THURSDAY, MAY 18, 1876

THE PRESS ON THE LOAN COLLECTION

THE opening of the Loan Collection of Scientific Apparatus has been accompanied by unanimous approval on the part of the London daily press, and of those weekly papers that have yet noticed it. This approval must be all the more gratifying to the well-wishers of science, and especially to those gentlemen by whose efforts the collection has been organised and arranged, that it is in all cases intelligently expressed. All the notices of the collection that we have seen show a fair appreciation of its great value, its purpose, and its significance, and we believe, without exception, they express a hope that it will be followed by a permanent collection, in the form of a Science Museum. On another page we give some account of the successful and altogether gratifying visit of the Queen on Saturday last, as well as the proceedings since, and here we think it will serve a good purpose to bring together public opinion on the collection, so far as that has yet been uttered through the press.

The *Times* of Saturday last, in a long article on the collection, speaks as follows :—

"The Exhibition which her Majesty the Queen privately visits and opens to-day is one of which not only England but Europe may be justly proud. Pride, however, is not the only sentiment we English should feel, for at last, if even only for a brief space, we have, under the name of a Loan Collection of Scientific Apparatus, a Science Museum as complete as those in which we have already enshrined our art and literature. For at least six months, therefore, we shall not only be as rich in this respect as France, Germany, Italy, Holland, and Switzerland, but far richer, since those nations, with an enthusiasm and goodwill which command our universal gratitude, have spoiled their ancient treasure houses, their laboratories and private collections, in order that science may be worthily represented among us now that our government have consented to provide a home, however temporary, for her.

"It is right and fitting that her Majesty should be the first to see how enthusiastically the applications of her government have been responded to, not only by other governments—chiefly those we have named—but by foreign men of science, as well as those of our own country, and it may be safely stated that such a sight as the Queen will see to-day when she opens the Museum is without a parallel in history. The world of art and of letters had advanced far long before science was considered to be anything more than a craze, more or less harmless. The natural consequence has been that at the present day governors and governed alike know much more about, and take much more interest in, art and literature, and collections representing them, than about science. If all the art treasures of Rome, Florence, the Hague, Amsterdam, Antwerp, Bruges, Paris, Dresden, Munich, Berlin, London, and some other cities which we might mention, were to be brought together, the interest taken in such a collection would be immense throughout the whole world. Although the Loan Collection is the exact equivalent, as regards science, of the collection we have foreshadowed as regards art, it is far too early for an equal amount of popular interest to be taken in it. The interest, however, if more limited, will perhaps be, on the whole, more intense in the case of those interested at all, for our people are beginning gradually to learn what science has done and what its future position must be, especially in a country like England, where science is wanted so much, if it be taught so sparingly. We believe it is no secret that those who have had to do with the formation of this collection have found in many cases that for want of such a national repository many instruments in the possession of private persons—instruments of the highest importance now that the history of science is looked after—have either been broken up or lost. This remark applies even to our public departments, which, as a rule, have only to do with the present, so that an instrument, however great its value may be from a scientific point of view, is regarded as lumber the moment it is superseded. The recommendation of the Duke of Devonshire's Commission, therefore, that a museum should be established, doing for the Physical and Mechanical Sciences what the British Museum—to take an instance—does for the science of Natural History, is one which might be carried out in the most perfect and at the same time economical manner in course of time, if it were understood that instruments that had served their purpose, whether for investigation or for use, would find an asylum where they would be looked after. It is rumoured that the Royal Society is not disinclined to transfer the instruments that it possesses to the charge of the nation under proper guarantees.

"To those more especially interested in science, whether as investigators, teachers, or appliers of science, or makers of scientific instruments, it is equally clear that the collection is of the very highest value. Indeed, the greater scientific activity and the general superiority of the work of the instrument-makers on the Continent, taken in connection with the opportunities which Continental students of science and instrument-makers have of handling and studying instruments will, if we are not much mistaken, strike every one. The moral is obvious. Nor does it end here. When we bear in mind that similar collections, though naturally far less complete than the present one, have existed in some cases for centuries in some of the Continental States, in some of which also science has formed an integral part of the curriculum not only of the Universities, but of the Schools, for half a century, the present backwardness of England in all that relates to scientific education is not far to seek."

The *Daily News* of Saturday, after speaking of the arrival of the long-expected contributions from Italy and of the necessary delay in the opening of the Collection, goes on to say :—

"But this delay is amply compensated by the completeness with which the task of arrangement has been performed. . . . It was not the intention of the Government to encourage a trade in scientific instruments—that is, to arrange a fair. The object sought is the promotion and extension of the knowledge of scientific methods both of research and instruction. The intercourse at present subsisting between scientific men is not of such an intimate kind that a new discovery—the invention or improvement of an apparatus—has a chance of becoming immediately known to the circles interested in it. It frequently happens that a person who makes use of a scientific fact in a new manner or for a new purpose does not publish his idea at all; much more frequently his communication reaches only a small circle of his countrymen, and only in comparatively rare cases is an opportunity afforded to scientific men of the same branch to see or examine the new invention. In addition to its historic and purely scientific aspect, the present exhibition supplies admirable illustrations of the present stage of development of the art of constructing scientific instruments. In the workshops of mechanical instrument-makers, manipulations requiring skill are in their application to certain apparatus developed traditionally to a very remarkable degree of perfection, and it is expected that mechanical instrument-makers and engineers will find in the present collection, by comparison with the work of others, the qualities in which they themselves are deficient. Aided in the work of comparison by the purely scientific system of classification now first adopted, the investigator will find much to suggest new trains of thought, as the science teacher will find new and improved means for inculcating the truths of nature. While the scientific instructor, the student, and the mechanician will find enough to absorb their interest, the general public will find infinite interest in much of the apparatus exhibited.

"There are already indications that the magnificent collection of scientific treasures brought together at the cost of much ability and energy on the part of the authorities of the South Kensington Museum will hardly be permitted to suffer redistribution to the four corners of the earth. Certain precious relics—the pride of Universities and museums—will probably be claimed at the conclusion of the Exhibition by their proper owners; but it is more than doubtful whether the makers of many of the most perfect modern instruments would not prefer them on view for an indefinite period rather than withdraw them altogether. Many of them have signified their willingness to present the nation with their exhibits out of hand, and there are other signs that a project--not new, but dormant for some time past—will shortly be revived. It is that of establishing in London an analogue of the Conservatoire des Arts et Métiers at Paris, of which a very poor imitation, if it can be called an imitation at all, exists in the Patent Museum. The present opportunity of forming a scientific and industrial museum, which would be the envy of Europe, appears to many scientific people too good to be lightly foregone."

The *Standard*, in an article on Wednesday last week, says:—

"The result is a collection which will delight the heart of every scientific man, and even to those who merely dabble in science the interest will be very great. . . .

"That the new loan collection of scientific instruments will be an exhibition popular with and largely frequented by the general public was probably never expected by its originators, but to scientific men, whatever be the branch of the subjects to which they give their attention, the collection will be of the highest interest. In its way it is certainly altogether unequalled, and we may presume that the intelligent pleasure of the comparatively small number of visitors will amply compensate its originators for the absence of the classes who have formed the vast majority among the patrons of the former international exhibitions."

The *Daily Telegraph* of Monday writes as follows:—

"By her presence on Saturday at the assembly which has thus hopefully preceded the public opening of the exhibition in the galleries bordering the garden of the Horticultural Society, the Queen stamped with an approval not less enlightened than gracious and kindly the most interesting and valuable scientific display that has ever been organised in this or any country of the world. . . .

"Many discoveries have been and are yet to be achieved by means of instruments exhibited in that grand collection at South Kensington; and we may reasonably infer that had it not been for the invention of certain apparatus the most important natural truths must have remained unknown. In the Loan Exhibition at South Kensington is laid the basis of a Science Museum such as was strongly recommended in the report of the Royal Commission on Scientific Instruction, over which the Duke of Devonshire presided. The Conservatoire des Arts et Métiers in Paris appears to have been the model observed by those most interested in the new scheme; and, the co-operation of foreign countries having been obtained, a collection which illustrates the past struggles as well as the existing triumphs and aspirations of science is now accessible to all who desire instruction of so wide and so elevating a character.

"Though it is utterly impossible within the compass of this notice to indicate a hundredth part of the wonderful attractive collection spread through these five rooms up stairs, we may at least assure all intending visitors that, with catalogue and handbook to guide and assist them, they may employ, to inestimable profit, half a long day in looking at object after object, and will then feel the necessity of another visit. Such a book [the Handbook] is a cyclopædia of useful knowledge in itself. Nor can the admirable arrangement of objects be passed over without praise. The inevitable fatigue of studying attentively a vast scientific museum is reduced as much as possible by the perfection of system and method, in classifying the objects, and in placing them well within view."

The *Engineer* says:—

"Owing to the excellent organisation which was made at an early date, and the support which has been afforded from all quarters, the exhibition seems likely to be even a greater success than was ever dreamt of when it was at first proposed."

Speaking of the Conferences the same journal goes on to say:—

"If these lectures and discussions are printed and collected into a volume, as there is some talk of doing, a most valuable addition to scientific literature will without doubt be made, especially if permanent photographs of the chief objects be taken and added to it by way of illustration. The conference room, however, is very small, and a bad shape for such a purpose; and if the meetings are as fully attended as one may expect them to be when lectures are to be delivered by such gentlemen as we have above mentioned in connection with the mechanical section, and by equally eminent ones in other sections, there is every likelihood that it will be found altogether too small and confined, in which case most probably the meeting will adjourn to the arena of the Albert Hall. There can be no doubt that the exhibition and meetings themselves will do much to further science in this country, but it is hoped that still more lasting results will accrue, as was shadowed forth by the Lord President and the Vice-president of the Council on Education, the Duke of Richmond, and Viscount Sandon, at the first meeting of the general committee, who referred to the recommendations of the Royal Commission on Scientific Instruction with regard to the creation of a science museum, and expressed a hope that the loan collection might become the means of developing the educational and other departments of the South Kensington Museum into a similar museum to the Conservatoire des Arts et Métiers in Paris, which would tend to the advancement of science and industrial progress in this country."

Last week's *Iron* speaks of the collection as follows:—

"The success of the Loan Collection of Scientific apparatus, to be inaugurated by the Queen this day (Saturday) is no longer a matter of doubt. The invitations to contribute have been responded to by the scientific world, both at home and abroad, with singular liberality, while the mass of material which has flowed in from all quarters has been dealt with by able and judicious hands. That the opening should have been somewhat delayed seems, too, rather a matter for congratulation than otherwise, as the completeness of the exhibition has been in consequence increased. Of the five sections under which the exhibits are grouped, it is true that some are still inadequately represented; but the very great interest of the physical and mechanical groups more than compensates for any deficiencies under the heads of chemistry, biology, and geology.

"The particular advantage which attaches to this latest modification of the now somewhat discountenanced International Exhibition is, that it brings together apparatus and models which the most attractive World Fair would never have drawn from their retirement. Men of science and students, as a class, are not influenced by the inducements which are most operative with ordinary exhibitors; but none the less is it necessary for the advancement of knowledge that their treasures should be, from time to time, examined and criticised by their fellows.

"There is much of interest in the geological and geographical sections, though nothing very new. Of the metallurgical division—with a miserable dozen exhibits out of a total of nigh on five thousand—what can be said? Is metallurgy devoid of scientific interest? Or has one of the greatest of England's industries no followers who care to do anything for its advancement? With this sole exception, the Science and Art Department must be held to have scored a great success, and to have saved the Government from the reproach of doing nothing for science. It only remains to hope that the magnificent collection which now fills the exhibition galleries will not be dispersed without an effort being made to secure for the nation such portion of it as may be obtainable, and suitable to form the nucleus of a technical and scientific museum, on the plan of the Conservatoire des Arts et Métiers of Paris and the similar institutions to be found in every large German city."

Such is what may be called "lay" opinion upon the importance and success of this unprecedented Collection; and that this opinion is endorsed by that of men of science themselves may be seen from the addresses of Mr. Spottiswoode and Dr. Siemens, which we are able to publish to-day.

THE REMINGTON TYPE-WRITING MACHINE

IN making comparison between the physical and the biological sciences, it is not difficult to recognise how it comes that they differ in one essential element. In the *physical* the forces in action are comparatively few, and of very different degrees of intensity. The centripetal and centrifugal tendencies, for instance, of moons and planets so far exceed the mutual attractions of the planets *inter sese*, that in the rough calculations of their orbits the latter may be omitted from consideration.

In the study of the phenomena of life, however, the innumerable forces which are found to be in play are so fairly balanced in their magnitude and tendencies, that the task of dissociating and classifying them is almost beyond the means at the disposal of the human mind.

In the study of the various machines which have from time to time been constructed with the purpose of economising or superseding the employment of the engine—muscle, expensive in the nature of the fuel it requires, although it is so economical in the way in which it uses it, a similar division may be made. In the steam-engine, however developed, the waste of force essential to the working of the valves is nothing in comparison to the power employed, nor in the telegraphic needle is much done by the current except the actual record which it makes.

But on looking at the sewing-machine or the more novel type-printing apparatus we can see that the ingenuity of America, stimulated by the idea of practical advantage, has been developed in a direction, not towards the discovery of more economic principles, but to the employment of forces already known in the mastery of complicated operations previously thought to be beyond the powers of any other mechanism than the hand of man. To obtain these results an entirely different conception has to be introduced. The power at the disposal of the operator has not to be directed simply to the performance of a single operation, like the movement of the needle in the sewing-machine or the impressing of the letter in the type-writer, but has to be distributed so that it may perform a series of simultaneous operations, all leading to a complicated result. The treadle of the sewing-machine in its movement, besides the rise and fall of the needle which it produces, works the thread loop-slip, shifts the fabric, and unwinds the cotton. The pressure on any one of the keys of the type-writer, besides the impression which it stamps upon the paper, shifts that paper, inks the type, and places each letter in its proper sequence.

In order properly to balance all these varied actions, great ingenuity and much practical experiment are necessary, and of the "Remington Type Writer," the only satisfactory instrument of the kind yet brought to public notice, the introducers, the most prominent of whom is Mr. Jefferson M. Clough, superintendent of the Remington Armoury, tells us that "during the time required to perfect the invention, about fifty machines were constructed, all upon the same general principle, but each differing more or less in the minor details."

This general principle is a most ingenious one. It is evident that the great difficulty in the construction of such an instrument is that it is necessary to have a large number of signs—letters of the alphabet, figures, stops, &c., arranged in such a manner that any one of them may, by the simple pressure on a corresponding key-note, be printed in any required order or sequence upon a paper sheet placed ready to receive it. There are many more or less elaborate ways in which this may be accomplished; none, we believe, so simple as that adopted by the Messrs. Remington. Their apparatus may be compared to a piano, even in its details. There is a key-board, on each key of which the letter it impresses is to be found indicated. The depression of each key raises a hammer. This hammer, however, instead of being covered with a felted pad, as in the piano, carries at its extremity a type-cast letter, which, in place of a stretched wire, strikes on a piece of paper the impression of the letter which it bears. So far the similarity between the two instruments is very close. But to produce sounds and to perpetuate impressions in black and white in any definite sequence, are two very different things, the latter being much the more difficult; and herein lies the ingenuity of the principle adopted in the type-writer. The hammers, instead of being arranged in one line, as in the piano, form a circle, in the exact centre of which each type-letter at the end of its hammer-lever strikes upwards. Two keys struck at the same time must consequently cause two type-letters to clash in their attempt to reach the same spot, the centre of the circle. This, however, does no injury to the instrument, although care must be taken not to cause it. Above the circle of levers the recording paper is situated, rolling on a drum, towards the operator, the whole being so placed that just before any letter of a word is struck that part of the paper on which the letter has to be impressed is nearly over the middle of the lever-circle. The depression of the key first moves the paper into the exact position and then prints the letter, figure, or stop. An independent key produces the blank between each two words.

The method of inking is excellent and unexpected. A strip of fine fabric, saturated with the ink is carried between two rollers so arranged that it intervenes *between* the paper to be printed on and the centre of the lever-circle. The type-carrying hammers do not, therefore, strike the paper itself at all, but only the ink-saturated band, which, as a result of the percussion, comes in contact with the recording paper, *but only in the parts where contact is made*, which are nothing more nor less than those corresponding to the configuration of the letter or figure employed. There is a simple shifting apparatus to carry this inking band from one roller to the other, and afterwards back again, which prevents the same part from being struck too often.

A side lever shifts the paper at the end of each line, and a small bell is struck to warn the operator when this has to be employed.

Into further detail we need scarcely enter. The whole instrument is not larger than a sewing-machine. Its cost is twenty guineas. It only writes in capitals, the total number of keys being forty-four, arranged in four rows of eleven in each. Its simplicity is the best guarantee of its durability.

As to the "typoscript" (in contradistinction to the manuscript of ordinary handwriting), there is no comparison between its clearness and that of average penmanship. It has, in fact, all the appearances of print, with its many advantages as regards legibility, compactness, and neatness. Errors, if detected soon enough, can be corrected by the repetition of the word or sentence, and the subsequent obliteration, upon reperusal, of the faulty lines. The ink employed can be transferred like transfer ink.

The principal question which this beautiful and ingenious little instrument suggests to our minds is, whether it would not be better for every one of us to learn the Morse telegraph language, and employ it for writing upon all occasions instead of the cumbrous letters now in vogue. Thought is more quick than formerly. Germany is rapidly rejecting its archaic type; why should we not go further and write in Morse, where spots and horizontal lines do duty for all necessary signs, and type-writers of the simplest form would be required?

ORIGIN OF LIFE

On Fermentation. By P. Schützenberger, Director at the Chemical Laboratory at the Sorbonne. With twenty-eight Illustrations. (Henry S. King and Co., 1876.)

Sur la Génération des Ferments. Par E. Fremy, Membre de l'Academie des Sciences, Professeur de Chimie à l'Ecole Polytechnique et au Muséum d'Histoire Naturelle. (G. Masson, Editeur, Libraire de l'Académie de Médecine: 1875.)

Evolution and the Origin of Life. By H. Charlton Bastian, M.A., M.D., F.R.S., Professor of Pathological Anatomy in University College, London. (London: Macmillan and Co., 1874.)

