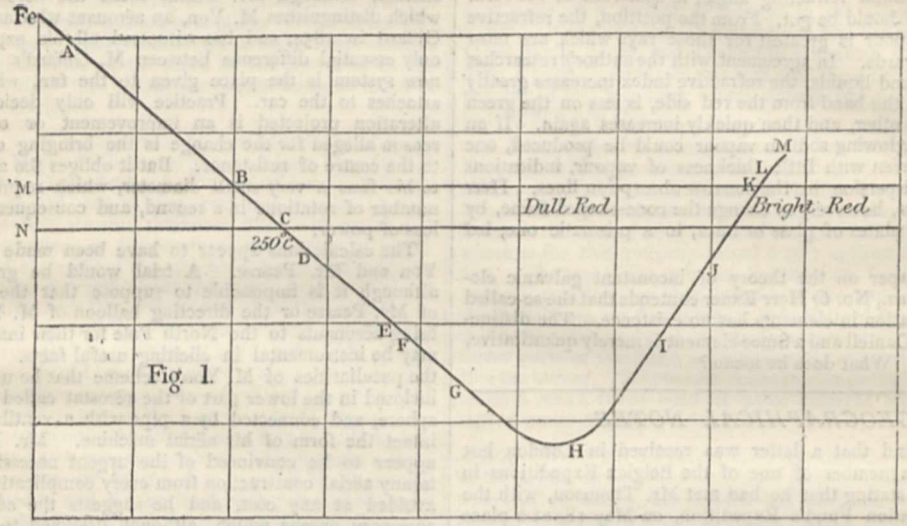


Fig. 1.

FIG. 1.—Iron.—A, sound very feeble at the temperature of the air; B, high note distinctly heard and increasing: C, feeble fizz now heard; D, fizz increased; E, quality of sound deepening; F, low note heard; G, sound very loud, low, medium, and high notes and buzz; H, no falling off; I, falling off now evident; J, marked diminution; K, fizz very soft, nearly gone; L, high note left; M, silence.

A large and very powerful induction-coil (resistance of secondary about 10,000), tried under similar circumstances, gave no result whatever.

Electrostatic Action.—As I have said, nothing was heard with the large induction coil when the secondary circuit was closed; but when it was interrupted at a mercury break, a loud hissing, rattling noise was heard. This could not have come by mechanical transmission from the induction-coil, which was several rooms off, the line wires being hung to the walls and jammed over three doors. It had its seat at the mercury pools of the break, and was doubtless due to electrostatic action. Similar sounds, only weaker, were observed with the smaller Ruhmkorf when the circuit was broken.

If two small disks separated by a small air-interval were made the terminals of an induction-coil, in the primary of which an interrupted current flows, they would form a condenser, and the difference of potential between them would vary in unison with the primary current. Consequently the electrostatic force of attraction would vary, and the disks, being set into vibration, would act as a telephone. The sounds in Thomson's singing condenser are probably due to this cause.

I have not attempted to carry this idea into practice, but I

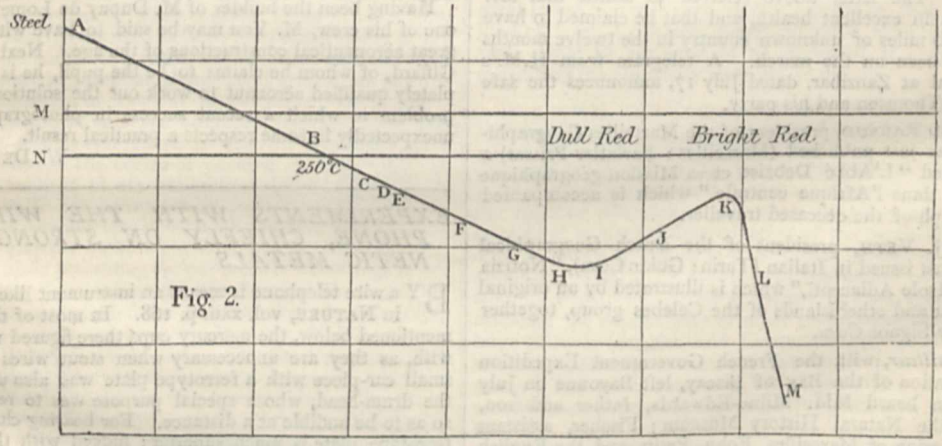


Fig. 2.

