THURSDAY, AUGUST 21, 1873

THE REPORT OF THE SCIENCE COMMISSION ON THE OLD UNIVERSITIES

I.

ONE of the two Royal Commissions appointed to inquire into University matters has just issued its Report, and it comes in the very nick of time; for while on the one hand the question of University reform is day by day attracting a larger share of public attention, on the other the Financial Commission may be expected to report shortly and make us acquainted with the actual resources available for fundamental reforms which all acknowledge must be made, though opinions differ as to the precise direction they should take.

When we state that the Report to which we refer has been drawn up by a Commission, the Chairman of which—the Duke of Devonshire—is the Chancellor of Cambridge University, and that to it are appended the names of Stokes, H. J. S. Smith, Sharpey, Huxley, Lubbock, the Marquis of Lansdowne, and Mr. B. Samuelson as Commissioners, the importance of the document becomes manifest. Nor is it lessened by the way in which the Report at its outset refers to "all those parts of human knowledge and culture which are not usually regarded as having any scientific character;" adding, "Least of all should we wish to imply that there is any antagonism between the literary and scientific branches of education and research; it is rather our conviction that neither branch can be neglected without grave detriment to the other; and that an University in which the Mathematician, the Experimental Philosopher, and the Biologist are actively engaged in the endeavour to advance human knowledge in their own provinces, is not on that account less likely to be productive of original labours in the fields of Literature and Learning."

The subjects are dealt with in the following order:—

I. The Courses of Study and the Examinations.
II. The Professoriate.
III. The Scientific Institutions within the Universities.
IV. The Colleges.
V. The Relation of the Universities to Technical Education, and to Education for Scientific Professions.
VI. The Duty of the Universities and the Colleges with regard to the Advancement of Science.

Under the first head an examination on leaving school equivalent to the German *abiturienten examen*, to be controlled by the Universities, is proposed, "so that the scientific student who had shown the requisite literary proficiency in the 'Leaving Examination' would find himself absolutely free, except so far as the examination in Divinity is concerned, from the first moment of his entrance to the University, to devote his whole time and energy to his scientific studies." The Commissioners adding their opinion that "any system which does not concede, from the first, this freedom to those students of Science who have given proofs of sufficient literary acquirements, involves an interference with their course of study which in many cases is prejudicial."

The opinion is also expressed that, in addition to the College Scholarships, University Scholarships in Natural Science should be founded at both Universities; scholarships comparable to those which already exist for various branches of classical learning, and, at Oxford, of Mathematical Science.

Under the heading of the Professoriate, lists of the Professorial and Collegiate teachers at Oxford and Cambridge are given and compared with similar lists for Berlin, with the remark that "it is impossible not to be impressed with the evidence which the list affords of the abundance and variety of the scientific teaching given in the University of Berlin by professors of great eminence. We would particularly call attention to the fact that the list includes not merely general courses adapted to the requirements of those students who are interested in Science only as a part of a liberal education, but also special courses on subjects taken from some of the newest and most interesting fields of scientific inquiry; so that instruction of the kind most likely to develop a scientific spirit in the mind of the learner, and given by the most competent teachers, is put within the reach of every student."

With regard to the proposed additions to the Scientific Professoriate, without attempting to decide what should be the ultimate organisation of the Scientific Faculty in Oxford, the Commissioners are of opinion that arrangements should be made at the earliest possible opportunity for the establishment of two Professorships in Physics, and two in Chemistry, in addition to those already existing; for the redistribution of the biological subjects (exclusive of those assigned to the Faculty of Medicine) in such a manner as to secure their being represented by five independent professors; and for the addition of two chairs, one in Pure Mathematics and one in Mathematical Physics. Lastly, they are disposed to recommend the establishment of a Chair of Applied Mechanics and Engineering.

Somewhat similar additions are proposed in regard to Cambridge.

So far we have dealt with professors of the first order, so to speak, but the appointment of adjoint professors, demonstrators, and assistants is also proposed in the following words:—

"Although the witnesses have been unanimous as to the necessity of strengthening the professorial staff, they do not entirely agree as to the way in which this should be done. Mr. Pattison would increase the number of independent Chairs of Science to twenty or even to thirty. On the other hand, there appears to be a feeling that the principal subjects should not be too much divided although it is admitted that at present they are too much grouped together.

"It must not be forgotten that an increase in the number of independent Chairs would render it necessary for the Universities to provide increased accommodation in laboratories, and additional apparatus. With the view of utilising to the utmost the existing appliances of this sort, some of the witnesses have suggested that the increase of the professoriate should, as far as possible, be provided for by an abundant supply of skilled assistants, of demonstrators, and of assistant professors, rather than by increased numbers of independent lecturers.

"The necessity for skilled assistants and for demonstrators of course made itself felt at a very early period, and though a certain number of such assistants and demonstrators have been supplied, yet the need for an increase in the number of these subordinate offices has already become apparent. It may be mentioned, for example, that at neither University is any assistance of this kind at present afforded to the Chair of Geology, or to that of Botany.