THE work on fermentation is one of the International Scientific Series. Starting with a thoroughly philosophical conception of his subject, the author points out that from our present stand-point of knowledge, all those phenomena classed together under the name fermentation, are but special cases of the chemical phenomena of life. To life, however, we are not to attribute any extra-material force or influence. Though the force that can reduce the complex chemical edifice called sugar in a certain determinate direction, is manifested only in the living cell of the ferment, yet this "is a force as material as all those we are accustomed to utilize." "In other words, there is really no chemical vital force. If living cells produce reactions which seem peculiar to themselves, it is because they realise conditions of molecular mechanism which we have not hitherto succeeded in tracing, but which we shall, *without doubt*, be able to discover at some future time." In the book will be found a clear and concise statement of our present knowledge of fermentation, and a brief history of the progress of opinion and research. The outstanding questions (and there are many) and diverse opinions are presented with scientific impartiality, as is also contradictory evidence. It is gratifying to observe how such rival theories as those of Liebig and Pasteur on the nature of fermentation can be swallowed up in a larger conception, and one at least of the combatants conclude that both may be right. "Fermentation," says Liebig, "is a movement communicated by instable bodies in process of chemical transformation." "I maintain," says M. Pasteur, "that the chemical act of fermentation is essentially a phenomenon correlative to a vital act." "So be it," replies Liebig, "'a vital act' is a phenomenon of motion; your special views fall within my theory." Necessarily large space in this work is given to the extensive and splendid researches of M. Pasteur, whose views the author follows in the main, though not at all times able to find them quite self-consistent or consistent with admitted facts. On the great question of most general interest—What is the origin of ferments? he adopts the conclusions of M. Pasteur.

The origin or generation of ferments is the subject of the work by M. Fremy, who has long and ably contested the theory maintained by M. Pasteur. According to this last distinguished chemist, all ferments are the offspring of living things similar to themselves; and when these organisms appear in any liquid, such as milk, or the juice of the grape, it is because the germs or eggs of these creatures have in some way been introduced into the liquid. M. Pasteur has made a great many interesting and most important experiments which to his mind demonstrate the doctrine of panspermism. The demonstration, however, is not universally accepted; and M. Fremy is among those who find it possible to admit the accuracy of most, if not of all, M. Pasteur's experiments without accepting his conclusions, while they in their turn bring forward observations and experiments which they hold to be quite irreconcilable with the hypothesis that ferments are always produced from germs of similar organisms. We can in no way refer to the innumerable experiments; we may, however, try to give in a few words some faint conception of the character of the discussion.

Whence, for instance, come the well-known organisms which appear in the expressed juice of the grape, and are invariably associated with alcoholic fermentation? "From germs that have found access to the liquid," says M. Pasteur. "No," replies M. Fremy, "they are evolved, as are all ferments, from the substance of the organic medium in which they appear." Now panspermitists have always taken for granted that the air is a vast reservoir of germs, all sorts of which they farther assume are everywhere and at all times being deposited on all solid and liquid substances. In perfect accordance with this opinion it was found that when the must of grapes was boiled to kill any germs that might have already got into it, and kept in a small flask from which the solid particles floating in the air were excluded, no fermentation took place. But, say the supporters of heterogenesis, that may not be because germs could not get in, but because by boiling you killed the vegetative life of the liquid. Well, answers M. Pasteur in triumph, it is all the same if you don't boil it. "Du suc de raisin pris dans l'intérieur du fruit et du sang retiré directement de la circulation se conservent sans altération, si on les préserve de l'influence des poussières atmosphériques. Dans ce cas, on ne peut pas invoquer la mort, par l'ebullition, des substances hémiorganisées vivantes qui existent dans le liquide." This is the fact which to M. Pasteur's mind ought to put an end to the discussion. The readers of NATURE know how he has used it against Dr. Bastian in his letter to Prof. Tyndall (NATURE, vol. xiii. p. 305), and the uninitiated might well look on this as a decisive blow; but the end is not yet. It was suggested long ago that in all experiments of this class the air in contact with the liquids described by Pasteur as "l'air pur, privé de ses poussières flottantes," soon became changed from its normal composition; it loses its oxygen, the presence of which is held to be an essential condition of the development of the alcoholic ferment. But this is not all. If the air contains the germs of the alcoholic ferment, "Why is it," asked M. Fremy very naturally, "that liquids in which this organism propagates and multiplies very rapidly if once introduced do not enter on fermentation when left exposed to the air?" Here is M. Pasteur's remarkable answer: "C'est que cette liqueur s'est couverte de moisissures; la place étant prise par les mycodermes, les ferments n'ont pas pu se développer." One step more. M. Pasteur has elaborately collected the dust from the atmosphere and carefully sown it in various prepared mediums without, however, once succeeding in obtaining alcoholic fermentation, although he sowed this dust in a liquid most suitable for the development of the alcoholic ferment. How has this awkward-looking fact been met by the advocates of the germ theory? Very simply, thus: Well it would appear, they observe, that after all the germs of the alcoholic ferment are not in the atmosphere, but the ferment always comes from germs nevertheless; the germs are on the surface of the grapes themselves. And M. Pasteur is ready with an experiment to prove it. Of course M. Fremy is equally ready with experiments and arguments to prove that it is not so.

Our space will not permit us to pursue the subject further. The morsel of the discussion which we have been able very imperfectly to present may, we hope, enable the general reader to perceive that we are still some way from that settled peace which follows victory. We make no pretence to have stated M. Fremy's case; the subject is intensely interesting, and we heartily recommend his book as a model of scientific discussion. In point of scientific temper he has altogether the advantage of his brilliant antagonist.

The following notice of Dr. Bastian's "Evolution and the Origin of Life" was written and put in proof a long time ago. It would have never been published, but for the fresh interest that Prof. Tyndall has given to the question.

It fell to the writer of this notice to review Dr. Bastian's "Beginnings of Life" (*Examiner*, Aug. 31, Sept. 14 and 28) on its publication in 1872. Our first words were these:—"One after another our ablest scientific workers are bringing the fruits of their labours and dedicating them as it were, humbly, to that profound philosophy of evolution of which Mr. Herbert Spencer may be said to be the prophet. In the work before us Dr. Bastian has attacked the enemies of evolution in what they have hitherto considered the very citadel of their strength. His chief point is that living organisms are evolved out of dead matter, containing neither spore nor germ, nor any such thing." Such was, and remains, our opinion concerning the relation of Dr. Bastian's researches to the theory of evolution.

It is part of the doctrine of evolution that living matter was once at least evolved from dead matter—from dead inorganic matter. Is there, then, or rather ought there to be, any inherent improbability in the supposition that living matter is now evolved from dead organic matter? Unless the conditions of life-evolution are known, and are known not to exist in the present state of our globe, the probability is surely the other way. Now the essential conditions of the process are, and will certainly remain for a very long time, one of Nature's darkest secrets. Why then do certain evolutionists so obstinately resist the assertion that Archebiosis has actually been known to take place? We cannot enlighten our readers on this point; nobody has ever been able to say why Dr. Bastian must be wrong.

At the same time, in trying to force evolutionists either to accept his conclusions or to stand convicted of inconsistency, Dr. Bastian may perhaps be held guilty of a little straining. Though we believe with Dr. Bastian that life-evolution is an every-day process, still we cannot agree with him that "the existence of such lowest and simplest organisms as the microscope everywhere reveals at the present day, is quite irreconcilable with the position that life-evolution has not occurred since an epoch inconceivably remote in time." To put somewhat strongly the reply of those who do not follow Dr. Bastian to this conclusion, his contention here is not unlike the reasoning of those critics of Mr. Darwin who argue that if men have been developed from monkeys there ought now to be no monkeys, for the plain reason that they ought to have all developed into men. The existence of lowest organisms may perhaps be irreconcilable with the position that life-evolution has not occurred since an epoch inconceivably remote in time, when coupled with Dr. Bastian's belief that in living matter there is "an internal principle or tendency leading to progressive complexity of development," whereby every living thing is kept constantly on the stretch for an opportunity to spring forward to a more complex structure. But this conception of an inherent principle of organisation, which, we must confess, appears to us rather ill-defined and unscientific, is not a part of the theory of evolution, and is expressly repudiated by Mr. Spencer and Mr. Darwin. Now, to those who know nothing about a "principle of organisation," there is no difficulty in conceiving lowest organisms remaining lowest organisms through a time indefinitely long. Indeed, what Dr. Bastian teaches concerning his world of Ephemeromorphs makes the conception very easy. "The complexly-interrelated individuals constituting this vast underlying plexus of infusorial and cryptogamic life must," he says, "remain wholly uninfluenced, so far as their form and structure are concerned, by what Mr. Darwin has termed 'Natural Selection.'" Surely it is quite as easy to conceive the mass of these ephemeromorphs going on for ever in an endless round as it is to picture one of them here and there setting out on its course of ascending development. But though Dr. Bastian, after proving his case, may have been somewhat zealous to convince the world and to confound his adversaries, no dispassionate reader of his books can fail to be struck with the simplicity and clearness of the reasoning, and the truly scientific candour of the author.

The complete argument is contained in this book, which may be profitably read by those who have not time to go through the larger work. Since the publication of that work some progress has been made. "Well-informed men of science," says Dr. Bastian, "no longer doubt that swarms of bacteria can be made to appear within sealed glass vessels containing suitable fluids, after the vessels and their contents have been exposed to the temperature of boiling water." That is, Dr. Bastian's experiments, which were at first discredited, have been verified by other workers, some of them with no bias towards a belief in spontaneous generation. But with this fact all well-informed men of science have not accepted Dr. Bastian's conclusion that these living things are evolved from dead matter. Not believing in spontaneous generation, they first supposed that Dr. Bastian must have bungled and deceived himself, because they had every reason to believe that living matter could not resist the temperature of boiling water. They are now obliged to admit that Dr. Bastian was not mistaken. Some, however, admitting this, prefer to give up their well-supported belief in the killing power of boiling water, rather than break with the sacred dogma, *omne vivum ex vivo*, in support of which they can now urge no single fact or argument.

In the treatise before us Dr. Bastian collects a great deal of evidence as to the amount of heat requisite to destroy life, which, summed up, amounts to this: "that all known forms of living matter with which accurate experiment has been made invariably perish at or below 140° F." And he details experiments of his own, in which living organisms appeared "within closed flasks which had been previously heated to 270-275° F. for twenty minutes, and to temperatures of over 230° F. for one hour." Having done this much, Dr. Bastian might, we think, rest satisfied for the present. If his readers fail to appreciate his facts, the little lessons in logic to which he occasionally treats them will not, we fear, help them much. We would also observe that though error may die hard, yet, if he has given it its death-wound, there is no great purpose to be served by triumphing over its last struggles and agonies. "Victorious along the whole line" may now be said of spontaneous generation with much greater truth than it was asserted by Prof. Huxley of the contrary view in 1870. With the facts as they now stand, it appears to us that no adverse criticism can do anything to shake the position which Dr. Bastian has given to the doctrine of the *de novo* origin of life. Some of the attempts that have been made to escape Dr. Bastian's conclusion, after admitting his facts, are curiosities in the way of scientific discussion. Now it is suggested that germs may have been protected from the destroying heat in the inside of enormous lumps almost as large as a pin's head. Again, and still better, that the germs of bacteria may escape death by reason of their excessive smallness. This last is a very happy thought, and deserves to be thoroughly worked out.

In conclusion, we would impress on those of our readers who may take some interest in this question, that there are special reasons why they ought not to rest satisfied with any second-hand statement. If they would know Dr. Bastian's case, they must read his book, which, thinks an American philosopher, Mr. Fiske, "may perhaps mark an epoch in biology hardly less important than that which was inaugurated by Mr. Darwin's 'Origin of Species.'"

Such was the light in which the question presented itself to one who, before studying Dr. Bastian's works, had passively accepted the doctrine *omne vivum ex vivo*. Only when we read Prof. Tyndall's paper of Jan. 13 did we find how far we were mistaken in supposing that the high honour of having settled a great question and added an important truth to our stock of science was about to be awarded to Dr. Bastian by universal consent. Certainly if we are to take Prof. Tyndall—a science teacher for whom we have the highest respect and admiration—as our guide and instructor on this subject, we might well blush at the youthful precipitation with which we threw ourselves into the arms of Dr. Bastian. We can only say that we had conscientiously tried to follow the controversy, and to make ourselves acquainted with the alleged and accepted facts. We honestly believed, and still believe, that we were making a simple statement of fact when we said, that Dr. Bastian's experiments, which were at first discredited, have been verified by other workers, some of them with no bias towards a belief in spontaneous generation, and that this was known to "well-informed men of science." When Prof. Tyndall says that he was "certainly not among the number" to whom the truth of Dr. Bastian's assertions was known, the phrase is slightly ambiguous. Of course Prof. Tyndall does not mean that he did not know that Dr. Burdon-Sanderson, for example, had by careful experiment established to his own satisfaction, though contrary to his expectation, that Dr. Bastian was accurate in his statement of fact. That Prof. Tyndall supposed it probable that Dr. Bastian and Dr. Burdon-Sanderson had committed "errors either of preparation or observation," and that he himself, were he to try, might escape such errors, is evidenced by his undertaking the course of experiments which for the present makes the question once more one of evidence. It was in this sense that Prof. Tyndall "did not know;" but in this sense it would have been an impertinence on our part, and even on the part of most "well-informed men of science" "not to know."

One word remains to be said. The question at issue is of profound biological importance with large practical bearings. It would be a disgrace to science, or rather to scientific men, were the present uncomfortable dead-lock of conflicting evidence to be permitted to remain for any length of time. Prof. Tyndall will, of course, publish descriptions of his experiments in the fullest possible detail; but the interested public have no just balance in which to weigh the accuracy and skill of Prof. Tyndall against that of Dr. Bastian. The high position of our great teachers undoubtedly carries with it certain obligations; and we scarcely think that we ask too much in the interest of science when we venture to suggest that steps should be taken towards the little friendly arrangement necessary for the settlement of the question.

DOUGLAS A. SPALDING

OUR BOOK SHELF

Solid Geometry. By Percival Frost, M.A. Vol. i. pp. 422. (London: Macmillan and Co., 1875.)

THIS excellent treatise is a revised and considerably enlarged second edition of the similar treatise brought out some few years since under the joint editorship of Messrs. Frost and Wolstenholme. The engrossing duties consequent upon Mr. Wolstenholme's holding the post of Professor of Mathematics at Cooper's Hill, have prevented his taking part in the bringing out of the present work. Great additions have been, and are being, made in this subject, as may be inferred from the fact that this first volume consists of 422 octavo pages, and even in this space many modes of treatment are omitted. "We cannot, however," writes Mr. Frost, "in a volume of moderate compass, pretend to include all the dual results to which our equations might give rise, but must confine ourselves to a development of the methods most generally useful."

The author reserves for his second volume "those parts which are chiefly interesting as pure geometry," bringing into the volume before us as much as he could, those parts of the subject which are more especially required by students who take up physical subjects. Prefixed to the text is a full table of contents: indeed both in this work and that by Dr. Salmon on the same subject, the full list reminds us (though drawn up on different principles) of the diagnoses of the natural orders prefixed to text books on the British flora.

The text is written with extreme lucidity, and the difficulties to be met with in its perusal do not arise from the style, but from the inherent difficulty of the matters treated of. In two or three places we come across the phrases "easy to see," p 154, "not hard to show," p. 157, and the like; of course here they are not intended to cover inability to expound the matter within reasonable compass, but still we think the proof might have been sketched out. When the student is going through the text step by step, he may even be able to work out the process by himself, but it is not so easy when the book is taken up at other times, when the previous steps in the reasoning are not fresh in the mind.

We note in Art. 192 that the elliptic sections are not pointed out; this and the definition of the *radical plane* (§ 166) which reads somewhat curiously to our mind, are the only defects we have been able to detect—we had marked many passages for comment, but all is so carefully done, and the work brought down to the latest discoveries, that we shall content ourselves with saying that the book is well entitled to a place by the side of Dr. Salmon's treatise. Mr. Frost, it is well known, employs the term "conicoid" for the surface of the second degree, and in the present work he gives his reasons for persisting (as he expresses himself) in retaining the term. We must just cite here the concluding part of his remarks; the surface of the second degree, "well deserves a distinctive name instead of being recognised only by its number, a mode of designation which, I am informed, a convict feels very acutely. Man might be always called a biped, because besides himself there exist a quadruped, an octopus, and a centipede, but, on account of his superiority, it is more complimentary to call him by some special name."

The list of typographical errors is, we believe, very small, and all are easily corrigible by the reader. The appearance of the book leaves nothing to be desired.

Physiologische Methodik: ein Handbuch der Practischen Physiologie. Von Dr. Richard Gscheidlen, Professor an der Universität zu Breslau. Erste lieferung.

DR. GSCHEIDLEN has undertaken to supply physiological students with a book which undoubtedly they very much need. He proposes to give a detailed and full account of the instruments and methods of practical physiology, and to consider the experimental basis on which our knowledge of the functions of the animal body are founded.

The book is to be published in parts; the first part, which we have before us, treats at considerable length of the measurements of volume, temperature, time, &c., needed in physiology and of the various instruments used in such measurements. It contains also the beginning of a chapter on physiological instruments and methods in general.

Altogether the present part gives good reason to hope that the work, when completed, will not only succeed in its main object of being useful to beginners, but will also be a valuable book of reference in physiological ways and means. We shall, however, reserve detailed criticisms till the book is published as a whole.

J. N. L.

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.*]

Periodicity of the Fresh-water Lakes of Australia

THE fresh-water lakes of Australia, though insignificant in size in comparison with the extent of the country, possess several features of considerable interest to the naturalist. Lake George, which is generally considered the largest sheet of fresh water on the Continent, is only some twenty-three or twenty-four miles in length and seven miles in breadth at the widest part, and even this lake had no existence twenty-four years ago. A bit of swampy ground across which drays could pass, occupied, in 1852, what is now the lowest part of the lake-bottom, and the rest was taken up by squatters and small farmers, who little dreamed, when they settled on the rich alluvial plain, that within a few years they would be hopelessly driven from their homes by the advancing waters. The present lake is situated, at an elevation of about 2,000 feet above the sea, at the lower end of a shallow basin formed by a fork near the southern extremity of the Blue Mountains, and about 150 miles from Sydney. This basin is some forty to fifty miles in length, and from fifteen to twenty miles in breadth, the mountains rising somewhat rapidly to a height of several hundreds of feet on every side except the south. The depth of the water at the present time is only from 25 to 30 feet, which, considering the extent of land submerged, affords a strong argument in favour of the supposition that the lake existed in past times, and was at least as extensive as it is now. An examination of the banks of the creek which runs into the head of the lake confirmed this hypothesis, and led me to believe that it has at one time been much more extensive than it is at present, for the horizontal layers of alluvial deposit could be traced along either bank at an elevation of 10 or 12 feet above the present lake-surface. This, however, could not have been the case within the last one hundred years—probably not within many hundreds of years—for the present lake is fringed with broad expanses of partially submerged forest trees, that must have attained a growth of more than a century before the waters overtook them. It may, therefore, I think, be assumed that the lake has never in recent times been so extensive as it is now, but that formerly it was much more so.