FIG. 2.—Steel.—A, fizzing sound and high note, neither loud; B, silence; C, high note comes in again; D, sharp fizz; E, buzzing sound and general increase of loudness. The other letters as with iron.

believe that telephones have been made on this principle by Edison and others.

External Magnetic Action.—If the stretched wire of the telephone be brought into a magnetic field so as to cross the lines of force, and an interrupted current passed, loud sounds are heard. I used a tuning-fork interrupter with two Bunsen's cells. When a thick copper wire was put into the telephone, at first nothing whatever was heard; but when a horse-shoe magnet was brought up, and held with its plane perpendicular to the wire, the note of the fork was heard very loud (much louder than in the neighbourhood of the fork itself, in fact), and comparatively pure. Little or none of the hissing or buzzing sound of which I shall have to speak by and by can be got in this way. It makes no great difference to the sound produced in this way whether we use a wire of 2 mm. diameter or a wire ·3 mm. in diameter. With the thin wire, however, the visible amplitude

of the transversal vibrations is much greater than with the thick. Using a brass wire 15 cm. long and ·4 mm. in diameter, I obtained with a tolerably powerful horse-shoe magnet transversal vibrations of 2 mm. amplitude or more.

The wire telephone, when used in this way, is pretty sensitive to magnetic influences. The presence of the pole of a bar magnet could be detected at a distance of several inches from the wire. It might be used to explore the magnetic field in a rough way. I found, for instance, that when I brought up a north pole on one side I could neutralise its effects by bringing up a north pole to a proper distance on the other side.

To get these sounds it is by no means necessary to have any elaborate arrangement of stretched wire and so forth. If a magnet be brought up to the wire leading to the telephone, the sound will be heard quite distinctly. If the wire be grasped tightly in the fingers between the magnet and the telephone wire, the sound is stopped, showing that it is transmitted mechanically along the wire. This experiment is certainly not new, but, although I have seen the possibility of such action mentioned (*e.g.* Wiedemann, "Galvanismus," Bd. ii. p. 602), I have nowhere seen any indication that the sounds are so marked and so easy to produce. I believe that this cause has been at work along with others in many experiments on the sounds obtained in magnetisation; for instance, in De la Rive's experiments. It is impossible, however, to decide with certainty, because no sufficient indications are usually given as to the nature of the magnetic field in which the wire conveying the interrupted current was placed.

The wire telephone arranged in this way with the wire in a strong magnetic field is well suited for reproducing music. Whether it could be adapted for articulate speech, I do not know.

The above experiments of course raise at once the question whether the sounds in the ordinary wire telephone and those I shall describe presently may not be due to the earth's magnetism. To settle this point, I stretched a brass wire 15 cm. long in the telephone; the wire was fine enough to give a feeble sound of itself when the interrupted current of two Bunsen's cells was passed through it. I shifted the apparatus about, so as to bring the wire as nearly as possible into the line of dip, and then placed it perpendicular to that position; but I could not detect the slightest change in the intensity of the sound. If it be borne in mind that here the distinction between wires as to their thickness is only important in so far as it affects their stiffness, it will, I think, be clear that this experiment settles that the earth's magnetism is not an operative cause with the current strengths I generally used. Another proof of this will be given by and by.

Effects due to the Magnetism of the Telephone Wire itself.—The following experiments were made with a view to test a conjecture of Prof. Tait's, referred to in a letter to NATURE, vol. xxii. p. 168, and to settle, if possible, the cause of the exceptional behaviour of iron wires in the experiments of De la Rive and Dr. Ferguson.

Two Bunsen's cells were used throughout, and the current was interrupted by a tuning-fork driven by an auxiliary battery.

My first experiment was made with an iron wire (A, 19 cm. long, ·50 mm. diameter). It gave a moderately loud sound to begin with, a low note with a predominating fizz, not unlike the fizz heard at the mercury cup in the far room (owing, I suppose, to the volatilisation of the spirit by the heat of the spark, which passes when the dipper of the tuning-fork leaves the mercury).