It will naturally be asked, What are the causes of its recent rapid growth, and what is likely to be the end of it? Without doubt the chief cause lies in the killing of the trees, which, until lately, covered almost uninterruptedly the whole basin except the lowest portion. The water is thus drained rapidly into the lake, and the surface exposed to evaporation reduced to a minimum. The trees have been destroyed chiefly by the squatter, in order to let in the sun and improve the grass. But another and unexplained cause has been at work during recent years destroying the bush, and the trees have died away mysteriously at the rate of scores, if not hundreds, of acres annually. Grub at the roots or within the bark, the injury done by cattle and sheep, opossums destroying persistently the young shoots, and various other pests, have been set down as the cause, but no explanation has as yet been accepted as satisfactory. It would seem rather as if the trees were suffering from some sickness such as animals are subject to, and many square miles of bush may be cleared away before the disease has spent itself.

Whatever may be the cause, the trees are rapidly disappearing within the drainage area of the lake, and the result will be that with improved drainage and less absorption the lake *must* increase in extent during the next few years, provided the rainfall does not seriously diminish during the same period. Another cause which has probably been at work enlarging the lake during the last twenty-four years, is an increased rainfall, but the argument on this point is rather drawn from the rapid growth of the lake than from any accurate observation. It has certainly happened once or twice during dry seasons that the lake has fallen a foot or two, but it has always recovered and advanced during the following year, so that its growth may be considered to have been continuous since the year 1852. After the winter of 1874, the lake rose from four to five feet, and during the severe drought of the following summer sank to the extent of from one to two feet, but with the returning rains it recovered its former level. If, up to the present time, the first and wet half of a cycle has been operating, and twenty-five years of deficient rainfall were now to commence, it would still, I think, be unreasonable to expect that the lake would contract very much—say to one-half or one-quarter its present size. The water that falls at the most distant spot in the basin is carried within a few hours into the lake—in the same manner as in other parts of the country it is carried into the rivers; and the same cause which tends to make the floods of the Hunter and other rivers more violent every year, will prevent Lake George from ever again becoming an insignificant pool. It may be noticed that cloudy summers—not necessarily rainy ones—would have a considerable effect in diminishing evaporation and thereby preventing shrinkage. A prevalence of westerly or northerly winds would have an opposite effect.

Near one of the squatter's houses, long ago submerged, was a well-stocked fish-pond. This the advancing waters soon appropriated, and its occupants finding their way into the lake, have increased to such an extent that the lake itself is now well stocked. These fish were chiefly the freshwater cod of Australian streams, and some of them have thriven so well that it is by no means rare to meet with specimens weighing from thirty to forty pounds each. Black swans, large flocks of three or four different kinds of ducks, with the red-legged ibis and other birds frequent the shores and afford good sport.

The general appearance of the lake shore is somewhat desolate on account of the enormous number of partially submerged trees that stand, some of them a mile or more, out in the water, and give the lake the appearance of an American river during a flood. The Eastern shore, however, is very beautiful for Australian scenery, the hills dotted with clumps of dark casuarina rising in beautiful grassy slopes from the water's edge.

At a few miles distance from Lake George to the eastward is Lake Bathurst, a much smaller sheet of water that appears to be under very much the same influences as the larger lake, the encroachment of the water being as well marked, although not so extensive.

It would be interesting to know all the influences at work in the increase of the Great Salt Lake, Utah, which is said to be growing at the rate of ten inches in vertical height yearly. As the whole country in the neighbourhood of this lake is destitute of trees, a periodic increase of rainfall is most probably the chief cause, in which case the lake's maximum may be expected to be reached at any time.

The cultivation of land previously bare might naturally be expected to cause a greater retention of moisture, whilst at the same time the hardening of the surface by the treading of cattle and sheep would cause the water to run off more easily; but the area of cultivated or pastured land within the drainage basin compared with that left in its primitive condition, is unknown, and it would be impossible to differentiate their effects.

It will be a subject of considerable interest to watch the conduct of these lakes during the next twenty years. R. ABBAY

The Cruise of the *Argo*

MANY useful suggestions were forwarded to me by the readers of NATURE before the yacht left Liverpool, in return for which I send my best thanks and a list of the places we have visited in the course of our most delightful and, as I trust, not unsuccessful voyage: Jan. 24, Madeira; Feb. 7, Antigua; Feb. 12, Barbuda; Feb. 13, St. Kitts; Feb. 14, Guadeloupe; Feb. 13, Dominica; Feb. 17, Martinique; Feb. 18, St. Vincent; Feb. 20, Grenada; Feb. 22, Trinidad; March 9, La Guayra; March 10, Caracas; March 17, Valentia; March 18, Puerto Caballo; March 21, Tucacas; March 27, Santa Marta; March 29, Savanilla; March 31, Carthagena; April 2, Kingston, Jamaica; April 13, Havanna (Museum most creditable). We leave to-morrow for Vera Cruz and the city of Mexico, with the Bahamas, Philadelphia, New York, and Niagara in prospect. We have had a clean bill of health and favourable weather throughout. One of the chief objects proposed by Mr. Cholmondeley in undertaking the voyage was to observe the habits of tropical birds in the west, and to increase his fine collection in the aviaries at Condover. Amongst the very numerous specimens of birds now on board are some that are extremely fine, and such as have rarely been brought to England in a living state.

In marine collecting most has been done in sponges, tunicates, and echinoderms. These, which have been gathered amply and in the rough, will no doubt on examination yield some good microscopic forms, and perhaps a few polyzoa, of which there has been to me, a most deplorable scarcity. In botanising, very fair success has been met with in Mosses, Lichens, and Jungermanniæ. A few most interesting fungi were collected in the deep forest in Trinidad. Entomology has not been neglected, but the extreme dryness of the season has been unfavourable. Of the eminent men, true students of nature, it has been my good fortune to meet, I must not now attempt to mention even the names. My great obligations to them will I trust find a suitable opportunity for acknowledgment. HENRY H. HIGGINS

Havana, April 10

Recent Discoveries in New Guinea; and Papua or Papooa?

THE ascent for ninety miles of a fine river in the south-east portion of New Guinea, in September last, by the mission vessel *Ellengowan*, has doubtless, before now, been made known in England (NATURE, vol. xiii. p. 76).

I expect, during the present year, to leave Samoa on my return to England, and I have some hope that I may take New Guinea *en route* to Australia, and visit the mission stations of the London Missionary Society on the south-east coast. If this hope is realised, I shall use every available means to determine what this large quadruped is, which has been tracked in three different parts of the island, if no one else makes the discovery before then.[1]

In concluding this letter, I wish to enter a protest against Dr. A. B. Meyer's orthography of the Malay names of New Guinea and the frizzly-haired portion of its inhabitants. He says (NATURE, vol. ix. p. 77, *note*): "I write Papooas, and not Papuas, because the Malays pronounce the word Papooa and not Papua." Surely Dr. Meyer must be aware that the vowel *u* in Malay is pronounced like *oo* in English. As early as 1812 Marsden, in his Malay Grammar (p. 12), gives as examples of the sound of *u* the "English *oo* in loom and tool." It appears to me not only pedantic and unnecessary, but also very objectionable, to make a change at the present time. Perhaps I feel more keenly on this point than most persons, owing to the fact that, with the assistance of a large staff of co-workers in various parts of the Pacific, I have in progress a comparative grammar

[1] It has been recently announced in the *Sydney Herald* that Signor D'Albertis has identified the large bird with the red-necked hornbill, and the droppings as those of the cassowary.—ED.

and dictionary of all the principal Malayo-Polynesian dialects, and am trying to reduce the whole to a uniform system of orthography. S. J. WHITMEE

Samoa, Jan. 3

The Visible Horizon

A POINT of some scientific interest has just been argued in the High Court of Justice. It was contended by the Solicitor-General that the three miles' limit of territorial waters was of modern origin, and by Sir R. Phillimore that it was due to that being the distance a cannon ball would reach from the shore. There can, however, be no doubt that the limit was recognised long before the invention of gunpowder.

Three miles is the distance of the *offing* or visible horizon to a person six feet in height standing on the shore. It is natural to suppose that the early maritime peoples of Europe would lay claim to the sea as far as the eye could reach. This distance they would find by experience was just *three miles*, and it can be proved mathematically to be correct. Measured by this standard —a tall man, usually taken as six feet high—the distance is invariable for all time, places, and peoples; measured by a cannon ball, it is constantly varying, and now ought to be five miles rather than three. The fact that the distance depends on both ocular and mathematical demonstration, and is not subject to improvement in gunnery, is the best explanation of its origin and application. B. G. JENKINS

Dulwich, May 8

Lunar Maps

LOHRMAN'S complete map, three feet in diameter, four sections of which were published in 1824, has been recently engraved by J. A. Barth, of Leipzig, under the supervision of Dr. Schmidt, director of the Athens Observatory, who has contributed a descriptive letterpress.

Schmidt's own map of six French feet diameter, will be issued before the end of the present year, from the *atelier* of the Royal Prussian Staff, the Prussian Government having, with great credit to itself, purchased that incomparable work. It is the result of thirty-four years' labour, and contains about 34,000 craters and an equal number of hills, besides over 350 rills and other objects. The difficulty of noting and correctly mapping this amazing number of lunar formations will be understood by anyone at all acquainted with the subject; and it will be seen that Dr. Schmidt has completed an achievement not surpassed in scientific capability and perseverance. A written text will accompany the map.

It were to be wished that our own countryman, Mr. Birt, could look forward to a similar recognition of his services. His great lunar map, of which we have heard nothing for some time, is on a plan quite different from Schmidt's, to which it would be found, if completed, an invaluable accompaniment by observers of the lunar surface; and it will speak but little for the scientific taste of our country if Mr. Birt's work is allowed finally to collapse for want of appreciation and encouragement.

Millbrook, Tuam, Ireland J. BIRMINGHAM

OUR ASTRONOMICAL COLUMN

THE STAR-LALANDE 27095 (BOOTES).—Olbers, writing to Bode in July, 1804, respecting his observations of the comet of that year, remarks of Lalande 27095, near the place of which star the comet was situated on March 22: "Ist nicht mehr am Himmel zu finden." It was observed by Lalande as a seventh magnitude, 1795, May 25 ("Histoire Céleste," p. 164), centre wire at 14h. 42m. 10s.

The star was observed by Bessel, 1828, May 24, as a 9th magnitude, and is No. 976 of Hour xiv. in Weisse's second catalogue. In the "Durchmusterung" it is 9·0. There is evidently reason for supposing the star to be variable.

It follows the sixth-magnitude-star B.A.C. 4906, 19s., and is 6′ 37″ north of it, the position for the beginning of the present year being R.A. 14h. 45m. 56s., N.P.D. 52° 6′·5.

THE FIRST COMET OF 1743.—Notwithstanding the very marked deviation of the orbit of this comet from a parabola, it does not appear that any attempt has yet been made to determine, directly from the observations, the true form of the orbit, or at any rate to work out elements which will satisfy the observations within their probable limits of error. It is true that these observations, with one or two exceptions, are by no means exact, and Olbers, who examined the question in 1823, was of opinion that, from their general uncertainty, an investigation into the nature of the conic section described was hardly worth the trouble it would involve. Notwithstanding this expression of opinion from so high an authority, it may be remarked that there are a sufficient number of observations in our possession which cannot fairly be supposed liable to serious errors to justify an attempt to deduce more satisfactory elements than those hitherto calculated.

The comet appears to have been first observed by Grischow or Grisso, at Berlin, on February 10, and his observation on the evening of that day was considered by Olbers to be the most certain of any he made upon this comet, and not liable to a greater error than 2′ or 3′. On February 14, 15, 16 and 19, Grischow, observing apparently with Margareta Kirch, also gives particulars from which probably fair positions might be deduced. And we have an observation by Father Frantz, of Vienna, on February 21, given in proper form in the "Philosophical Transactions" of the Royal Society. Also a good observation by Maraldi at Paris on February 13, and one by Cassini on February 17, which last, however, is open to some doubt, not only for a reason pointed out by Olbers, but from an error as to the comparison star. Zanotti's observations at Bologna, form the longest series, and extend from February 12 to 28, but they are only published (in *Mémoires de l'Academie*, 1743) in longitude and latitude to minutes of arc, without further detail, and were not given by Zanotti as having any pretensions to accuracy. The parabolic orbit with which Olbers was content to discontinue his computations was the following:—

Perihelion Passage, 1743, Jan. 10, at 20h. 29m. 37s. Paris M.T.

	° ′ ″	
Longitude of perihelion	92 57 51	
,, ,, ascending node ...	67 31 57	
Inclination to ecliptic	2 16 16	
Perihelion distance...	0·83818	(Earth's mean distance = 1)

These elements agree well, according to Olbers, with the positions observed on Feb. 10 and 28, and with the longitudes on Feb. 13 and 21, but the latitudes on these days differ by 14′ and 10′ respectively, which is precisely the kind of discordance, which we might expect to find, if the true orbit of the comet were an ellipse of short period. It will be remembered that Clausen considered this comet identical with that of November 1819, detected by Blanpain at Marseilles, with a period of 6·73 years before 1758 and 5·60 years after 1817, and that at the suggestion of Olbers the perturbations were calculated at the Collegio Romano to the year 1836, when the comet had been expected to re-appear. The orbit of short period which appears in catalogues with Clausen's name, was calculated from Zanotti's observations of Feb. 12, 20, and 28, with a pre-supposition as to the length of the major-axis. As already remarked, no attempt, so far as we know, has yet been made to deduce elements direct from the observations, which shall represent them with smaller errors than the parabolic orbits of Lacaille, Olbers, and Struyck.

Grischow records that on the evening of Feb. 11, 1743, the apparent diameter of the comet was 18′, that it appeared like a greyish-white cloud, but with close attention, "ein kleines helles Pünctlein in der Mitte gewahr." We find by calculation that the comet at this time was distant from the earth only 0·051 of the earth's mean distance from the sun, and are reminded that such an object would have afforded an opportunity of the kind to which Mr. Marth has lately adverted, for a determination of the amount of solar parallax. A similar opportunity may recur at any time, and, as is most probable, very suddenly; we can only hope that observers will be equal to the next occasion.

THE MINOR PLANETS.—Of the members of this group, in addition to the four older ones, Ceres, Pallas, Juno, and Vesta, at present favourably placed for observation, the brighter are Hera, Iris, and Melpomene; Hera and Melpomene are a little below the tenth magnitude, and Iris about 9·5. The following are approximate positions for Greenwich midnight:—

	Hera.		Iris.		Melpomene.	
	R.A.	N.P.D.	R.A.	N.P.D.	R.A.	N.P.D.
	h. m. s.	° ′	h. m s.	° ′	h m. s.	° ′
May 20	... 16 45 53	... 104 11	16 56 25	... 114 5	15 29 27	... 92 15
,, 24	... 16 42 26	... 104 5	16 52 28	... 113 53	15 25 36	... 92 3
,, 28	... 16 38 52	... 103 59	16 48 22	... 113 40	15 21 50	... 91 54
June 1	... 16 35 15	... 103 54	16 44 10	... 113 26	15 18 14	... 91 48

THE GREENWICH TIME SIGNAL SYSTEM

IN NATURE for April 1 of last year (vol. xi. p. 431) we gave a description of the new Sidereal Standard Clock of the Royal Observatory at Greenwich. Fundamentally important as is this clock in all that concerns its relation to exact astronomical science, it performs also another and more immediately practical duty, that of regulating the time of great part of the United Kingdom. And we propose now to trace the connection existing between this purely astronomical clock and those by which the daily business of our lives is arranged.

A few words of preliminary history may not be uninteresting. Formerly, when, comparatively speaking, little communication existed between the people of different towns, each place kept its own local time. But when railways began to be extended through the country in all directions, such manner of reckoning time could not with any regard to convenience be followed in arranging the movements of trains. The adoption of one uniform system of counting time having, as regards railways, thus become a necessity, all towns in connection with railways, as a matter of convenience, fell sooner or later into the same system, one now universally followed. The time of the meridian of Greenwich is that employed. This selection was probably in part accidental. The railway authorities, when seeking for uniformity, would naturally be led to take as standard the time of the most influential place, and so adopt metropolitan time, which happens to be, practically, Greenwich time. But however this may be, the selection was for another reason a happy one. The meridian of Greenwich is that from which longitudes are counted on all British maps, and Greenwich time having been already long used by the navigator, means of obtaining a proper knowledge of it at seaports was very desirable. Its adoption for railways by facilitating the after-introduction of the time-signal system as now existing was therefore a fortunate circumstance.

The regular exhibition of accurate time for public use, by any kind of authoritative signal, was commenced at Greenwich in the year 1833, when the first time-ball was erected on the eastern turret of the ancient portion of the Observatory buildings, principally for the purpose of giving Greenwich time to chronometer makers and seamen. It has been dropped every day since the year mentioned, excepting only during some periods of repair, and occasionally on days of violent wind. The ball, which is about five feet in diameter and painted black, is by mechanical means raised half-way up its mast at 5 min. before 1h. as a preparatory signal; at 3 min. before 1h. it is hoisted to the summit. It drops at 1h. true Greenwich mean solar time. Formerly it was discharged by an attendant who, watching a clock the error of which had been previously ascertained, pressed the ball-trigger at the proper instant, but since the year 1852 it has been discharged by automatic means, as will be explained further on. The first start of the ball, or its separation from the cross (indicating the cardinal points) immediately above, is very sudden, and is the phase to be noted; afterwards (to avoid injury to the building), a piston, connected by a long rod to the ball, falls into a nearly air-tight cylinder, and so checks its descent that it comes gently to rest at the foot of the mast.

Within a few years of the establishment of the Greenwich ball, others were erected at British observatories near to ports and harbours, as Edinburgh, Liverpool, Glasgow, &c., principally also for the service of shipping. And such signal balls or equivalent means of exhibiting time are now to be found at many observatories abroad, as for instance at the Cape of Good Hope, Madras, Bombay, Sydney, Melbourne, Mauritius, Quebec, Washington, &c. Originally such time-balls could only be dropped at an observatory or institution at which time was determined by celestial observation, but on the introduction of the electric telegraph an observatory could be made the centre of a system from which, by galvanic means, time-balls could be dropped at, or time-signals given to, distant points.

On the first establishment of the electric telegraph in England, the connection of the Royal Observatory with the telegraphic system and its possible application to the daily distribution of time throughout the kingdom soon engaged the attention of the Astronomer Royal, but before things had come to any definite shape, the scheme for laying a submarine cable between England and France was proposed, and active steps taken to carry it out. The progress of this work was watched with interest by astronomers on both sides of the channel, and some of the active members of the Institute of France having expressed their earnest desire to take advantage of the new cable for galvanic determination of the difference of longitude between the Observatories of Paris and Greenwich, the Astronomer Royal became enabled in the year 1852, principally with the assistance of Messrs. E. Clark (of the then existing Electric Telegraph Company) and C. V. Walker (of the South-Eastern Railway Company), to establish the long-desired communications on the English side. The application of the telegraph to the direct determination of longitude will not, however, further concern us at present. As soon as telegraphic connection with the Royal Observatory was complete, the system of transmitting time signals from Greenwich for distribution by the Electric Telegraph Company on their lines was commenced, special apparatus having been for the purpose prepared both at Greenwich and London. This we now proceed to describe.

The Mean Solar Standard Clock of the Royal Observatory, the principal clock of the whole time-signal system, erected in the year 1852 specially for the work, is always kept adjusted as nearly as possible to exact Greenwich mean time. It is a clock of Shepherd's construction, with seconds pendulum, and is maintained in action by galvanic means alone. But it works others sympathetically. The wire which carries the galvanic currents from the pendulum to the electro-magnets to drive the hands is continued, before returning to the battery, to other electro-magnets in connection with the hands of other dials in different parts of the Observatory building, so that the hands on all the dials advance simultaneously, the forward motion of the whole system depending entirely on the one pendulum of the standard clock. Of these various clocks, one is fixed in the boundary-wall of the Observatory; it is daily consulted by great numbers of people, and will be familiar to every visitor to Greenwich Park. Several are placed in the Chronometer Room for use in the daily comparison of the Royal Navy and other chronometers, the difference between the time shown on one of these dials and that of any chronometer giving immediately the error of the chronometer without further calculation. Other dials are to be found in different office rooms in which accurate time is necessary. All these clocks, including a seconds' relay, *a*, in the accompanying sketch, are *driven* by the galvanic current, but the standard clock further *controls* (by seconds' beats passing to London on a special wire from the seconds' relay) other clocks in London, on a principle, introduced nearly twenty years ago by Mr. R. L. Jones, in which the galvanic force is used, not as the driving power, but as an auxiliary, to keep right clocks already going very nearly right, each by its own motive power. The principle has assumed various practical forms, but that proposed by Mr. Jones is generally employed, and is as follows :—The ordinary bob of the pendulum to be controlled being removed, a horizontal galvanic coil is substituted. At each swing of the pendulum the coil encircles permanent bar magnets fixed to the clock-case, and the galvanic current received at each second from the controlling clock circulates through the wire of the coil. Then (within certain rather wide limits), whether the clock to be controlled tends to lose or gain, the magnetic action produced between the coil and the permanent magnets at the instant of passage of the current so accelerates or retards the pendulum that the clock is maintained in perfect sympathy with the controlling clock.

Thus, at Greenwich various mean-time clocks within the Observatory, and several in London, depend on the one pendulum of the standard clock at Greenwich. But it is a condition that the clocks shall continue to show exact Greenwich time, and as no pendulum will perform with the necessary accuracy for any long period, it becomes essential to provide convenient means of making periodical correction. The plan used at Greenwich is as follows :—To the pendulum of the Mean Solar Standard is attached a slender bar magnet about five inches long, carried parallel to the rod by an arm projecting forwards from it. Immediately below, in a central and vertical position, and supported by the clock-case, is placed a hollow galvanic coil, the accelerating and retarding coil. The lower end of the magnet passes closely over the upper end of the coil. A galvanic current when passed through the coil imparts to it magnetic properties, reversion of the current reversing the direction of its magnetism. If the current be such as to cause attraction between the adjacent ends of the swinging magnet and fixed coil, the pendulum, carrying with it the whole system of clocks, will be accelerated ; an opposite current causing repulsion will conversely produce retardation. The only caution to be observed is that correction must not be made too rapidly, otherwise the controlled clocks,

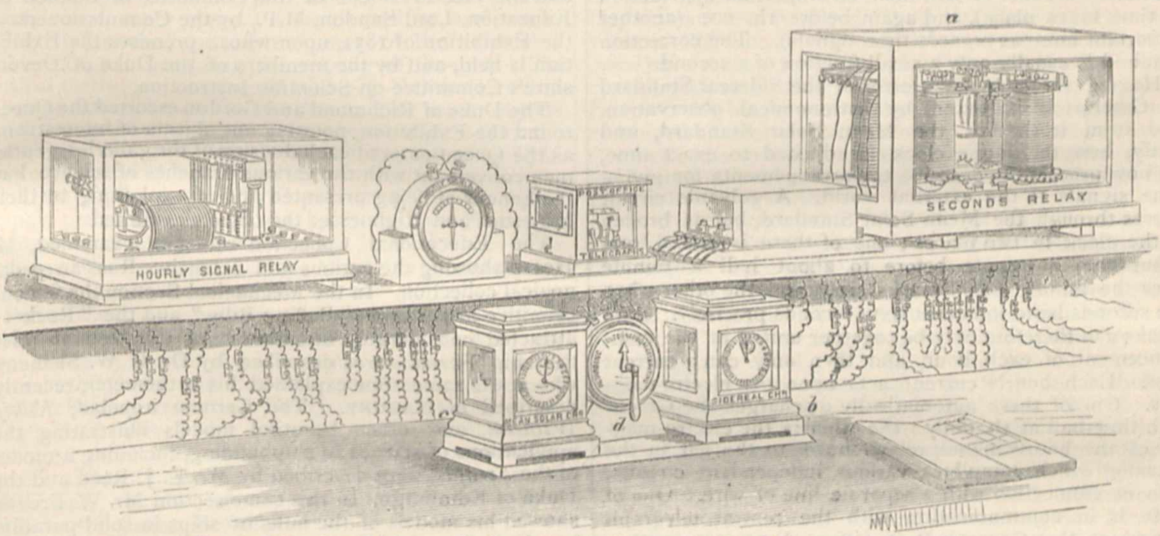

FIG. 1.—Time Signal Apparatus in the Computing Room at the Royal Observatory, Greenwich.

which are, as it were, merely *guided* by the controlling current, might, so to speak, break away from control. As at present arranged, to produce an acceleration or retardation of one second, the current must remain in action for about ten minutes.

Having described the mean-time system of clocks, and the magnetic appliance for correction of accumulated error, we have now to show how at any time the amount of correction required is determined. This makes it necessary to turn our attention to the system of sidereal clocks, and we shall now see how (as was stated at the beginning of this article) the Sidereal Standard is the real timekeeper of the country. This clock, with the system of sidereal clocks in connection therewith, was so fully described in the article already once referred to, that it will only be necessary to repeat here that amongst other things it galvanically registers its seconds on the paper of the revolving cylinder of the chronograph, and drives the sidereal chronometer *b*, situated on a certain desk in the Computing Room. Without going into further explanation it will be understood that, selecting a proper star of the *Nautical Almanac* list, the transit of which over the meridian has been observed with the transit circle and registered on the chronograph the times of its passing the several wires are extracted from the chronograph record, and the mean taken, which being corrected for the small errors of position of the instrument, and also (as the observations are taken by various observers) for "personal equation," the true clock-time of meridian passage, reduced to one standard, is found. The difference between this and the *Nautical Almanac* right ascension of the star for the day gives the error of the sidereal standard, which is also the error of the sidereal chronometer *b*. Unlike the mean-time clocks (which are required always to show true time), the error of the sidereal clocks is allowed to accumulate, and correction applied as necessary in any calculation in which time by one of the sidereal clocks enters.

Near to the sidereal chronometer *b* there is placed, on the same desk in the Computing Room, a mean solar chronometer, *c*, sympathetic with the Mean Solar Standard. Between these chronometers is fixed a commutator, *d*, by means of which a galvanic current can be thrown into the accelerating and retarding coil of the Mean Solar Standard. When the commutator index stands in the position shown in the drawing no action takes place ; when turned to the right the current accelerates the clock ; when turned to the left it retards the clock. To ascertain at any time the amount of correction required, the two chronometers are compared, usually by watching for a coincidence of beats. Knowing the error of the sidereal standard, by astronomical observation as described, the true sidereal time of comparison becomes known; the corresponding mean solar time is then easily calculated, and the error of the mean solar system of clocks immediately found. The commutator handle is then turned to throw a battery current into the accelerating and retarding coil, such as will attract or repel the pendulum magnet of the Mean Solar Standard, according as the clock is found to be slow or fast. The Mean Solar Standard and the various clocks in sympathy with it (those driven by it at Greenwich and those controlled by it at London) all receive the same correction, and are all brought to exact Greenwich mean time. By the arrangement described it will be seen that the Superintendent of the Time Department can at any time refer the Mean Solar system of clocks to the Sidereal Standard, and find and correct the error of the Mean Solar Standard and the whole system of mean solar clocks, whilst engaged in his ordinary office duties, and without moving from his position in the Computing Room. Correction is usually made every morning before 10h. A.M. (because at that hour an important distribution of time takes place), and again before 1h. P.M. (another important hour as regards time signals). The correction required is usually only a small fraction of a second.

Having shown how the error of the Sidereal Standard at Greenwich is found by astronomical observation, and from it that of the Mean Solar Standard, and lastly, how the latter clock is adjusted to exact time, we now proceed to describe the arrangements for giving time signals to the external world. A galvanic circuit passes through the Mean Solar Standard, but is broken in the clock in two places; one of these is united from about half a minute before to about half a minute after the minute hand marks sixty, and the other when the seconds hand indicates sixty seconds precisely. Both breaks can therefore only be together united at the commencement of each hour, and then only can a current pass. Each hourly current acts upon two electro-magnets. One of these automatically discharges the Greenwich time-ball at 1h. daily; the other is the electro-magnet of the hourly signal relay (shown to the left in the drawing) which completes various independent circuits, each in connection with a separate line of wire. One of these is in communication with the central telegraph station of the General Post Office, London; another extends to the London Bridge Station of the South-Eastern Railway Company. Along each line a galvanic signal passes hourly from the Observatory, day and night, for further transmission by apparatus under the control of other parties, and at this point (excepting in the case of the Deal time-ball to be hereafter spoken of) the special responsibility of the Observatory terminates. The small bell and galvanometer in the drawing marked respectively "Post Office Telegraphs" and "S.E.R. Hourly Signals," indicate at the Observatory the passage of the signals on these wires.

(*To be continued.*)

THE OPENING OF THE LOAN COLLECTION

THE Loan Collection was auspiciously opened on Saturday last by the visit of the Queen, and that it has exceeded all expectations is sufficiently shown by the opinions of the public press, which we have collected in another page. The Queen's visit is admitted on all hands to have been a complete success. Her Majesty herself, the Empress of Germany, and the other distinguished personages who accompanied her, showed a genuine interest in the collection, and especially in those apparatus to which their attention was particularly drawn. The *Times* is "authorised to say that not only did her Majesty express to the Lord President of the Council, the Duke of Richmond, her gratification with the exhibition and with its success—exceeding any that could possibly have been anticipated of it—but that her Majesty desired to make known how much she was gratified by the manner of her reception and by the solicitude with which her visit was made interesting by the several scientific men who explained to her the nature of the objects exhibited."

Besides the German Empress, the Queen was accompanied by the Princess Beatrice, the Duke of Edinburgh, the Duke of Cambridge, Prince Edward of Saxe-Weimar, and among others who accompanied the Royal party during their tour round the collection were the Duke of Sutherland, the German, Austrian, Russian, and French and Spanish Ambassadors, the Italian Minister, the United States Chargé d'Affaires, besides a considerable number of the most eminent representatives of British and Foreign science, most of the members of the several committees, and many of the exhibitors.

The Queen was received at the south-eastern entrance to the Exhibition by the Duke of Richmond and Gordon and the Vice-President of the Committee of Council on Education, Lord Sandon, M.P., by the Commissioners of the Exhibition of 1851, upon whose premises the Exhibition is held, and by the members of the Duke of Devonshire's Committee on Scientific Instruction.

The Duke of Richmond and Gordon escorted the Queen round the Exhibition, pointing out objects of interest, and as the Queen entered each division of the galleries, gentlemen conversant with the various branches of science had the honour of being presented and of explaining to their Majesties and Highnesses the objects exhibited.

The Educational Collection was first examined, M. Heard showing the curious and extensive Russian pedagogical collection. In the Mechanical Section the famous primitive locomotives "Puffing Billy" and the "Rocket" attracted considerable attention. In this section also the ship *Faraday* was described by Dr. C. W. Siemens, who at the same time explained his bathometer, recently described in NATURE. The German ironclad, *König Wilhelm*, and other beautiful models illustrating the applications of science to shipbuilding, including a model of the *Serapis*, were described by Mr. E. J. Reed and the Duke of Edinburgh. In this same section Mr. W. Froude showed his models of the hulls of ships in solid paraffin, by which the valuable experiments were made which were recently described by him at length in NATURE. Prof. Tyndall's explanation of the lighthouses and fog-horns excited considerable interest, the Siren fog-horn being sounded to illustrate the usefulness of the signal. In the Fish Museum Mr. Frank Buckland was ready to explain the many interesting objects and processes shown there. As the party passed into the gallery of Electricity and Magnetism, the enharmonic organ of Perronet Thomson was heard from above playing "God save the Queen." In the section just mentioned M. Breguet, of Paris, gave a brilliant display of the electric light, while Prof. Carey Foster explained the great Haarlem natural magnet. Mr. Gramme's magneto-electric machines were shown Spottiswoode, and various telegraphic instruments by by Mr. Culley. As her Majesty proceeded leisurely through the collection, Sir William Thomson showed his wonderfully ingenious tide-calculating machine, Joule's apparatus for researches in heat, and an apparatus for deep-sea soundings. Prof. Kennedy exhibited the important collection of kinematic models sent by Prof. Reuleaux, of the Royal Technical Academy, Berlin. The Walter type-composing machine was explained by Mr. J. C. Macdonald, Sir Joseph Whitworth described his millionth-of-an-inch measuring apparatus, while Mr. Chisholm explained various standard measures, a fine collection of standards made for the Russian Government by Dr. Werner Siemens, being particularly observed. The Astronomer Royal, Sir George Airy, showed the telescopes of Sir W. Herschel and Lord Rosse, and a little telescope of Newton's.

Prof. Eccher exhibited some interesting memorials of Galileo, his bust, telescope with broken lens, and other objects, invaluable relics, which the Queen expressed her gratification to see generously confided to the care of this Department of her Government by Signor Peruzzi, the Syndic, and the City of Florence. Mr. John Evans, in the Geological Department, exhibited results of the Sub-Wealden boring; and in the spacious gallery and conference room devoted on Saturday to Geography, Sir Henry Rawlinson showed the Queen Livingstone's maps, and illustrated the route of Lieut. Cameron; Lieut. Cameron himself exhibited his charts of the interior of Africa. Capt. Evans, the Hydrographer of the Navy, showed the original logs of Captain Cook and the log of the *Bounty*, and Admiral Ommanney a log of Sir John Franklin. A collection of German maps, explained by Major von Vistinghoff, and the interesting collection of fossil leaves shown by Baron von Ettinghausen, of Graetz were also inspected. In the Biological Department Prof. Burdon Sanderson and Dr. Lauder Brunton showed Marey's and other apparatus for recording and registering vital motion, and the instrument of Prof. Donders, of Utrecht, for measuring the velocity of thought. The musical instruments explained by Mr. J. Baillie Hamilton naturally attracted much attention. The other objects which attracted the attention of and were explained to the Queen and her party were Dalton's apparatus by Prof. Roscoe, Cavendish's and Black's balances by Dr. Frankland, early photographs by Capt. Abney, Russian heliographic plates and engravings by Baron von Wrangell, spectroscopes and radiometers by Prof. Guthrie, Otto von Guericke's air-pump and the Magdeburg hemispheres by Prof. Clerk Maxwell.

Before leaving the galleries, a telegram was despatched through one of the Morse instruments exhibited by our Post Office by the Empress Augusta of Germany, in the name of the Queen and herself, to the German Emperor in the following words :—"The Queen and the Empress have passed through the collection at the Exhibition of Scientific Apparatus and have been very much interested." Her Majesty the Queen desired that the same intelligence should be communicated to her eldest daughter the Crown Princess.

To quote the *Daily News* :—

"Throughout the course of the long promenade from the south-eastern entrance of the building in Exhibition-road to the exit in the Prince Albert's-road, neither the Queen nor the Empress of Germany exhibited the slightest sign of physical or mental fatigue. On the contrary, their majesties seemed rather inclined to remain for a space in converse with the learned expositors than to treat the inspection as a matter of ceremony."

During the visit, Sir Francis Sandford, Major Donnelly, Mr. Cunliffe Owen, and Mr. Norman Lockyer, were specially introduced to the Queen and Empress.

The Collection was opened to the public on Monday, and the number of visitors has been much greater than most people expected. They belong to all classes, and inspect the apparatus with evident interest and intelligence. The galleries, indeed, bear quite a lively aspect, and there is little danger of the Collection being a failure for lack of a public. We have no doubt, as its value and nature become known, the number of visitors will largely increase.

The first of the Conferences in connection with the Collection was opened on Tuesday, Lord Sandon making a short address of welcome.

"I have come down," he said, "to express my gratitude, and that of Her Majesty's Government, to the different men of science who are the real authors of what I may call the present success. I have had means of knowing personally the extraordinary sacrifices of time and labour of those men of science in this country who have produced the success. It is gratifying, if only for one reason—it has shown what a feeling of intellectual brotherhood exists. We have had the highest men of science of this kingdom working together to produce this very remarkable exhibition. When we think of their zeal and self-sacrifice and determination, the country cannot be too grateful. And these qualities have not been confined to this country, but far beyond this island. It has been a matter of universal remark, the zeal, the determination, and friendly feeling which have been shown by men of science all over the world. We have—the Lord President and myself—done all that we could do to make this not a gazing place merely, but to give as much instruction as possible to those who desire to receive it. These Conferences will be a source of the greatest possible gratification, old friendships will be renewed, new friendships will be created between men of science of other parts of the world. These Conferences will, we trust, be much appreciated. The examination of the collections will be much assisted by the admirable handbooks which have been prepared by men of the highest capacity. Allow me also to express my sense of the very high service which the officers of the Science Department have rendered; their zeal, their highly cultivated intelligence, devotion of time and almost of health—we have reason to be proud of serving the Queen in concert with such officers. To the different men of science I express my hearty good wishes for exertions towards the continued success of the Exhibition. When those Conferences come to a close we shall feel that a great work has been done on behalf, not of this country only, but for the whole of the world."