When a portion of the wire was heated with a Bunsen flame the sound increased very much for a short time, and then died away again considerably after the wire got red hot. On allowing the wire to cool, the sound, after a short time, suddenly swelled out and then fell away again. The permanent sound was, however, louder than it had been at first.[1]

I soon satisfied myself, by cautiously bringing the flame up to the wire, that there is a certain temperature at which the sound is a maximum. The wire was heated up to white heat and allowed to cool pretty rapidly, and it was found that the sound was at its loudest at a dull red heat, just before the phenomenon of the re-glow occurred, along with which a peculiar crackling could be heard, due, no doubt, to the abnormal contraction and extension of the iron at that temperature.

Several causes at once suggested themselves. The alteration of the elasticity of the wire was dismissed as probably not the *principal* cause at all events; for the increase of the sound begins at comparatively low temperatures. Although I did not expect to find any such thing, I looked for a maximum of resistance at a high temperature by placing the iron wire in one circuit of a differential galvanometer, balancing it with an equal resistance in the other, and then heating. I found, as is already known, that the resistance increases with great rapidity after dull red heat, but obtained no indication of a maximum.

The most probable explanation seemed to be the magnetic properties of the wire. It is well known that the magnetic susceptibility of iron (that is, loosely speaking, its power to become inductively magnetised under the influence of a given magnetic force) is at its maximum about dull red heat; that it declines very rapidly at higher temperatures, and is almost insensible at a bright red heat. The coercitive force of iron, that is, its power to retain magnetism permanently, unaided by external magnetic forces, disappears at a much lower temperature.

The sound in the above experiment depends, therefore, upon temperature in the same way as the magnetic susceptibility of the iron wire. This is strong proof that the sound is simply due to the fact that the iron is magnetised. I convinced myself by direct experiment that the effect extends throughout the whole of the wire, for I found that two flames at different places produced, when properly applied, more effect than one, and that, as I brought more and more of the wire to the proper temperature, the sound grew louder and louder. The fact that on cooling the permanent effect was greater than before probably corresponds to the fact that, under certain circumstances, the permanent magnetism is increased by heating and subsequent cooling,

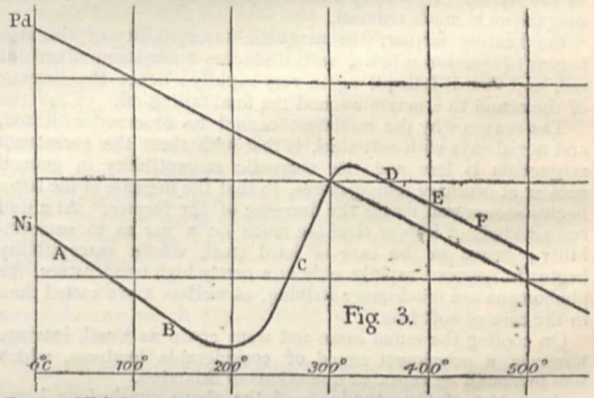


Fig. 3.

FIG. 3.—Nickel.—A, buzz and low note, both loud; B, low note, gone; C, buzz, tending to soften; D, buzz, gone; E, feeble high note; F, high note.

of which fact it was easy enough to make certain by testing the magnetism before and after heating.

I next took a piece of steel piano wire (B, 20 cm. long, ·9 mm. diameter) and mounted it in the telephone. At first no sound whatever could be heard. On magnetising it longitudinally, by stroking once or twice with a pair of magnets, a sound was heard quite distinctly, viz., a gentle fizz accompanied by a high note. On magnetising more strongly this sound became somewhat louder, but retained the same character. Gentle heating with a spirit-lamp decreased the sound; but it recovered its intensity when the wire was allowed to cool, and remained permanently a little louder than at first. Repeated gentle heating and cooling increased the permanent sound somewhat.

The wire was then strongly heated with a Bunsen flame. At first the sound died away to a minimum, then it increased, and was very loud about a dull red, then it fell off again. When the wire cooled the sound rose to a maximum, and then fell off, no minimum being perceptible. After this the permanent sound was a good deal louder, but the diminution on slightly heating could no longer be observed with certainty.

I next heated the steel wire B to white heat throughout, so as to deprive it entirely of all magnetism, and tempered it by dropping it into cold water when dull red. When put into the telephone after this treatment it gave no sound whatever. One stroke with a pair of bar magnets caused it to sound quite distinctly. It gave a gentle fizzing sound along with a very high note. Repeated gentle heating and cooling gave the same

[1] This phenomenon was observed by Dr. Ferguson independently, and exhibited to the Royal Society of Edinburgh at the meeting before that at which an abstract of the present paper was read.

results as I had got before. I then gradually raised the temperature till part of the wire was bright red, and finally allowed it to cool. As the temperature rose, the original fizzing sound died out, then the high note became inaudible, then there was a short interval of almost complete silence; after that a high note came in, then the fizzing sound again, which very quickly changed into a deep buzz, accompanied by a very low note like that of the tuning-fork, a note of medium pitch, and a high note (and possibly others), then the buzz died out, and at last the high note was left. When the wire cooled, the phenomena recurred in the corresponding order. First the buzz came back along with the low and medium notes, then it died away, and the high note alone was left; then there was silence, then the high note again, and lastly the fizzing sound.

Most of the notes heard, certainly the most prominent of them, appear to have little relation to the tuning-fork. They seemed to be affected to some extent by the tension of the wire.

When a magnet was brought up to the wire the deep note, obtained in a similar way with wires of other metals, was heard along with those peculiar to iron and steel.

These experiments with the steel wire appear to me to settle the question as to the cause of the sound in thick iron wires. The fact that the wire can be put into a condition in which no sound is produced, and then made to sound by magnetising it, shows that the action is due to the magnetism of the wire, and is also an additional proof that the earth's magnetism had nothing to do with it.

This view is still further confirmed by the effect of heat on the tempered steel wire. The first effect of heat is to destroy the permanent magnetism of the wire, hence the initial diminution of the sound. At a temperature of about 250° C. the permanent magnetism is much reduced.

On heating farther, the magnetic susceptibility of the steel begins to increase rapidly, until it reaches a maximum about dull red, and then it falls off again very rapidly; hence the increase of the sound to a maximum and the final falling off.

The reason why the minimum cannot be observed with iron, and not always with soft steel, is that with them the permanent magnetism is less and the magnetic susceptibility in general greater at ordinary temperatures, so that the increase of the latter begins sooner and masks the decrease of the former. At a dull red all kinds of iron or steel are much on a par as to susceptibility; hence in the case of hard steel, whose susceptibility begins to increase rapidly only at a pretty high temperature, the phenomena are much more striking, as well as more varied than in the case of soft iron.

On cooling the sound came and went again as usual, leaving, however, a permanent sound of considerable loudness, which was increased by repeated operations of this kind.

As a test of the soundness of the above conclusions I was anxious to examine the behaviour of the other strongly magnetic metals, and Prof. Tait kindly put several pieces of nickel and cobalt at my disposal.

The piece of nickel used was 3 cm. long, 2 mm. broad, and about ·6 mm. thick. It was hard soldered to platinum terminals, and mounted in the usual way, after being heated red hot and dipped in water at dull red.

At first it gave a very feeble high note, accompanied by a gentle fizzing sound. One stroke with a magnet caused it to emit a loud buzzing sound. On heating gently this sound was somewhat reduced, and on heating farther the hissing sound died away, and a high note was left, but it too was extinguished before the nickel was visibly hot.

I made some temperature determinations by means of an air-bath and a mercury-thermometer, and found that at 200° C. the buzzing noise first began to be softened down. After 250° C. the diminution appeared rather more rapid, but at 350° C. the sound was still quite loud; after that the falling off was very rapid, and somewhere (say 400° C.) beyond the range of the thermometer, the mercury in which just boiled at the end of the experiment, the sound died out rather suddenly.

The behaviour of nickel is therefore exactly what we should expect from its magnetic properties, for it loses its magnetic susceptibility, according to Faraday and others, somewhere between 350° C. and 400° C.

I found with nickel, as with iron, that the current itself at a certain high temperature could produce much the same effect as I got by magnetising. On testing a piece of nickel after being magnetised by the current I found it to be transversely magnetised. This induced me to try magnetising my nickel strip transversely, but although I got results this way they were not so good as I had got by magnetising longitudinally.

I was thus led to try the following experiment, the result of which is at least curious. Instead of passing the current through the nickel itself as before, I passed it round two flat pieces of iron electro-magnet-wise. These were placed with their ends pretty close together, and the nickel was stretched between them so that it lay in a nearly uniform field of magnetic force, whose strength varied in unison with the interrupter.