Mr. Spottiswoode, the President of the Section of Physics, to which Tuesday was devoted, then delivered his inaugural address, which we are glad to be able to give below, as also that of Dr. C. W. Siemens, the President of the Section of Mechanics, which met on Wednesday. The other addresses on Monday were by Mr. W. Huggins, D.C.L., F.R.S., on the present state of Spectroscopic research relating to the Stars and Nebulæ; Mr. Norman Lockyer, F.R.S., and Capt. W. de W. Abney, R.E., on Spectroscopic Research in Solar and Molecular Physics; M. le Professeur Soret, on a Spectroscope with a fluorescent eye-piece; Prof. R. Bellamy Clifton, M.A., F.R.S., on Interference, and Instruments for the measurement of Optical Wave Lengths; Mr. H. C. Sorby, F.R.S., on the original form of the Spectrum-microscope, and the various subsequent improvements, and additional apparatus; the Earl of Rosse, D.C.L., F.R.S, on Zöllner's Photometer; Prof. Sir W. Thomson, LL.D., F.R.S., on the principles of Compass Correction in Iron Ships; M. Sarasin-Diodati, on De la Rive's Researches in Statical Electricity; and the President, on some recent forms of Polariscopic Apparatus.

In the Section of Mechanics, which met yesterday, besides the address of the President, Dr. Siemens, the following papers were read :—

Sir Joseph Whitworth, Bart., F.R.S., on Linear Measure; Mr. C. W. Merrifield, F.R.S., on Solid Measurement; followed by a communication from Prof. Tilser (Bohemian Institute, Prague); Prof. Sir W. Thomson, LL.D., F.R.S., on Electrical Measurements; M. Tresca (Sous-Directeur du Conservatoire des Arts et Métiers, Paris), on Flow of Solids; Prof. Kennedy, on Kinematics, &c.

The Chemical Section meets to-day, when, after the address of the President, Prof. Frankland, the following papers will be read :—

Dr. J. H. Gilbert, F.R.S, on some points in connection with Vegetation; Mr. W. F. Donkin, M.A., of Keble College, Oxford, on the Ozone Apparatus of Sir B. Brodie, Bart., F.R.S.; Mr. A. Fletcher, H. M. Inspector of Alkali Works, on the Gases discharged from Alkali Works; Professor Andrews, F.R.S., Experiments on Gases.

On the 19th and 24th the Section of Physics will again meet; Mechanics on the 22nd and 25th; Chemistry on the 23rd; Biology on the 26th and 29th; and Physical Geography, Geology, Mineralogy, and Meteorology on May 30 and June 1 and 2.

The following are the arrangements which have been made in the Section of Mechanics:—22nd May.—Mr. Barnaby, C.B., Director of Naval Construction to the Admiralty, Naval Architecture; Mr. W. Froude, M.A., F.R.S., Fluid Resistance; Mr. Thomas Stevenson, Lighthouses. 25th May.—Mr. F. J. Bramwell, F.R.S., Prime Movers; Mr. Hackney, B.Sc., Furnaces; Général Morin, Directeur du Conservatoire des Arts et Métiers, Paris, Ventilation; Professor Zetzsche, Electric Telegraphs.

A general idea of the arrangements in other sections will be obtained from the list in last week's NATURE, p. 34.

Besides these Sectional Meetings, several *soirées* have been arranged, the first of which, that of Physics, took place last night. A Geographical *soirée* will be held on Saturday night.

Several visits have, moreover, we believe, been arranged, including one to H. M. S. *Challenger*, which is expected home every day.

The following are the names of some of the distinguished foreigners who have come to London in connection with the Loan Collection:—*Germany:* Dr. R. Schöne, Herr Wilhelm Kirchner, Dr. Biedermann, Dr. Neumayer, W. Verners, C. Desaga, Herr Lingke, M. Borus, Dr. Julius Fettbach, Dr. H. Rohrbeck.—*Russia:* Baron von M. Wrangell, M. Heard, Dr. Selim Lemström, Capt. M. Rkeman, R.A., M. Ovsiannikow, Prof. A. von Oettingen.—*Italy:* Il Com. Blaserna, Prof. De Eccher, Cav. Meucci.—*Austria:* Baron von Ettinghausen, Dr. Albert von Ettinghausen, Dr. Leopold Pfaundler.—*Holland:* Prof. Dr. P. L. Rijke, Dr. J. W. Gunning, Dr. D. de Loos, Prof. Dr. J. Bosscha.—*Switzerland:* M. Soret, M. Hagenbach, M. Forel, M. Wartmann, Prof. Favre, M. E. Gautier, M. Th. Turrettini, M. E. Sarasin, Prof. E. Hagenbach-Bischoff, M. R. Pictet.—*Belgium:* A. Renard, Prof. C. de la Vallée Poussin, Prof. G. Dewalque.—*Spain:* Señor Juan E. Riaño,.—*Orange Free State:* His Honour, the President of the Orange Free State.—*France:* M. Tresca, M. Golaz, M. Breguet, P. Jablochkoff.—*Norway:* Prof. P. Waage.—*Sweden:* Dr. Christian Lovén.

SECTION—PHYSICS.

Opening Address by W. Spottiswoode, F.R.S., &c.

THE opening of this Exhibition may prove an epoch in the science of Great Britain. We find here collected, for the first time within the walls of one building, a large number of the most remarkable instruments, gathered from all parts of the civilised world, and from almost every period of scientific research. These instruments, it must be remembered, are not merely masterpieces of constructive skill, but are the visible expression of the penetrative thought, the mechanical equivalent of the intellectual processes of the great minds whose outcome they are.

There have been in former years, both in this country and elsewhere, exhibitions including some of the then newest inventions of the day; but none have been so exclusively devoted to scientific objects, nor any so extensive in their range as this. There exist in most seats of learning museums of instruments accumulated from the laboratories in which the professors have worked; but these are, by their very nature, confined to local traditions. The present one is, I believe, the first serious, or at all events the first successful, attempt at a cosmopolitan collection.

To mention only a few among the many foreign institutions which have contributed to this undertaking, we are especially indebted to the authorities of the Conservatoire des Arts et Métiers of Paris, the Physical Museum of Leyden, the Tayler Foundation of Haarlem, the Royal Museum of Berlin, the Physical Observatory of St. Petersburgh, the Tribune of Florence, and the University of Rome.

Among those in our own country, we have to thank the Royal Society, the Royal Institution, the Ordnance Survey, the Post Office, the Royal Mint, the Kew Observatory, besides various other institutions and colleges, which have freely contributed their quota.

To enumerate even the chief of the individual instruments of historical interest would be a task beyond the limits both of my powers and of your patience. But I cannot refrain from naming as especially worth notice among the astronomical treasures, a quadrant of Tycho Brahé, telescopes of Galileo, a telescope of Newton, some lenses by Huygens, one of Sir W. Herschel's grinding machines for specula, and a telescope made by himself in intervals between his music lessons during his early days at Bath, at a time when, to use her own words, his sister Caroline "was continually obliged to feed him by putting victuals by bits into his mouth." This also is probably the "mirror from which he did not take his hands for sixteen hours together," and with which he may have seen for the first time the Georgium Sidus. To come to later days, we have the original siderostat of Foucault, lent from the Observatory of Paris, a compound speculum by the late Lord Rosse, the photoheliograph from Kew, and from still more recent times a complete transit of Venus equipment, from the Royal Observatory at Greenwich.

Turning to other branches of physics, we have a "composed microscope," now nearly three centuries old, constructed in 1590 by one Zacharias Janssen, a spectacle-maker, possibly a connection, or at all events a worthy predecessor, of M. Janssen, the celebrated astronomical spectroscopist. We have an air-pump, and two "Magdeburg hemispheres," with the original rope traces by which horses were attached in the presence of the Emperor Charles V., in order, if possible, to tear them asunder, when exhausted by the air-pump. We have the air-pump of Boyle, the compressor of Pappin, Regnault's apparatus for determining the specific heat of gases, Dumas's globe for the determination of vapour densities, Fizeau and Foucault's original revolving mirrors and toothed wheels, whereby the velocity of light was first determined independently of astronomical aid, Daguerre's first photograph on glass, and the earliest astronomical photographs ever taken. To these may be added De la Rive's instruments for statical electricity; the actual table and appurtenances at which Ampère worked; and some contrivances as if fresh from the hands of Faraday himself.

Yet rich as is this part of our collection, and interesting as it might be made in the hands of one versed in the history and anecdote of the past, we must not linger even about these pleasant places. Indeed a museum of only the past, venerable though it might be, would be also grey with the melancholy of departing life. For science should be living, instinct with vigour and organic growth. Without a continuance into the present, and a promise for the future, it would be like a tree whose branches are broken, whose growth is stopped, and whose sap is dried. And if I may carry the simile a stage further, an exhibition of the present, with no elements of the past, would be like the gathered fruits to be found in the market-place, ready to hand, it is true, but artificially arranged. But when past and present are represented in combination, as has been attempted here, the very newest achievements will be found in their natural places as ripened and ever-ripening fruit in the garden from whence they have sprung.

In reviewing the series of ancient, or at least now disused, instruments, one thing can hardly fail to strike the attention of those who are accustomed to the use of the modern forms. It is this—how much our predecessors managed to achieve with the limited means at their disposal. If we compare the magnificent telescopes, the exquisite clockwork, the multiplicity of optical appliances, now to be found in almost every private, and still more in every public, observatory, with those of two centuries past; or, again, if we look at the instruments with which Arago and Brewster made their magnificent discoveries in polarised light, in contrast to those with which the adjoining room is literally teeming, we may well pause to reflect how much of their discoveries was due to the men themselves, and how comparatively little to the instruments at their command.

And yet we must not measure either the men or their results by this standard alone. The character of the problems which nature propounds, or which our predecessors leave as a legacy to our generation, varies greatly from time to time. First, we have some great striking question, the very conception and statement of which demands the very highest powers of the human mind; unless, indeed, the clear and distinct statement of every problem may be regarded as the first and most important step towards its solution. Next follow the first outlines of the solution sketched in bold outline by some master hand; afterwards, the careful and often tedious working out of the details of the problem, the numerical evaluation of the constants involved, and the reduction of all the quantities to strict measurement. It is in this part of the business that the more elaborate instruments are especially required. It is for bringing small differences to actual measurement, for detecting quantities otherwise inappreciable, that the complex refinements with which we are here surrounded become of the first importance. But happily this somewhat overwhelming complication is not of perennial growth, for, curiously enough, by a kind of natural compensation, it relieves itself. In reviewing from time to time the various aspects of a problem in connection with the instrumental appliances designed for its solution, the essential features come out by degrees more strongly in relief. One by one the unimportant parts are cast aside, and the apparatus becomes reduced to its essential elements. This simplification of parts, this cutting off of redundancies, must not, however, be understood as detracting from the merit of the original devisors of the instruments so simplified; the first grand requisite is to effect what is necessary for the solution of the problem, then follows the question whether it can be done more simply or by some better process.

And this leads me in the next place to advert for a moment to the advantages which may accrue to the cultivators of science, and through them to the nation at large, from a national collection of scientific apparatus. Through the liberality of our foreign neighbours, and through the exertions of our own countrymen, we have here a magnificent specimen, an almost ideal exemplar, of what such a collection may be. By bringing together in one place, and by rendering accessible to men of science generally, the instrumental treasures already accumulated, and constantly accumulating, we should not only portray in, as it were, living colours the history of science, we should not only be paying just tribute to the memory of the great men who have gone before us, but we should afford opportunities of reverting to old lines of thought, of repeating with the identical instruments important but half-forgotten experiments, of weaving together threads of scattered researches, which could otherwise be taken up again only with difficulty, and after an expenditure of much and irretrievable time.

Let me now turn for a moment to the other side of the picture. If the collection in the midst of which we are here assembled is an evidence of the valuable relics which still remain to us of the great men who have passed away, the circumstances under which some of them have found their way hither, and the vacant places due to the absence of others, are no less evidence of how much the preservation of such objects would be promoted by the establishment of a museum such as I have ventured to suggest. Many circumstances contribute to thrust into oblivion, or to put absolutely out of reach of future recovery, original apparatus. First, the paramount importance and immediate uses of an improved instrument or a new invention; next, in Government departments such as the Survey, the Post Office, &c., the imperative demands of the public service, which leave little or no time for a retrospect of the past; and if I may add a word from the experience of private individuals, the pressing calls of space and expense lead the possessors to throw away, or to utilise, by conversion of the materials to new purposes, apparatus which has done its work. I venture to particularise one or two considerations, which will probably have occurred to many of you, but which appear to me to illustrate the above remarks. In the case of the Ordnance Survey it is almost certain that the current work of the department would never have required, and it is doubtful whether any private interposition would have brought about, the removal of the disused instruments, here exhibited, from the cellars at Southampton. Again, the Post Office would hardly have been justified in devoting valuable time to the arrangement, or valuable space to the storage, of instruments no longer on active service, except at the call of a public department, or for a public purpose. And surely it would be a matter of serious regret that the time already spent upon the collection now before us should have no issue beyond the purposes of the present exhibition. To take another instance; we have here fragments, but only fragments, of Baily's apparatus for repeating Cavendish's experiments; but of Cavendish's own apparatus we have simply nothing. Again, Wheatstone's instrumental remains must inevitably have been broken up and scattered or destroyed, if there had not been found at King's College a resting-place, and authorities intelligent enough to appreciate and willing to receive them. Of other individuals from whom apparatus, now of historical interest, has been received, some from sheer lack of space have been breaking up old instruments, while others, from a modesty commendable in itself, were with difficulty persuaded of, and even now are only beginning to perceive, the value, in a national and cosmopolitan point of view, of their own contributions. Lastly, there is, I think, little doubt but that, if the objects in question were to go a-begging, they would be gladly received in some of the foreign museums which have so liberally contributed on the present occasion.

To put the suggestion in a more tangible form I would venture to suggest that, in the first instance, instruments whose immediate use has gone by, but which are nevertheless of historical interest, lent either by public departments or by private individuals, might remain here on permanent loan; further, that other instruments as they pass out of active service, for example, from the Admiralty, from the Board of Trade, from the Ordnance Survey, or from the other departments, should similarly find a place in this museum. In such a category also might be included the scientific outfit of the *Challenger*, and of the Arctic Expeditions, and likewise those of expeditions for the observations of the transit of Venus or of solar eclipses. To these might be added apparatus purchased for special investigations through the parliamentary grant annually administered by the Royal Society. And further if, as I would suggest, this deposit of instruments be made without alienation of ownership, then private societies or even individuals might be glad to avail themselves of such a depository of instruments not actually in use.

In making such a suggestion, it must of course be assumed that the custody of property so valuable in itself, and so delicate in its nature, would be confided to a curator thoroughly competent for such a charge, but I abstain from entering prematurely into further details.

And now let me turn in conclusion to one more aspect of this great undertaking. We have here collected not only the instruments which represent the most advanced posts of modern science, but we have not a few of the men whose genius and perseverance have led the way thither; men who stand in the forefront of our battle against ignorance and prejudice and against the host of evils which a better scientific education must certainly dispel; we have men whose powers are competent for, and whose very presence is an inspiration to, further progress. But, while taking this first opportunity of offering them a hearty welcome, I shall however best consult both their feelings and your wishes by abstaining from any panegyric upon them in their presence, and by giving them an opportunity of speaking, and you of hearing them, upon some of their own subjects in illustration of the remarkable instruments which they have with so much pains and trouble brought under our view.

SECTION—MECHANICS.

Opening Address by Dr. C. W. Siemens, F.R.S.

IN opening the proceedings of the Conferences regarding Mechanical Science, it behoves me to draw attention to the lines of demarcation which separate us from other branches of natural science represented in this Exhibition.

In the Department of Applied Science we have collected here apparatus of vast historical interest, including the original steam cylinder constructed by Papin in 1690, the earliest steam-engines by Savery and by James Watt, the famous locomotive engine the "Rocket," by which George Stephenson achieved his early triumphs, as well as Bell's original marine engine, and a variety of models illustrative of the progress of hydraulic engineering and of machinery for the production of textile fabrics. In close proximity to these we find a collection of models illustrative of the remarkable advance in naval architecture which distinguishes the present day.

It would be impossible to deny the intrinsic interest attaching to such a collection or its intimate connection with the progress of pure science; for how could science have progressed at the rate evidenced in every branch of this Exhibition, but for the great power given to man through the mechanical inventions just referred to. Yet were Mechanical Science at these Conferences to be limited to the objects exhibited in the South Gallery (and separated unfortunately from apparatus representing physical science by lengthy corridors filled with objects of natural history), we should hardly find material worthy to occupy the time set apart for us. But, thanks to the progress of opinion in recent days, the barrier between pure and applied science may be considered as having no longer any existence in fact. We see around us practitioners, to whom seats of honour in the great academies and associations for the advancement of pure science are not withheld, and men who, having commenced with the cultivation of pure science, think it no longer a degradation to follow up its application to useful ends.

The geographical separation between applied science and physical science just referred to, must therefore be regarded only as accidental, and the subjects to be discussed in our section comprise a large proportion of the objects to be found within the rooms assigned more particularly to physics and chemistry. Thus all measuring instruments, geometric and kinematic apparatus, have been specially included within our range, and other objects such as telegraphic instruments, belong naturally to our domain.

With these accessions, mechanical science represents a vast field for discussion at these conferences, a field so vast indeed that it would have been impossible to discuss separately the merits of even the more remarkable of the exhibits belonging to it. It was necessary to combine exhibits of similar nature into subdivisions, and the Committee have asked gentlemen eminently acquainted with these branches to address you upon them in a comprehensive manner.

Thus they have secured the co-operation of Mr. Barnaby, the Director of Construction of the Navy, to address you on the subject of Naval Architecture, and of Mr. Froude to enlarge upon the subject of fluid resistance, upon which he has such an undoubted right to speak authoritatively. Mr. Thomas Stevenson, the Engineer of the Northern Lighthouses, will describe the modern arrangements of Dioptric lights, which mark a great progress in the art of lighting up our coasts. Mr. Bramwell has undertaken the important task of addressing you on the subject of Prime Movers, and Prof. Kennedy upon the kinematic apparatus forwarded by Prof. Reuleaux, of Berlin. M. Tresca will bring before us his interesting subject, the flow of solids. Mr. William Hackney will address you upon the application of heat to furnaces, for which he is well qualified both by his theoretical and practical knowledge. Mr. R. S. Culley, Chief Engineer of the Postal Telegraphs, will refer you to a most complete and interesting historical collection of instruments, revealing the rapid and surprising growth of the electric telegraph.