I found that with this arrangement the nickel sounded very much as it did when the current was passed directly through it. The sound was not so loud, but its quality appeared to be the same. The sound, however, was loudest when the plane of the nickel strip was parallel to the lines of force, being very feeble when the plane of the strip was perpendicular to the lines of force.

A piece of watch-spring was tried in the same way, with exactly similar results.

This experiment is of course very nearly the same as some of those by which the sounds due to the magnetisation and demagnetisation of iron are usually demonstrated. A very full account of these sounds will be found in Wiedemann's "Galvanismus," Bd. ii. p. 565 *et seqq*.

I tried a piece of cobalt 6 cm. long and 6 mm. broad, ·7 mm. thick, in the ordinary way. In its original state it gave no sound whatever. After being magnetised longitudinally by a large number of strokes it gave a sound, very feeble, however, compared with that got in the same way from iron and nickel, or even from hard steel; it was, moreover, more of a pure note and less of a hissing noise. Heating in the first place diminished this initial sound, so that there came an interval of comparative silence, then the sound rose again, and by and by the familiar buzz came in; but up to a bright red heat no maximum was reached. On cooling, the phenomena reappeared in the proper order.

Cobalt behaves, therefore, just as we should expect from its refractory magnetic nature.

I may mention one curious phenomenon that appeared once or twice with cobalt and once or twice with a piece of steel. On cooling, after the maximum was past, the buzz had died away, and a period of comparative silence had come, strong beats began to be heard, which lasted for a considerable time, and then died away as the temperature fell. Various causes for these might be assigned. It might have happened that two parts of the metal were at different temperatures, and gave notes nearly in unison. It may very well have been interference between notes due to permanent and temporary magnetism; for in cobalt generally, and with the particular piece of steel in question, the minimum was not marked by the absolute silence which probably indicates cessation of the sound due to permanent magnetism before that due to temporary magnetism begins.

Relation to Thermo-electric Properties.—As it seemed to be of some interest to connect these magnetic sounds with the curious thermo-electric peculiarities of iron and nickel brought to light by the recent researches of Prof. Tait,[1] I asked the help of his assistant, Dr. C. G. Knott, who has had great experience in work of this kind.

The sounding-wire, a short piece of which was always used in order to get the phenomenon pure, was inclosed along with a double or triple thermo-electric junction in a small tube made by rolling up a piece of sheet-copper. The tube was then heated up in the blowpipe flame. This was a rough way of setting to work, but it was sufficient for our purpose.

The diagrams (Figs. 1, 2, 3), made by Mr. Knott, with the appended notes, will show the results. I have given the observations made during heating, as being on the whole probably nearest the mark. The cooling, except in the case of nickel, which was inclosed in a wide iron box, and did not require to be raised to a very high temperature, was much more rapid than the heating, and consequently inequalities of temperature due to the different positions of the sounding-wire and the junction would have been more apparent. In point of fact the discrepancy was not great.

The abscissa in the case of nickel is the temperature in centigrade degrees, in the other cases it is the electromotive force of a junction formed of a certain pair of platinum iridium alloys (called M and N) much used by Tait in his thermoelectric researches, because their lines on his thermoelectric diagram are

[1] *Trans.* R. S. E., 1872, 3, vol. xxvii. p. 134, &c.

nearly parallel (see p. 140 of the paper above referred to). The ordinate in all these cases is the thermoelectric power.

The special feature here is the period of silence at the neutral point of N and steel, viz., about 250° C.

This observation agrees remarkably well with the theory that the initial sound in the case of steel is due to its permanent magnetism; for, according to Faraday, steel loses its coercitive force about the temperature of boiling almond oil. See also Marshall (*Proc. R.S.E.*, 1871-72, p. 605). On cooling, owing doubtless to the fact that exposure to a high temperature had softened the steel, which was very hard to begin with, no period of absolute silence appeared, and beats were heard.

It was difficult to distinguish whether the note at E and F was or was not due to the singing of the Bunsen flame. The observations, on cooling, exactly corroborated those taken during heating.