Measurement.—Regarding the question of measurement, this constitutes perhaps the largest and most varied subject in connection with the present Loan Exhibition. In mechanical science, accurate measurement is of such obvious importance, that no argument is needed to recommend the subject to your careful consideration. But it is not perhaps as generally admitted, that accurate measurement occupies a very important position with regard to science itself, and that many of the most brilliant discoveries may be traced back to the mechanical art of measuring. In support of this view I may here quote some pregnant remarks made by Sir William Thomson in his inaugural address delivered in 1871 to the members of the British Association, in which he says—"Accurate and minute measurement seems to the non-scientific imagination, a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient long-continued labour in the minute sifting of numerical results. The popular idea of Newton's grand discovery is that the theory of gravitation flashed upon his mind, and so the discovery was made. It was by a long train of mathemetical calculation, founded on results accumulated through prodigious toil of practical astronomers, that Newton first demonstrated the forces urging the planets towards the sun, determined the magnitude of those forces, and discovered that a force following the same law of variation with distance urges the moon towards the earth. *Then* first, we may suppose, came to him the idea of the *universality of gravitation;* but when he attempted to compare the magnitude of the force on the moon with the magnitude of the force of gravitation of a heavy body of equal mass at the earth's surface, he did not find the agreement which the law he was discovering required. Not for years after would he publish his discovery as made. It is recounted that, being present at a meeting of the Royal Society, he heard a paper read, describing geodesic measurement by Picard, which led to a serious correction of the previously accepted estimate of the earth's radius. This was what Newton required; he went home with the result, and commenced his calculations, but felt so much agitated, that he handed over the arithmetical work to a friend; then (and not when, sitting in a garden he saw an apple fall) did he ascertain that gravitation keeps the moon in her orbit.

Faraday's discovery of specific inductive capacity, which inaugurated *the* new philosophy, tending to discard action at a distance, was the result of minute and accurate measurement of electric forces.

Joule's discovery of thermo-dynamic law, through the regions of electro-chemistry, electro-magnetism, and elasticity of gases was based on a delicacy of thermometry which seemed impossible to some of the most distinguished chemists of the day.

Andrews's discovery of the continuity between the gaseous and liquid states was worked out by many years of laborious and minute measurement of phenomena scarcely sensible to the naked eye.

Here, then, we have a very full recognition of the importance of accurate measurement, by one who has a perfect right to speak authoritatively on such a subject. It may indeed be maintained that no accurate knowledge of any thing or any law in nature is possible, unless we possess a faculty of referring our results to some unit of measure, and that it might truly be said—*to know is to measure.*

To resort to a homely illustration of this proposition, let us suppose a traveller in the unknown wilds of the interior of Africa, observing before him a number of elevations of the ground, not differing materially from one another in apparent magnitude. Without measuring apparatus the traveller could form no conclusion regarding the geographical importance of those visible objects, which might be mere hillocks at a moderate distance, or the domes of an elevated mountain range. In stepping his base line, however, and mounting his distance-measurer, he soon ascertains his distances and observations with the sextant and compass, give the angles of elevation and position of the objects. He now knows that a mighty mountain chain stands before him, which must determine the direction of the watercourses and important climatic results. In short, through measurement he has achieved perhaps an important addition to our geographical knowledge. As regards modern astronomy, this may almost be defined as the art of measuring very distant objects, and this art has progressed proportionately with the perfection attained in the telescopes and recording instruments employed in its pursuit.

By the ancients the art of measuring length and volume was tolerably well understood, hence their relatively extraordinary advance in architecture and the plastic arts. We hear also of powerful mechanical contrivances which Archimedes employed for lifting and hurling heavy masses; and the books of Euclid constitute a lasting proof of their power of grappling with the laws regulating the proportion of plane and linear measurement. But with all the mental and mechanical power displayed in those works, it would seem strange that no attempt should have been made on the part of the ancients to utilise those subtle forces in nature, *heat* and *electricity*, by which modern civilisation has been distinguished, were it not for their want of the means of *measuring* these forces.

Hero of Alexandria tells us that the power of steam was known to the Egyptians, and was employed by their priesthood to work such pretended miracles, as that of the spontaneous opening of the doors of the temple, whenever the burnt offering was accepted by the gods, or as we moderns would put it, whenever the heat generated by combustion was sufficient to produce steam in the hollow body of the altar, and thus force water into buckets whose increasing weight, in descending, caused the gates in question to open.

Unfortunately for them, the Academia de Cimento of Florence had not yet presented the world with the thermometer, nor had Toricelli shown how to measure elastic pressures, or there would at any rate have been a probability of those clear-headed ancients applying the power of steam for preparing and transporting the materials, which they used in the erection of their stupendous monuments, and for raising and directing the water used in their elaborate works of irrigation.

The art of measuring may be divided into the following principal groups.

First. That of linear measurement, the measurement of area within a plane, and of plane angles; comprising Geometry, Trigonometry, Surveying, and the construction of linear measures, distance meters, sextants and planimeters, of which a great variety will be found within this building.

The subject of linear measurement will, I am happy to state be brought before you by one whose name will ever be remembered as the introducer into applied mechanics of the absolute plane, and of accurate measure, I mean Sir Joseph Whitworth. It is to be regretted, I consider, that Sir Joseph Whitworth adopted as the unit of measure, the decimalized inch, instead of employing the centimetre, and I hope that he will see reason to adapt his admirable system of gauges, also to metrical measure, which, notwithstanding any objections that could be raised against it on theoretical grounds—that, namely, of not representing accurately the ten millionth part of the distance from one of the earth's poles to its equator—is, nevertheless the only measure that has been thoroughly decimalized, and which establishes a simple relationship between measures of length of area and of capacity. It possesses, moreover, the great practical advantage of having been adopted by nearly all the civilized nations of Europe, and by scientific workers throughout the world. Sir Joseph Whitworth's gauges, based upon the decimalized inch, are calculated to maintain their position for many years, owing to the intrinsic mechanical perfection which they represent, but the boon conferred by their author would be still greater than it is if, by adopting the metre, he would remove the last and only serious impediment in the way of the unification of linear measurement throughout the world. A discussion will probably arise regarding the relative merits of measurement *à bout*, of which Sir Joseph Whitworth is the representative, and of measurement *à trait*, which is the older method, but is still maintained by the Standard Commissioners, both in this country and in France.

The second group includes the measure of volume or the cubical contents of solids, liquids, and gases, comprising stereometric methods of measurement, the standard measures for liquids, and the apparatus for measuring liquid and gaseous bodies flowing through pipes, such as gas meters, water meters, spirit meters, of which, likewise a great variety of ancient and modern date will meet your eye, and upon which Mr. Merrifield will address you.

Another method of measuring matter is by its attraction towards the earth, or, thirdly, the measurement of weight, represented by a great variety of balances of ancient and modern construction. These may be divided into *beam weighing machines*, which appears to be at the same the most ancient and the most accurate, into spring balances and torsion balances. The accuracy obtained in weighing is truly surprising, when we see that a mass of one ten-millionth part of a gramme suffices to turn the scale of a well-constructed chemical balance. Perfect weighing, however, could only be accomplished in a vacuum, and, in accurate weighing, allowance has to be made for the weight of air displaced by the object under consideration. The general result is that the mass of light substances is really greater than their nominal weight implies, and this difference between true and nominal weight must vary sensibly with varying atmospheric density.

Weighing in a denser medium than atmospheric air, namely, in water, leads us fourthly to the measurement of specific gravity which was originated by Archimedes when he determined the composition of King Hiero's crown by weighing it in water and in air.

Among measures of weight, may be noted a balance, which weighs to the five-millionth part of the body weighed, sent by Beckers Sons of Rotterdam; another from Brussels weighing to within a fourteenth millionth part of the weight, in weighing small quantities; a balance formerly used by Dr. Priestley; and Professor Hennessy's standards derived from the earth's polar axis, as common to all terrestrial meridians.

Next comes fifthly, *the Measurement of Time*, which although of ancient conception has been reduced to mathematical precision only in modern times. This has taken place through the discovery by Galileo, of the pendulum, and its application by Huygens to time-pieces in the 17th century. The most interesting exhibits in this branch of measurement are, from an historical point of view, the Italian, German, and English clocks of the 17th century, the Timekeeper which was twice carried out by Captain Cook, first in 1776, and which, after passing through a number of hands, was brought back to this country in 1843, and an ancient striking clock, supposed to have been made in 1348; it has the verge escapement which is said to have been in use before the pendulum. The methods employed in modern clocks and watches for compensating for variation of the thermometer and barometer, are illustrated by numerous exhibits, notably the Astronomical Clock, with Sir George Airy's compensation, which will form the subject of a special demonstration by Messrs. Dent and Co.

The measurement of small increments of time has been rendered possible only in our own days by the introduction of the conical pendulum, and other apparatus of uniform rotation, which alone conveys to our minds the true conception of the continuity of time. Among the exhibits belonging to this class, must be mentioned Sir Charles Wheatstone's rotating mirror, moved by a constant falling weight, by which he made his early determination of the velocity of electricity through metallic conductors; the rotative cylindrical mirror, marked by successive electrical discharges, which was employed by Dr. Werner Siemens in 1846, to measure the velocity of projectiles, and has been lately applied by him for the measurement of the velocity of the electric current itself, and the Chronometric Governor, introduced by him in conjunction with myself, for regulating Chronographs, as also the velocity of steam engines under their varying loads; Foucault's Governor, and a considerable variety involving similar principles of action.

Another entity which presents itself for measurement is, sixthly, that of *Velocity*, or distance traversed in a unit of time, which may either be uniform or one influenced by a continuance of the cause of motion, resulting in acceleration, subject to laws and measurements applicable both in relation to celestial and terrestrial bodies. I may here mention the instruments latterly devised for measuring the acceleration of a cannon-ball before and after leaving the mouth of the gun, of which an early example has been placed within these galleries. Other measurers of velocity are to be found here, Ships' Logs, Current Meters, and Anemometers.

In combining the ideas of weight or pressure with space, we arrive at seventhly, the conception of work, the unit of which is the foot-pound or kilogrammetre, and which, when combined with time, leads us to the further conception of the performance of duty, the horse-power as defined by Watt. The machines for the measurement of work, here exhibited, are not numerous, but are interesting. Among these may be mentioned Professor Colladon's Dynamometrical Apparatus constructed in 1844; Richard's Patent Steam Engine Indicator, an improvement on Watt's, and Mr. G. A. Hirn's Flexion and Torsion Pandynamometers.

Eighth. The Measurement of *Electrical Units*—of electrical capacityof potential—and Resistance, forms a subject of vast research, and of practical importance, such as few men are capable of doing justice to. It may be questioned, indeed, whether Electrical Measurement belongs to the province of mechanical science, involving, as it does, problems in physical science of the highest order; but it may be contended on the other hand that at least one branch of Applied Science, that of Telegraphy, could not be carried on without its aid. I am happy to say that this branch of the general subject will be brought before you by my esteemed friend Sir William Thomson, than whom there is no one more eminently qualified to deal with it. I may, therefore, pass on to the next great branch of our general subject, the ninth: *Thermal Measurement.*—The principal instrument here employed is the thermometer, based in its construction, either upon the difference of expansion between two solids, or on the expansion of fluids such as mercury or alcohol—(the common thermometer) or upon gaseous expansion (the air thermometer); or again, it may be based upon certain changes of electrical resistance, which solids and liquids experience when subjected to various intensities of heat. With reference to these, the air thermometer represents most completely the molecular action of matter which is the equivalent of the expansibility. I shall not speak of the different scales that have been adopted by Réaumur, Celsuis and Fahrenheit, which are based upon no natural laws or zero points in nature, and which are therefore equally objectionable upon theoretical grounds. Would it not be possible to substitute for these a natural thermometric scale? One commencing from the absolute zero, of the possible existence of which we have many irrefutable proofs, although we may never be able to reach it by actual experiment. A scale commencing in numeration from this hypothetical point would possess the advantage of being in unison throughout with the physical effects due to the nominal degree, and would aid us in appreciating correctly the relative dynamical value of any two degrees of heat which could be named. Such a scale would also fall in with the readings of an Electrical Resistance Thermometer or Pyrometer, of which a specimen has been added to this collection by myself.

When temperature or intensity of heat is coupled with mass we obtain the conception of quantity of heat, and if this again is referred to a standard material, usually water, the unit weight of each being taken, we obtain what is known as specific heat. The standard to which measurements of quantity of heat are usually referred is the heat required to raise a pound of water one degree Fahrenheit, or the cubic centimetre of water one degree Centigrade.

The most interesting exhibits in this branch of measurement, are, from an historical point of view, the original spirit thermometer of the Florentine Academia del Cimento, and the photographs of old thermometers; the original Lavoisier Calorimeter for measuring the heat disengaged in combustion, Wedgwood's and Daniell's Pyrometers.

As illustrating modern improvement may be instanced a long brass-cased thermometer showing the variation in the readings, when the bulb and when the whole thermometer is immersed; a thermometer with flat bulb to improve sensitiveness; a thermo-electric alarum, for giving notice when a given temperature is reached; an instrument for measuring the temperature of fusion by means of electric contact invented by Prof. Himly; Dr. Andrews' apparatus for measuring the quantity of heat disengaged in combustion; Dr. Guthrie's diacalorimeter for measuring the conductivity of liquids for heat, and a thermometrictu be by Prof. Wartmann for determining the calorific capacities of different liquids by the process of cooling.

Finally, Joule has taught us how to measure the unit of heat dynamically, and the interesting apparatus employed by him from time to time in the various stages of the determination of this most important constant in applied mechanics, are to be found, rightly placed, not among thermometers, and other instruments placed in the physical sections, but among the instruments required in the determination of three great natural standards—of length, time, and mass, and their combinations.

Another branch of the general subject is the *Measurement of Light*, which may be divided into two principal sections, that including the measurement of the wave-length of lights of different colours, and the angle of polarization, which belongs purely and entirely to physical science; and the measurement of the intensity of light by photometry, which, while involving also physical problems of the highest order, has an important bearing also upon applied science. The principal methods that have been hitherto employed in photometry are by the comparison of shadows, that of Rumford and Bouguer; by employing a screen of paper with a grease-spot, the lights to be compared being so adjusted that the spot does not differ in appearance from the rest of the paper, Bunsen's method; Elster's, by determining in combustion the amount of carbon contained in a given volume of a gas; and the one lately introduced by Prof. Adams and Dr. Werner Siemens, by measuring the variation in the electrical resistance of selenium, under varying intensities of light.

Before concluding, I wish to call your attention to two measuring instruments which do not fall within the range of any of the divisions before indicated. The first is an apparatus designed chiefly by my brother, Dr. Werner Siemens, by which a stream composed of alcohol and water, mixed in any proportion, is measured in such a manner that one train of counter wheels records the volume of the mixed liquid; whilst a second counter gives a true record of the amount of absolute alcohol contained in it. The principle upon which this measuring apparatus acts may be shortly described thus:—The volume of liquid is passed through a revolving drum, divided into three compartments by radial divisions, and not dissimilar in appearance to an ordinary wet gas-meter; the revolutions of this drum produce the record of the total volume of passing liquid. The liquid on its way to the measuring drum passes through a receiver containing a float of thin metal filled with proof spirit, which float is partially supported by means of a carefully-adjusted spring, and its position determines that of a lever, the angular position of which causes the alcohol counter to rotate more or less for every revolution of the measuring drum. Thus, if water only passes through the apparatus the lever in question stands at its lowest position, when the rotative motion of the drum will not be communicated to the alcohol counter, but in proportion as the lever ascends a greater proportion of the motion of the drum will be communicated to the alcohol counter, and this motion is rendered strictly proportionate to the alcohol contained in the liquid, allowance being made in the instrument for the change of volume due to chemical affinity between the two liquids. Several thousand instruments of this description are employed by the Russian Government in controlling the production of spirits in that empire, whereby a large staff of officials is saved, and a perfectly just and technically unobjectionable method is established for levying the excise dues.

Another instrument, not belonging to any of the classes enumerated, is one for measuring the depth of the sea without a sounding line, which has recently been designed by me, and described in a paper communicated to the Royal Society. Advantage is taken in the construction of this instrument, of certain variations in the total attraction of the earth, which must be attributable to a depth of water intervening between the instrument and the solid constituents of the earth. It can be proved mathematically that the total gravitation of the earth diminishes proportionately with the depth of water, and that if an instrument could be devised to indicate such minute changes in the total attraction upon a scale, the equal divisions on that scale would represent equal units of depth. (See NATURE, vol. xiii., p. 431.)

Gravitation is represented in this instrument by a column of mercury resting upon a corrugated diaphragm of thin steel plate, which in its turn is supported by the elastic force of carefully tempered springs representing a force independent of gravitation. Any change in the force of gravitation must affect the position of this diaphragm and the upper level of the mercury, which causes an air-bubble to travel in a convolute horizontal tube of glass placed upon a graduated scale, the divisions of which are made to signify fathoms of depth. Special arrangements were necessary in order to make this instrument *parathermal*, or independent of change of temperature, as also independent of atmospheric density, which need not be here described. Suffice it to say that the instrument, which has been placed on board the S. S. *Faraday* during several of her trips across the Atlantic, has given evidence of a remarkable accordance in its indications with measurements taken by means of Sir William Thomson's excellent pianoforte wire-sounding machine; and we confidently expect that it will prove a useful instrument for warning mariners of the approach of danger, and for determining their position on seas, the soundings of which are known.

Another variety of this instrument is the horizontal attraction meter, by which it will be possible to obtain continuous records of the diurnal changes in the attraction of the sun and moon as influencing the tides. This instrument belongs, however, rather to the domain of physics than to that of mechanical science.

These general remarks upon the subject of measurement may suffice to call your attention to its importance, several branches of which, those of *Linear*, *Cubical*, and *Electrical Measurement*, will now be dealt with.

The discussions which will follow these addresses will be carried on under circumstances such as have never before co-operated, namely, the presence of leading men of science of all civilised nations, who will take part in them, and the easy reference which can be had to the most comprehensive collection of models of scientific apparatus—both of modern and ancient—which has ever been brought together.