It appears to me that these experiments establish that a series of sounds are produced by the passage of a varying current through magnetised iron, nickel, and cobalt, which depend on the fact of their magnetism. They are apparently of the same nature as those observed heretofore in magnetising and demagnetising iron.

I believe that the phenomena above described explain the exceptional power of iron wires of considerable thickness, as sounders in the wire telephone. When the iron wire is very thin it is most likely that the effect obtained with thin wires of ordinary metals predominates, and it is possible that the magnetic effect may in that case be very small. I cannot say, however, that I have settled this point, which clearly involves an experimental difficulty.

At all events I hope the above observations will be of sufficient interest to attract notice to a subject which has not been much studied lately, notwithstanding its important bearings on the theory of the telephone, and what is of more scientific importance still, the theory of magnetism in strongly-magnetic bodies, a department of physics which stands in as much need of additional light as any that I know. G. CHRYSTAL

INTERNATIONAL METEOROLOGY

THE International Meteorological Committee appointed by the Congress of Rome (1879), will hold its first meeting at Berne on the 9th proximo.

The following is the programme of questions to be considered by the Committee :—

1. Report on the action of the Committee since the date of the Congress at Rome.
2. Report of the Polar Conference (Weyprecht's project) held at Hamburg in October, 1879.
3. Proposed Conference for Agricultural Meteorology, summoned for September 6 at Vienna.
4. Proposed comparison of the Standard Instruments of the chief Observatories of Europe.
5. Proposed Catalogue of Meteorological Observations and of Meteorological Works and Memoirs in all languages.
6. Proposed International Tables for the reduction of observations.
7. Proposal for an International Meteorological Dictionary.
8. Report on the Meteorological Organisation of England in 1877, being a Supplement to the Fifth Appendix to the Report of the Roman Congress.
9. Proposal by Capt. Hoffmeyer for an International Telegraphic Service for the North Atlantic.
10. Proposal respecting the exchange of Meteorological Publications by post.

The Circular concerning the meeting, which is issued by Prof. Wild and Mr. Scott, requests all persons wishing to make any communications to the Committee to address them to Mr. Scott, at 116, Victoria Street, during the current month.

A private Conference on the relations of Meteorology to Agriculture and Forestry will be held at Vienna on September 6. The following is the programme of subjects for discussion :—

1. What are the mutual relations of the meteorological elements on vegetation, not only those which are proved to exist, but those which are theoretically supposed to be probable?
2. What observations of meteorological elements are to be particularly attended to, with especial reference to their influence on vegetation?
3. How far, and in what way, can meteorological observatories and stations, without interfering with their other work, include these observations in their sphere of operation?
4. Would it not be useful with a view of establishing special systems of observations for this object, as, for instance, phenological observations, to prepare general instructions?
5. Can, at the present moment meteorological central offices issue weather forecasts for the use of agriculture, with reasonable prospects of utility, and if this question is answered in the affirmative, how can the service be organised as fully as possible?

Preliminary materials for the answers to these questions will be found in the Reports of Dr. Lorenz and Dr. Bruhns to the Roman Congress on Article 35 of the Programme. These Reports have also been published separately in German, and partially in French in the collection issued by the Central Office at Rome of all Reports presented to the Congress. In the latter volume the Report of M. Denza on the same subject is to be found.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

A TOWN'S meeting was held at Liverpool last week for the purpose of hearing a report from the committee appointed a year or two ago as to the progress of a scheme for establishing a University College in Liverpool. The report showed that in spite of bad times a very gratifying readiness had been exhibited on the part of a number of the leading residents of Liverpool to contribute to the necessary funds, several of whom had promised sums of 10,000*l.* each for the endowment of different chairs. The Earl of Derby had also promised a similar sum, the result being that 80,000*l.* was already insured. The college is to be upon the broadest basis, being non-sectarian, and offering no disabilities of any kind to intending students. A resolution was moved thanking donors to the fund, pledging the meeting to the furtherance of the scheme, and recommending that the different classes and businesses of the town should form themselves into committees for the purpose of canvassing.

IN reply to a question by Sir J. Lawrence on Monday as to the embarrassed position of the United College of St. Andrews, Sir W. Harcourt stated that the Government would consider the report during the recess, with a view to making some proposal early next session.

A COMMITTEE is to be appointed to inquire as to the existing establishments which are available for intermediate and higher education in Wales.