SCIENCE AT THE MANSION HOUSE

FOR the first time probably in the history of this country, science has been publicly acknowledged as a great force or power in the kingdom, on a level with literature and art. This, we think, is the legitimate conclusion to be drawn from the entertainment on Saturday by the Lord Mayor at the Mansion House of so many distinguished representatives of science, following hard as it did upon the opening of the loan collection by her Majesty the Queen. The company was numerous—there were about 300 present—as well as distinguished, and included several eminent foreign representatives of science, who have come over to the opening of the loan collection. The meeting was quite as successful as such meetings usually are, and the speeches on the whole much more sensible and appropriate. The following report of the speeches we take from the *Morning Post*:—

The Lord Mayor, in proposing the toast of the evening, "The Representatives of Science," spoke very happily. We were scarcely, he said, conscious of what we owed to science. If the inventor of the first small crane or lever for lifting water from a well were to come upon the scene now-a-days he would have some difficulty in persuading himself that it was the same world, and not some kind of paradise very far in advance of the world with which, in his day, that person was acquainted. Science was one of the mightiest of all the intellectual pursuits that man could follow. His Lordship said he had an intense admiration for the representatives of literature, but he could hardly express the feelings with which he regarded the men who laboured in the various phases of science. What did we owe to it? and what were we coming to? To science we owed every easement we enjoyed in the work of our daily life. Science enabled us, in comparison with past generations, to live our lives over and over again. It enabled us to travel such mighty distances within so short a space of time as a few years ago would have been inconceivable; and, what with the aid of the electric telegraph, it placed us in almost immediate communication with nearly all parts of the world. Having referred to the vast saving of manual labour which had been effected through the aid of science by machinery and appliances of various kinds, his Lordship expressed his gratification at the presence of representatives of so many branches of science.

Dr. Hooker, who was the first to respond, remarked that the occasion might be regarded as marking an important epoch in the history of science. It had been his pleasure to attend the various exhibitions for the promotion of science and art which had been held in this country and abroad by our own and by other Governments since 1851, and not only to study their contents but also to inquire into their origin and connection, and what might be called their individuality. With respect to the exhibition which the present banquet might be said to commemorate, he could see many marks which distinguished it from those that had gone before it. It had been brought to its present remarkable state by the indomitable energy of a very few workers whom it might be invidious to particularise, though he could not forbear mentioning the name of Mr. Lockyer. Originating as it did almost spontaneously, it had received the support of the Government from the active interest that was taken in it by the Lord President and the Vice-President of the Council, and from the diplomatic action which resulted in getting foreign Governments to send their delegates to visit the exhibition and to take part in conferences on the occasion of its opening. It had derived no small support from the countenance which had been graciously bestowed upon it by the Queen. In continuation, Dr. Hooker said, look at the state of science now and what it was 300 years ago. It had advanced with such strides as had marked the progress of no other branch of intellectual pursuit. Compare, or rather contrast, the progress of science in modern times with that of literature and the fine arts. With regard to literature, as with regard to the fine arts in this country, more especially in the case of sculpture and architecture, we had to look back ages almost to find a starting-point in their general progress, and even in the case of the most modern of the fine arts—painting—we were referred back to the cradles of its birth in Italy, Spain, and the Low Countries. With regard to the Exhibition for the Advancement of Science, what was to be its future? Was it to be a matter of a few weeks or months, and then to pass away for ever? It was to be hoped not. It was the earnest desire of scientific men to form the nucleus of a great national museum of a permanent character for the benefit not only of scientific men but for the benefit of the public in general, and he felt sure that science would not look to the public in vain for aid in the endeavour to realise that important object. It was an object worthy of great and noble efforts, and he felt assured that such efforts would not be wanting on the part of the City of London.

After a few remarks from Sir John Hawkshaw, Sir George Airy, the Astronomer Royal, replied for that branch of the toast which he represented, and spoke of science under two heads, which, for want of better terms, he said he might describe as practical and contemplative science. Of the present state of practical science it was impossible to speak too highly. It was impossible for any one who had even a partial acquaintance with what was going on in our manufacturing districts especially, and in all those labours which were for the benefit of mankind, not to be struck with the enormous amount of ingenuity and enterprise which were brought to bear upon those industries with a view to material gain. Material gain was the aim of practical science. As for what he termed the contemplative branch of science, which embraced especially all those pursuits relating to the constitution of nature, the object in that case was not material gain or personal advantage, but the results at which it aimed were in their way not inferior to or less welcome than those of practical science.

Mr. Justice Grove in proposing "The Health of the Lord Mayor," humorously remarked that his lordship when inviting such a body of representatives of science to partake of his splendid hospitality, must have been actuated, not only by a lively sense of favours received, but also by a lively sense of favours to come. Mindful of what science had done for commerce and manufactures in the past, the first magistrate of the city of London had doubtless an eye at the same time to the advantages which manufactures and commerce would reap from the labours of science in the future. There was nothing in which the Lord Mayor could do himself more honour than in entertaining at his table the votaries of science, to whom, on the other hand, nothing could be more gratifying or encouraging than this mark of recognition and appreciation on his part of the value of their labours.

To the toast of "The Foreign Representatives of Science," Prof. Blaserna responded.

Altogether, we think, both the Lord Mayor and the representatives of science are to be congratulated on the success of this entertainment, which will no doubt form a precedent for future ones of a similar kind.

NOTES

COL. PREJEVALSKY is about to set out on a new exploring journey into Central Asia, which will probably last for about three years. His purpose is to explore especially the basin of the Lob-nor from Thian-shan to the Himalayas. Col. Prejevalsky proposes to visit this summer Eastern Thian-shan from Kuloga to Hama, and to pass the winter upon the Lob-nor and in the deserts which extend to the east of this lake, mainly to solve the question as to wild horses and camels. Next spring he will observe the migrations of birds on Lob-nor and proceed to Lhassa. He will then explore the upper course of the Brahamapootra and the northern slopes of the Himalayas, as also Eastern Thibet and Southern China, and if circumstances permit, he will return by Western Thibet and enter Russia by Kashgar. The programme of the expedition is as follows:—1. Geographical and ethnographical descriptions. 2. An itinerary sketch at sight. 3. Astronomical determinations of places. 4. Meteorological, psychometric, and hypsometric observations. 5. Observations of mammals and birds. 6. Botanical, zoological, and mineralogical collections. 7. Photographic sketches. The Russian Geographical Society has expressed its emphatic approval of the programme, and the Emperor has ordered 24,740 roubles to be devoted to the expedition from the treasury.

FROM Commander Cookson we hear that H.M.S. *Petrel* is bringing home two living specimens of the Giant Tortoise of the Galapagos Islands, from Albemarle Island. A large supply of food was provided, and if this does not fail, and at the same time if the cold in the region of Cape Horn has not proved too intense, we may hope to see the specimens alive, for the first time in this country, during next month.

FROM the *Rochester Democrat and Chronicle* (U.S.) we learn that a gentleman of Rochester, New York, who does not wish his name to be published, has, through Prof. Henry A. Ward of that city, given to the University of Virginia, a sum of 5,500*l.* to be expended in the formation of a fully appointed cabinet of the natural sciences, including mineralogy, geology, and zoology. The donor has also given a building, at the cost of more than 4,000*l.*, for the collection, to be built near Charlesville, four miles from Monticello. Prof. Ward, in making the collection, will visit the principal European cities.

IN the *Proceedings of the Royal Irish Academy*, p. 427, Dr. Robinson gives us a paper on the theory of the cup anemometer, and the determination of its constants. The paper is an extremely valuable one, as indicating the line of research to be followed in prosecuting anemometrical experiments. So far as we are aware, Dr. Robinson is the first who has formed a just apprehension of the viscosity of the air in its bearings on such experiments, and adopted the necessary precautions in accordance therewith.

AT the meeting of the Edinburgh Botanical Society, held on the 11th inst., an interesting communication was read from the Rev. D. Landsborough, on experiments in growing several Australian plants and trees in Arran, in the Firth of Clyde, including among others the great Australian tree-fern and other tree-ferns, acacias, and gum-trees. The blue gum grew 11½ inches the first year, 4 feet the second, and 6 feet the third. The *Eucalyptus pendulosa* also grows well in sheltered situations along the west coast, and Mr. Landsborough expects to see it generally introduced in a few years, and form a valuable addition to our evergreen shrubs.

A CORRESPONDENT writes with reference to the "Plaster cast of portion of antler of reindeer from La Madelaine, Dordogne, France," in the loan collection, the original of which is preserved in France. The thicker end, the label states, is pierced with a hole. "There are as many as four holes in some specimens. *Their use is unknown.*" Our correspondent states that these implements may have been used by former inhabitants of France in the same manner as a very similar tool usually made of deer-horn is now in use or was very recently, by some tribes of the "Red men" of North America. Where bows and arrows are in use, the arrows are made of a very hard and tough willow. This willow may not always be quite straight, or is liable to get warped or crooked in the process of drying. If so, the bends or curves are straightened by the intended arrow being put through the hole in the horn, and a strong pressure applied in the proper direction to counteract the curve. This has sometimes to be done over and over again before perfect straightness is obtained. It may be asked why are three or four holes sometimes found in the same piece of horn? If the holes are of different sizes the reply is not difficult. It is probable that the people who use these tools had wood of different thicknesses (say for arrows and spears) to manipulate; if so, holes of different sizes would be required. It will, he thinks, be generally noticed that the edges of the holes are rounded; this would be done to prevent the otherwise sharp edge injuring the fibre of the wood. Near the specimen referred to, there is one in which one side of the hole has apparently been broken away by a violent strain, possibly applied in the manner and for the purpose above stated.

THE able director of the Royal Zoological Museum of Lisbon, José Vincente Barboza du Bocage, well known for his valuable researches on the natural history of the shores of Portugal, and especially on the Fauna of the Portuguese possessions in Africa, was unanimously elected a foreign member of the Linnean Society at their last meeting, May 4. Prof. William Nylander, of Helsingfors, a cryptogamic botanist of deservedly high reputation, also had the same honorary distinction conferred on him.

PARTS xlvii. and xlviii. of Mr. Dresser's "History of the Birds of Europe," completing the fourth annual volume of this important work, has just been issued with its usual punctuality. Nearly 400 species of birds have now been figured and described, and as the total European avifauna is probably between 600 and 700 species, three more volumes will be required. These will, almost certainly, be issued within three years from the present date, and we may therefore with great confidence anticipate the successful conclusion of a monograph, which, whether for the beauty of its illustrations, or for the fulness and accuracy of its information, will stand in the very first rank of ornithological literature.

IN Petermann's *Mittheilungen* for May is an article, accompanied by a map, showing the number, classification, distribution, &c., of the institutions for higher instruction in Germany. Following the continuation of the analysis of Prejevalsky's Mongolian travels is an interesting article on the recent travels of Dr. Emil Helub in South Africa, mainly in the Limpapo and Zambesi regions and the region of the salt-pans between Christiana and Mamusa. The information seems to be mainly obtained from the *Diamond News and Griqualand West Government Gazette* of Feb. 23, 1875. Probably the most interesting article is a detailed account of Giles's expedition from Beltana in South Australia, to Perth in Western Australia, in May–November, 1875. Giles's route was on an average four degrees to the south of Forrest's, which, again, was about the same distance south of that of Warburton. Giles has the same barren tale to tell as his predecessors. We believe he is to make a diagonal journey from north-west to south-east, though from this we can hardly expect many new results. A valuable map accompanies the paper in the *Mittheilungen*, which is to be continued.

THE latest news received by the Russian Geographical Society from Dr. Miclucho Maclay is dated from Cheribon (Java) in March last. He announces that before leaving Batavia he sent to St. Petersburg many zoological collections, and will bring his anthropological and ethnographical collections to Europe on his return, in 1877.

A BRANCH of the Russian Geographical Society will probably be shortly founded at Omsk, in Siberia.

M. DE MÄINOF, Secretary of the Ethnographical Section of the Russian Geographical Society, has announced to the Society that he is preparing a complete treatise on Russian ethnography. It will appear in parts, each containing a description of a section of the people.

M. L. ESTOURGIES has been charged by the Belgian Government, in company with M. Sylvain Jacquemin, civil engineer, to make a scientific journey through the Transvaal Republic.

THERE is to be a Congress of Alpine Clubs at Pistoja and Florence on June 10 and 11. Several expeditions have been arranged.

MR. J. H. ANGUS has made a gift to the Adelaide University, of a scholarship of 2,000*l.* yearly, tenable for three years, to encourage the training of scientific men, especially civil engineers, with a view to their settlement in South Australia; the winner of the scholarships to spend six months of the term in visiting the great engineering works of Europe or America, towards which the donor gives 100*l.* additional.

MAILS for the Polar ships *Alert* and *Discovery* will be made up for conveyance from Portsmouth on or about May 25, by the steam yacht *Pandora*, Capt. Allen Young having kindly consented to convey letters for the officers and crews of the Polar ships to be deposited at the depôts. All letters should be sent through the post-office prepaid the inland rate of postage, and addressed "Arctic Yacht *Pandora*, Portsmouth." No letters containing articles of value should be sent. No newspapers should be sent, as the Admiralty will send a sufficient supply.

THE University of Oxford is to confer upon Dr. Warren De la Rue the degree of M.A. by diploma.

THE ANNUAL Meeting of the Victoria Institute is postponed from the 22nd to the 29th of May.

LIEUT. CAMERON will, on Tuesday next, read to the Anthropological Society a paper on the Anthropology of Central Africa, in the theatre of the Royal School of Mines, Jermyn Street, at 8.30 P.M.

DOCENT THEEL, zoologist, a member of the Swedish Expedition of last year, to Novaya Zemlya, Docent Arnell, botanist, and Dr. Trybom, entomologist, have left Stockholm for Riga, whence they proceed overland to Siberia, where they will remain till autumn, making scientific observations and collections, and returning by the steamer *Ymer*, which Prof. Nordenskjöld has chartered for a voyage to the Yenisei.

M. JANSSEN, although he has not yet obtained possession of his regular observatory, has established large photographising telescopes at his residence at Montmartre. He found that during the cold period from the beginning of May up to the 10th, the sun had no spots at all. The photographs are about twenty centimetres in diameter.

C. M. STUART, of Harrow School, has been elected to the Natural Science Exhibition at St. John's College, Cambridge. A second exhibition was at the same time conferred on J. Nall, of Manchester Grammar School.

AT a recent meeting of the French Academy, M. Lecoq de Boisbaudran communicated some further facts regarding the new metal gallium. The specimen he had formerly presented owed its solidity to the presence of a small quantity of foreign bodies. Pure gallium, of which he had now prepared nearly ten centigrammes, melts at about 29°·5 C.; hence it liquefies when it is seized between the fingers. It is very easily held in superfusion, which explains how a globule has been kept liquid for weeks in temperatures descending occasionally almost to zero. Electrolysed gallium from ammoniacal solution is identical with that obtained from potassic solution. Once solidified, the metal is hard and resistant, even at a few degrees under its melting point; but it can be cut, and has a certain malleability. Melted gallium adheres easily to glass, on which it forms a beautiful mirror, whiter than that produced by mercury. Heated to a bright red in presence of air, gallium oxidises but very superficially, and does not volatilise; it is not sensibly attacked in the cold state by nitric acid, but in heat the solution operates with liberation of nitrous vapours. The density of the metal (determined approximately from a specimen weighing sixty-four milligrammes) is 4·7 at 15°, and relatively to water at 15°. The mean of the densities of aluminium and of indium is 4·8 at zero. Thus the density confirms theoretical prevision, while the extreme fusibility is a fact completely unexpected.

THE Marine tanks of the Royal Aquarium, Westminster, are being rapidly filled with water brought from Brighton by Messrs. Hudson, who supplied the Crystal Palace. For some time past many of the fresh-water tanks have been stocked, but the first marine fish has but quite recently arrived. It is a somewhat rare one in captivity—the *Motella tricerata* (Yarrell), commonly called the spotted leopard fish. It is placed in a central tank, so that the peculiarity of the "fin" in the neck can be well seen. Couch, in his "History of Fishes," refers to this fin as being always in rapid action, but with this particular specimen it is often at rest. He points out that while its intimate structure shows that it is destitute of any power of propulsion or of regulating motion, it is well furnished with nerves which render it acutely sensible to impression. The functions of the fin have, so far as we know, not been determined.

MR. WALPOLE, on Tuesday, moved for leave to introduce "A Bill for making further provision respecting the University of Cambridge and the Colleges therein." Following the recommendations of the Duke of Devonshire and the Oxford and Cambridge University Commissions, he indicated the nature of the changes desired as follows:—The extension of the professoriat, and a complete organisation of the system of inter-collegiate lectures and classes, for which provision would have to be made oaer and above that which had already been made, for museums, libraries,n ad the other apparatus which might be necessary for the prosecution of scientific investigation. The following are the names of the seven Commissioners it is proposed to appoint:—The Bishop of Worcester, Lord Rayleigh, the Lord Chief Justice, the Right Hon. E. P. Bouverie, Prof. Stokes, Rev. Prof. Lightfoot, and Mr. G. W. Hemmings. Mr. Cross said the Bill might be regarded for all practical purposes as a Government measure.

THE animals deposited in the Gardens of the Zoological Society by H.R.H. the Prince of Wales, include, among others, two Musk Deer (*Moschus moschiferus*); two Thar Goats (*Capra jemlaica*); four Indian Elephants (*Elephas indicus*), aged about 7, 6, 1½ and 1½ years; five Tigers, (*Felis tigris*); a Cheetah (*F. jubata*); a Viverrine Cat (*F. viverrina*); five Leopards (*F. pardus*); an Indian Civet Cat (*Viverricula indica*); two Dwarf Zebus (*Bos indicus*); seven Indian Antelopes (*Antilope cervicapra*); three Axis Deer (*Cervus axis*); three Ostriches (*Struthio camelus*); several pairs of Impeyan Pheasants (*Lophophorus impeyanus*); Cheer Pheasants (*Phasianus wallichii*); Horned Tragopans (*Ceriornis satyra*); Chukar Partridges (*Caccabis chukar*). Besides the Prince's specimens, the following are the most important additions of the week:—Two Secretary Vultures (*Serpentarius reptilivorus*), presented by Mr. M. G. Angel; an Egyptian Cobra (*Naja haje*), presented by the Rev. G. H. R. Fisk; and a Maholi Galago (*Galago maholi*), presented by Dr. R. A. Zeederberg, all from S. Africa.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, May 4.—On the Modification of the Excitability of Motor Nerves produced by Injury, by G. J. Romanes, M.A., F.L.S.

It has long been known that when a nerve is cut, or otherwise injured, its excitability at or near the seat of injury undergoes a marked increase. No one, however, has attempted to determine the relative degree of this increase towards make and towards break of the current respectively. The author found that when the nerve-section rested on the *kathode*, the *increase* of excitability was manifested towards *make*, and scarcely at all towards break; while, conversely, when the section rested on the *anode*, such *increase* was manifested towards *break*, and scarcely at all towards make. These facts are of considerable interest in relation to the theory of electrotonus. The *degree* of the latter increase, however, is out of all proportion greater than that of the former; for while the ratio of excitability before and after cutting was represented by the numbers 36 : 46 in the case of the kathodic make, such ratio was represented by 2 : 32 in the case of the anodic break. Mr. Romanes explains this disproportion by the consideration, that as the sensitiveness to the kathodic make is so much greater than is that to the anodic break *before nerve-section*, after the general sensitiveness of the nerve has been increased by section, the increase has not so much room to assert itself in the former as it has in the latter case, before it reaches zero of the stimulating current's intensity. Thus the figures 2 : 32 :: 36 : 46, though not expressing any *numerical* proportion, may yet express a *real* proportion, if the zero of the current's intensity be represented say by 50 in the above scale of nervous excitability, and if it be granted that the value as a stimulus of any given increment of current is determined by the proportion which such increment bears to the intensity of current that is required to produce adequate stimulation. This explanation is confirmed by a method of graduating the galvanic stimulus other than that of graduating the intensity of the current, viz., by graduating its *duration*. In this way it was found that, in respect of voltaic stimuli of very short duration, the sensitiveness to the kathodic make is much more increased by cutting than is that to the anodic break.

Mr. Romanes further observed that when a frog's gastrocnemius is subjected to a weak galvanic current, a part or parts of it will sometimes pulsate in a strictly rhythmical manner. This was proved to be a nervous effect by observing that it ceased when the attached sciatic was thrown into anelectrotonus.

With minimal stimulation of curarised muscle, the author found that considerably more effect is produced by first laying on the anode and then the kathode, than is produced if this order is inverted. This fact is just the converse of what Hitzig found to be true of cerebral stimulation, and as such it may be taken as confirmatory of his views concerning the reversed relations that subsist between central and peripheral voltaic excitation.

May 11.—"On some Thallophytes parasitic within recent Madreporaria." By P. M. Duncan, M.B. F.R.S., President of the Geological Society.

"Condensation of Vapour of Mercury on Selenium in the Sprengel Vacuum." By R. J. Moss, F.C.S., Chemical Laboratory, Royal Dublin Society. Communicated by G. Johnstone Stoney, F.R.S.

Royal Microscopical Society, May 3.—Mr. H. C. Sorby, F.R.S., president, in the chair.—Mr. Chas. Brooke, F.R.S., proposed a special vote of thanks to the president for the conversazione given by him on the 21st inst.—A paper was read by Mr. Blake on the occurrence of what appeared to be Foraminifera in the coralline oolite, and specimens in illustration were exhibited under microscopes in the room.—Mr. J. Glaisher communicated a paper by Dr. Gayer, describing the apparatus employed and the process adopted by him in India for the purpose of taking photo-micrographs with high powers.—A paper by Dr. J. J. Woodward on the markings of the body-scale of the English gnat and the American mosquito was read by the Secretary.—Some notes upon the same subject by Dr. Anthony were also communicated.—A short paper by Mr. Stodder on the identity of *Frustulia saxonica*, *Navicula rhomboides*, and *N. crassinervis* was read by the Secretary.—Mr. Chas. Stewart called attention to a curious living organism exhibited by Mr. Badcock, and which the Fellows present were requested to examine with a view to its identification.

Victoria (Philosophical) Institute, May 8.—After the election of new members, of whom fifty were announced as having been admitted during the past four months, it was stated that Prof. Birks would deliver the Annual Address for 1876.—A paper on the metaphysics of Scripture was then read by Prof. Challis, F.R.S.

BERLIN

German Chemical Society, March 27.—A. W. Hofmann, president, in the chair.—A. Flückiger has proved the presence of *carvacrol* in the oils of *mentha viridis* and of *anethum graveolens* by producing its characteristic combination with sulphuretted hydrogen.—O. Fischer described nitroso-acetanilide, $NC_6H_5 . C_2H_3O . NO$, an unstable compound from which acetaniline is easily reproduced.—J. Dümmer, by the action of amidophenol, $C_6H_4OHNH_2$, on sulphuret of carbon, has obtained an oxysulphocyanide of phenyl, C_7H_5NSO.—W. Smith has observed, that by passing through a red-hot tube naphthaline-vapour together with terchloride of antimony or tetrachloride of tin, a good yield of dinaphthyle is formed—

$$6C_{10}H_8 + 2SbCl_3 = Sb_2 + 6HCl + 3C_{20}H_{14}.$$

W. Thoerner has studied the action of hydrogen and of chlorine on tolylphenyl ketone. The latter gives rise to three crystallised substitution compounds :—

$$C_6H_5 . CO . C_6H_4 . CH_2Cl, \quad C_6H_5 . CO . C_6H_4 . CHCl_2,$$
and
$$C_6H_5 . CO . C_6H_4CCl_3.$$

The latter with water yields the acid $C_6H_5 . CO . C_6H_4COOH$. With zinc and hydrochloric acid the ketone yields a pinacoline, $\begin{matrix} C_6H_5 \\ C_6H_5 \end{matrix} \!\!>\! C \!<\!\! \begin{matrix} C_6H_4CH_3 \\ CO . C_6H_4 . CH_3 \end{matrix}$, as well as an isomeride.—H. Eimpricht described a number of substitution-compounds of meta-amido-benzosulphuric acid with bromine.—C. Councler has obtained borate of allyl, $Bo(OC_3H_5)_3$, a liquid boiling at 170°, by the action of boric anhydride on allylic alcohol.—Lothar Meyer, after decomposing sulphate of copper by metallic zinc, found in solution nothing but neutral sulphate of zinc, while metallic copper and basic sulphate of zinc were deposited on the metal. Evolution of hydrogen gas takes place during this process.

April 10.—H. Eimpricht described new derivatives of sulphobenzolic acid.—H. W. Vogel reported on the spectroscopic reactions of blood.—Robert Schiff described the action of isosulphocyanide of phenyl with aldehyde-ammonia. The body expected $C{=}S{-}NHC_6H_5{-}NH . \underset{\displaystyle CH_3}{\underset{|}{CH}} . OH$, or $C_{11}H_{19}N_3O_2S$ loses water and ammonia, and yields a well crystallised substance, $C_{22}H_{31}N_5O_2S_2$, thus :—

$$2C_{11}H_{19}N_3O_2S - 2H_2O - NH_3 = C_{22}H_{31}N_5O_2S_2.$$

The new body with acetic anhydride yields a phenylated and acetylated sulpho-urea : $C{=}S{-}NH . C_6H_5{-}NH . C_2H_3O$.—G. Schultz has treated isodinitrodiphenyl with tin and hydrochloric acid, thus transforming it into an isomeride of benzidine, called by the author diphenyline, $C_{12}H_8 (NH_2)_2$, crystallising in colourless scales, and fusing at 53°.—W. Staedel and L. Rügheimer have studied the action of alcoholic ammonia on chloro-acetyl-benzol $C_6H_5{-}CO{-}CH_2Cl$. The results are two bodies. One insoluble in ether, but soluble in boiling alcohol, from which it crystallises in silky needles, fusing at 194°, proved to be isomeric with indol, having the formula $C_6H_5{-}C{-}CH_2$ (the C and CH_2 joined below through N, $C{=}N$ and $N{-}CH_2$).—The other substance soluble in ether appears to correspond to the formula $C_6H_5{-}CO{-}CH_2NH_2$.—E. Demole, studying the action of bromine on clorhydrine of glycol, has found the following products of reaction : bromide of ethylene, bromochloride of ethylene, bromhydrine of glycol and bromo-acetic ether.—F. Beilstein and A. Kurbatoff have prepared two tetrachlorobenzols in which the four atoms of chlorine are situated at 1 . 2 . 3 . 5 and 2 . 3 . 5 . 6 respectively ; by starting from corresponding trichloranilines. The latter when oxydised yields chloranil, from which the authors conclude that in chinone the two atoms of oxygen occupy the positions 1 : 4.—E. Ullrich and H. von Perger described the differences between iso-anthraflavinic and anthroxanthinic acids.—F. Kessler described spectral apparatus for lecture purposes, the novelty of which consists in retransmitting the spectrum through the prism that engendered it, so as to obtain a dispersion of double magnitude.—H. Tollens described a shortened method of obtaining levulinic acid, $C_5H_8O_3$, from fruit sugar.—V. Meyer and F. Forster have repeated M. Einnemann's experience of decomposing normal propylamine with nitrous acid, and they arrive at the result that not only isopropylic alcohol but also normal propylic alcohol and propylene are thus engendered. The latter, combining with water, yields the isopropylic alcohol, the formation of which was hitherto unexplained.—O. Wallach and Th. Heymer have succeeded in combining directly chloral and trichlorolactic acid, thus forming chloralid, and proving that chloralid is the ether of trichlorethylidene with trichlorolactic acid. Lactic acid also combines with chloral.—A. Michaelis and E. Benzinger have reduced nitrophosphenylic acid to *amidophosphenylic* acid,

$$C_6H_4(NH_2) . PO(OH)_2,$$

white brilliant needles soluble in water. With soda-lime they yield aniline and phosphates. Nitrous acid transforms it into nitrate of diazophosphenylic acid : $PO_3H_2 . C_6H_4N = N . NO_3$. Phosphenylic acid and soda-lime yields benzol, while nitrophosphenilic acid and soda-lime yields nitro-benzol. The same chemists have produced phosphenyl-bromide, $C_6H_5PBr_2$, a colourless liquid, by passing hydrobromic acid gas into the corresponding chloride. With bromine it forms two solids of the formula $C_6H_5PBr_4$ and $C_6H_5PB_{16}$ respectively.—H. Lecco has obtained from sodium-nitromethane, CH_2NaNO_2, an anhydride, $C_2H_3N_3O_3$.—W. Michler, from an acid lately described dimethylamidobenzoic acid, $C_6H_4 . N(CH_3)_2 . COOH$, has obtained a basic ketone,

$$C_6H_4 . N(CH_3)_2{-}CO{-}C_6H_4 . N(CH_3)_2.$$

A third rest, $C_6H_4N(CH_3)_2{-}$ can replace an atom of hydrogen in this ketone, thus producing a complicated non-basic ketone.—H. Zincke has obtained, by the action of H on β benzoyl-benzoic acid, an anhydride, $\begin{matrix} O & - & CO \\ | & & | \\ C_6H_5CH & - & C_6H_4 \end{matrix}$; and from it, by chloride of phosphorus, anthrachinone.—C. Liebermann and H. Palm described β bromonaphthaline, $C_{10}H_7Br$, obtained from β naphthylamine by passing through the corresponding diazo-compound and naphthol.—A. Frank showed zeolith-like crystallisations in slowly-cooled glass. The same chemist showed wrought-iron transformed into silicium-iron by immersion in molten glass.—C. Bücking has transformed anisic aldehyde, $C_6H_5{}^{OCH_3}_{COH}$ into paraoxybenzoic aldehyde, $C_6H_5{}^{OH}_{COH}$, fusing at 111°.

April 24.—N. Gerber described an apparatus for closing the fat contained in milk.—P. J. Anster has transformed solid dibromobenzoles into three isomeric dinitro-dibromobenzoles; one of which he transformed into nitro-dibromo-aniline.—R. Ebert and V. Marz described two isomeric disulphonaphthalic acids, $C_{10}H_6(SO_3H)_2$, formed simultaneously and separated by the unequal solubility of their chlorides in benzol. With cyanide of potassium two bicyanides and the corresponding dinaphthoic acids were obtained; while fusion with potash transforms one of the sulpho-compounds into $C_{10}H_6(SO_3H)OH$, which with water yields β-naphthol; while the other sulpho compound yields dioxynaphthaline with a melting-point 186°.—F. Woreden discussed the constitution-formula of naphthaline.—F. Priwoznik finds the crystals formed in Leclanché's battery to correspond to the formula $ZnCl_2(NH_3)_2$.—H. Vogel defended the spectroscopic analysis of blood, sustaining that the spectroscopic reaction of indigo cannot be confounded with that of blood.—A. Oppenheim and H. Emmerling have continued their researches on the oxidation of oxyuvitic acid. Nitric acid yields hydro-oxybenzoic acid, while a mixture of sulphuric with fuming nitric acid produces trinitrocresol apparently identical with that obtained by Liebermann from nitro-coccinic acid.—P. Griess has formed combinations of phenol with one molecule and with two molecules of diazobenzol.

Vienna

Geological Society, Jan. 18.—The director, M. v. Hauer, presented a paper by M. F. Seeland, intended for the *Jahrbuch*, on the Erzberg, near Hüttenberg, in Carinthia, in which the author gives a detailed description of the geological relations of these mines, so very important to the iron industry in the Alpine districts. A map on the scale of 1·8640, and some sections, show the structure and distribution of the rocks, of which the following are specified:—Gneiss, mica-schist, Tourmaline rock, crystalline limestone, mica-schist containing garnets, amphibolite, argillaceous mica-schist, eclogite, besides the beds containing the ores.—M. E. Döll showed some minerals from Waldenstein, in Carinthia, among them a Pyrrhotite metamorphosed into ochreous red iron ore, which had not been noticed before; pure antimony, &c.—Dr. Neumayer, on the geological structure of the peninsula Oenalkidike, on the coast of Macedonia. By far the largest area of the whole country is covered with crystalline schists of the most varied lithological composition. In these strata are imbedded in some parts considerable masses of crystalline marble; for instance, on Mount Athos. The whole complex of schists and marbles forms a geological unity. Of a more ancient date there is only a small-grained gneiss, composing the peninsula of Zongo.—Dr. R. Hörnes, a paper contributing to the knowledge of the Megolodontes from the Alps.

Paris

Academy of Sciences, May 8.—Vice-Admiral Paris in the chair.—The President announced the presence of the International Committee of Weights and Measures, meeting in Paris for the first time since the various States represented had given legal sanction to the convention prepared by the diplomatic conference. The following papers were read:—On osmium, by MM. Sainte-Claire-Deville and Debray.—Note on fermentation, *à propos* of criticisms by Drs. Brefeld and Traube, by M. Pasteur. In a recent brochure Dr. Brefeld retracts his assertion that life cannot exist in an atmosphere deprived of oxygen. Examples, *Mucorracemosus* and beer yeast.—Note on electric transmissions without conducting wires *à propos* of recent papers by MM. Bouchotte and Bourbouze, by M. Th. Du Moncel. He recounts experiments he made some thirty years ago, and the theoretical deductions drawn.—On a calcareous alabaster from Mexico, by M. Damour. This new import, known as *onyx de Tecali*, is made into various ornaments, stands, pendulum supports, &c. It has undulating layers of various hues, and takes a fine polish.—On the flooding of the Seine, and the means of preserving Paris from the overflow of the river, by M. Belgrand. With quays insubmersible by floods of a given height Paris might be preserved (1) from overflows of these floods, by prolonging the collecting sewers from the quays to the fortifications, isolating them completely from the river, and keeping them at their normal level by engines at the Clichy works; (2) from subterranean inundations, by means of a drainage lower than the submerged caves, and without communication with the river and the sewers, and maintaining the ordinary level with centrifugal pumps and turbines worked by the water of the city.—M. Colladon was elected correspondent for the section of mechanics, in place of the late M. Seguin.—New solution of the general equation of the fourth degree, by M. Weichold.—New system of marine maps for navigation, by arcs of great circle, by M. Hilleret.—Extraction of gallium from its ores, by M. Lecoq de Boisbaudran.—Action of zinc on solutions of cobalt, by M. Lecoq de Boisbaudran. He has sometimes met with considerable quantities of cobalt in the metallic sponge resulting from action of zinc on the solution of blende in aqua regia. He notes the conditions of this singularity.—Influence of carbonic acid on the respiration of animals, by M. Raoult. Slow chemical actions are generally limited by the presence of the products formed; if the latter are not liberated the reactions remain incomplete. M. Raoult verified by experiment on rabbits, that the presence of carbonic acid in inspired air diminishes the quantity of carbonic acid produced, and especially that of the oxygen consumed in an hour; in other terms, the presence of carbonic acid in inspired air is an obstacle to hæmatosis.—On acetyl-persulphocyanic acid, by M. de Clermont.—On the exchanges of ammonia between the atmosphere and mould, by M. Schlœsing. These preliminary experiments show distinctly that, in general, mould borrows ammonia from the atmosphere. The supposed exhalation of ammonia during drought is, in all probability, an error; it is the contrary that occurs.—On the oscillation of the half of November, observed at Nijni Novgorod, by M. Bobynine.—On the existence of mercury in the mineral state in the department of l'Herault, by M. Thomas. He has found it flow abundantly from the detritus from a mountain called Bois de Cazilhac, in the canton of Ganges, also elsewhere. A particular lichen is found in those parts.—On the properties of the oysters called Portuguese, by M. Champouillon. These are from the Bay of Lisbon and mouth of the Tagus, where they have great fecundity, occupying an extent of about 50 kilometres. They have a claw-like shell, with small characteristic black point inside and a dark fringe. Analysis of the extracted oyster shows it to contain much more bromine and iodine than oysters on the English coast (0·039 gr. iodine and 0·052 gr. bromine in 1 kilogramme of the animal substance, which contains, besides, 760 grammes of water, and a slightly violet colouring matter). It is a valuable food, and is theoretically well suited for prevention of scrofula, ganglionic swellings, rickets, and perhaps also phthisis. This oyster cannot thrive on the coasts of Normandy, Belgium, or Britain.—Action of hydiodic acid on quercite, by M. Prunier.—Analysis of native magnetic platinum of Nischné Tagilsk (Oural), by M. Terreil. The considerable proportion of nickel in the ore is interesting.—Anatomy of the heart of Crustaceans, by M. Dogiel. (This forms part of a series of researches designed to throw light on the cause of rhythmic contractions of the heart in vertebrates.) The ligaments of the heart in these animals do not play the direct physiological *rôle* that has been attributed to them; and the membrane which separates the heart from the liver, the digestive apparatus, and the genital organs of a lobster, is much more complicated and important that has hitherto been supposed, both as to structure and its *rôle* in the movement of the heart.

CONTENTS