THE Superior Council of Instruction in France has terminated its second session. The most notable feature has been the introduction of descriptive natural history in the eighth class, that is, in the first step of classical education.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, No. 6.—On electric expansion, by G. Quincke.—On the thermal and optical behaviour of gases under the influence of electric discharges, by E. Wiedemann.—On the electro-magnetic rotation of the plane of polarisation of light in gases, by A. Kundt and W. C. Röntgen.—On the theory of inconstant galvanic elements, by F. Exner.—On the specific heat of water, by A. Wüllner.—On the specific heat of mixtures of acetic acid and water, by M. A. von Reiss.—On a changed form of my proof of Maxwell's law of distribution of energy, by O. E. Meyer.—Researches on heat-conduction in liquids (continued), by H. F. Weber.—On anomalous dispersion in glowing sodium-vapour, by A. Kundt.—On a simple method of galvanic calibration of a wire, by V. Strouhal and C. Barus.—Explosive actions by ice, by Ed. Hagenbach.—On the funnel-valve in evacuated tubes, by W. Holtz.

No. 7.—Experiments on stationary vibrations of water, by G. Kirchhoff and G. Hansemann.—On the nature of galvanic polarisation, by W. Beetz.—Key for electric circuits, by the same.—On electric expansion (continued), by G. Quincke.—Experiments for determination of an upper limit for the kinetic energy of the electric current, by H. R. Hertz.—On fluorescence, by E. Lommel.—Researches on heat-conduction in liquids, by H. F. Weber.—On the transverse vibrations of a bar of variable cross-section, by G. Kirchhoff.

SOCIETIES AND ACADEMIES

LONDON

Entomological Society, July 7.—J. W. Dunning, M.A., vice-president, in the chair.—Mr. Jenner Weir, on behalf of Mr. J. W. Douglas, exhibited a female specimen of *Noctua c-nigrum*.—Mr. McLachlan exhibited a piece of sugar-cane from Queensland much eaten by some undetermined lepidopterous larvæ, of which specimens were shown. Mr. W. L. Distant was able to state that this was a quite distinct larva from that infesting sugar-canes in Madras, of which he had lately received specimens.—Miss Ormerod exhibited specimens of various sugar-cane borers from British Guiana, and read notes thereon.—Mr. Distant exhibited a specimen of the larva of *Hepialus vivescens*, the so-called vegetable caterpillar of New Zealand. The spores of *Cordiceps robertsii*, falling on this caterpillar, become parasitic, destroying it, and growing therefrom in the form which has caused many erroneous statements to be made.—Mr. Billups exhibited a larva of *Plusia chrysitis* and some specimens of an ichneumon (*Paxylloma sp.*) that was parasitic thereon.—Mr. Phipson exhibited a remarkable variety of *Pyrameis cardui*.—A note was read from Mr. Sidney Churchill of Teheran on *Argas persicas*.—Mr. Roland Trimen communicated notes on the pairing of a butterfly with a moth, and on a supposed female of *Dorylus helvolus*, Linn.—Messrs. Godman and Salvin communicated a paper entitled "A list of Diurnal Lepidoptera collected in the Sierra Nevada of Santa Marta, Columbia, and the vicinity."

VIENNA

Imperial Academy of Sciences, May 13.—On the theory of Volta's fundamental experiment, by Prof. Exner.

June 3.—On a method of indicating the variations of volume of the heart, by Prof. Knoll.—The variation of molecular weight and molecular refractive power (second part), by Dr. Janovsky.—On preliminary determination of the orbit of the planet (178) Belisana, by Herr Rüling.

June 10.—Preliminary communication on the spermogonia of Æcidiomycetes, by Prof. Rothoy.—On electrical ring-figures and their change of form by the magnet, by Prof. Reitlinger and Dr. Wächter.—On the magnetisability of iron at high temperatures, by Prof. Wassmuth.—On the development of gases from metals, by Prof. Suess.—On the path of the comets 1843 I and 1880*a*, by Herr Weiss.—On so-called chemical repulsion, by Dr. Lecher.

June 17.—Contributions to an investigation of the phylogeny of plant-species, by Prof. v. Ettingshausen.—Optical notices, by Prof. v. Lang.—On the localisation of functions in the periphery of the human brain, by Prof. Exner.

PARIS

Academy of Sciences, July 19.—M. Edm. Becquerel in the chair.—The following papers were read:—Researches on the organic alkalies, by M. Berthelot. This relates to ethylamine and trimethylamine, their heat of combustion, &c.—Modifications of respiratory movements by muscular exercise, by M. Marey. The respiratory curves obtained from young soldiers with a (so-called) *pneumograph* show that after a gymnastic course they breathe about twice as much air as before; the number of respirations is reduced from twenty to twelve per minute, but their amplitude is more than quadrupled. At the outset the respiration is considerably modified by running (600 m. in about four minutes), but after from four or five months' exercise this running has no perceptible effect.—On strengthening the immunity of Algerian sheep against splenic fever by preventive inoculations; influence of inoculation of the mother on the receptivity of the fœtus, by M. Chauveau. Direct contact of the animal organism with the bacteridian elements is not necessary to its ulterior sterilisation. Preventive inoculations act on the humours proper, which are rendered sterile and sterilising, either by removal of substances necessary to bacteridian proliferation, or rather by addition of matters adverse to this proliferation.—On the construction of the dam of Gileppe, Belgium, by M. de Lesseps.—Ephemerides of comet *b* 1880 (Schäberle), by M. Bigourdan.—Reply to a remark of Mr. Sylvester's concerning the lessons on the theory of numbers of Dirichlet, by M. Dedekind.—On the cause of the fugitive spectra observed by M. Trouvelot on the solar limb, by M. Tacchini. He has often observed such spectra (attributed by M. Trouvelot to solar disturbances) on passage of swallows and other birds across the sun. In simultaneous observations on three days, by Prof. Ricco, at Palermo (where birds are very rare), no such spectra were recorded; and M. Tacchini finds, as one might expect, that they become less frequent as the sun rises in the sky.—On atmospheric electricity, by M. Mascart. His observations at the College of France are made with a Thomson quadrant electrometer, the deflections of the needle being transmitted to a pencil. The two pairs of quadrants are kept at equal potentials of contrary sign by two poles of a battery which communicates with the ground; the needle is connected with a vessel letting flow a continuous stream of water into the outer air. Generally the potential of the air, always positive, is found much higher and more uniform by night than by day. From 9 p.m. to 3 a.m. it varies little, falls at daybreak, reaches a minimum about 3 p.m., then rises rapidly to a maximum about 9 p.m. (It is commonly thought there are two maxima, morning ond evening; and two minima, one in the day, the other at night. M. Mascart considers insulation has been too much neglected.)—On the alternative currents and the electromotive force of the electric arc, by M. Joubert. When the current intensity is *nil* there is no difference of potential between the carbons, but the difference quickly reaches 40 to 50 volts, which is preserved nearly constant till the current is again very weak. The final fall is very sudden. The difference of potential remains the same during the period of the current, though the mean intensity of this be largely varied.—On a new air-thermometer, by M. Witz. This is a sort of Leslie's thermometer, with one air-globe kept at constant temperature by means of a thermal regulator of special form.—On some fluorised combinations of uranium with the alkaline metals, by M. Ditte.—On the atomic weight and the principal properties of glucium, by MM. Nilson and Pettersson. The atomic weight is 13·65 if the earth is equal to Gl_2O_3.—On some combinations belonging to the group of creatines and creatinines, by M. Duvillier.—Action of chloride of ethyl on ethylamines, by MM. Duvillier and Buisine.—Action of electrolysis on benzine, by M. Renard. A new body named isobenzoglycol, $C_6H_6(OH)$, is obtained.—On a peculiar alteration of butcher-meat, by M. Poincaré. He has found cylindrical pointed elements, with cuticles crossed by lines which seem outlines of cells, and granulated. He thinks they may be phases or metamorphoses of tænioides, causing tænia in some eaters of raw meat.—On the production of charbon by pasturages, by M. Poincaré. The disease was traced in one case to the grass of a meadow being constantly wet with a liquid of marshy look; in this were found numerous bacteridia like those in the blood, and injection of it into a guinea pig produced charbon.—Observations on the origin of fibrillæ in the bundles of connective tissue, by M. Laulanié.—On the Echinida of the tertiary strata of Belgium, by M. Cotteau.

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