"A Natural Science Professor should have, in the first place, sufficient skilled assistance to relieve him from all mere drudgery in the preparation of his lectures. In the second place, he should have such further assistance as may be necessary to enable him to carry on original researches. And, thirdly, although no professor would wish to hand over the superintendence of the practical teaching in his laboratories entirely to others, he should be enabled to discharge this duty of superintendence without an undue sacrifice of time. The work should be done under the professor's eye, but its details should be entrusted to competent demonstrators, appointed by and responsible to him.

"So far there is a general agreement; but the question whether assistant professors should be appointed at all, and if so, how far the dependence of the assistant professor upon the principal professor of the subject should be carried, has given rise to some divergence of opinion. We have already stated that we regard as indispensable the establishment of a certain number of new Chairs, to be independent of, and to take equal rank with, the existing Chairs. If the Universities are to become great schools of Science, it is of the first importance to secure for them the permanent services of a very considerable number of scientific men of established reputation; and we cannot perceive how this object is to be attained otherwise than by offering to such men, without any reservation whatever, the same academical *status* which has hitherto been enjoyed by the University Professors. We consider, therefore, that in any extension of the Professoriate, this is, without doubt, the first point to be attended to. But we are also disposed to attach great weight to the suggestion that, in addition to the Professorships representing the great divisions of Natural Science, University Teachers, who might be termed Adjoint Professors or Readers, should be appointed to undertake the instruction in special branches. It would be undesirable to place an Adjoint Professor in a position of complete subordination to the Principal Professor of the subject; and it would probably be very difficult to arrange any plan of partial subordination which could work satisfactorily. We are, therefore, of opinion that the Adjoint Professors should not be regarded as assistants to the Professors, but should be responsible for the due discharge of the duties assigned to them to a Board or Council, appointed by the University, and not to any individual Professor.

"It is important that the Universities should be able to secure the services of men who have shown their ability to promote Science, and to become successful teachers of it, by offering them places, such as the Adjoint Professorships, which would give them an opportunity of distinguishing themselves; and, with this view, it is very esirable that as much independence as possible should be allowed to the Adjoint Professors, in order to make the appointments attractive to the best men. On the other hand, as it is obvious that the perfection of the means and system of instruction in the Universities is of primary importance, an organisation of, and control over, the courses of instruction would be necessary, as otherwise there might be an excess of lectures in some subjects, and a deficiency in others. We are of opinion that these difficulties might be overcome, and a sufficient amount of liberty combined with systematic organisation, if, as we shall presently recommend, a Central Board, or Council, should be formed, representing the Scientific Faculty, and having definite functions with regard to the scientific teaching within the Universities.

"We may observe that the financial argument in favour of extending the Professoriate (at least in the first instance) by the institution of offices not intended to take equal rank with the existing Chairs, rather than by increasing the number of the Principal Professorships, will probably lose some of its force when a careful estimate is made of the difference which the adoption of the one plan or the other would make in the charge to be laid upon the funds of the Universities. It is quite true that the emoluments of an Adjoint Professor need not be so great as those of one of the Principal Professors; and that to this extent there would be a saving. But whether an additional professor of any subject be termed an Adjoint Professor, or whether his Chair be regarded as co-ordinate with the existing Chairs, the difficulty would always remain that if he is to be of any use at all he must be furnished with the necessary apparatus; he must have a room to lecture in, a room or rooms to work in, and the classification of the students will also probably require additional space. Laboratories of chemistry, physics, and physiology have been already provided; it would, therefore, not be necessary to create a large establishment for any new professor. But it is certain that the only way in which the Universities can increase the usefulness, at the same time that they increase the number, of the professors, is by being ready to make, from time to time, such moderate additions as may be necessary to the buildings which they appropriate to Science."

Under the heading "Duties of Professors," we have the following:—

"It has been suggested that, in the case of certain professorships at both Universities, the functions of Original Research might be separated from direct instruction. To a professor the duty of teaching is a matter of daily routine; whereas, original research is a duty which belongs to no day in particular, and which is, therefore, very likely to be neglected in comparison with the other. Nevertheless, we cannot see any just and sufficient reason, in the case of the professorships, for a total separation of the two functions; and even Sir Benjamin Brodie, who has supported the view that some distinction should be made between offices appropriated to teaching and those appropriated to original research, would not have the separation absolute, and would consider it of importance that even a professor whose chair was founded chiefly with the latter view, should be called upon to produce, from time to time, in the form of lectures, the results of investigations in new departments of Science. Lecturing is not the only mode in which scientific instruction may be imparted. A professor who should undertake the direction of a laboratory in which advanced students were to be trained in the methods of scientific research, would be very far from holding a sinecure office, and would be rendering the highest, as well as the most direct, service to scientific education.

"We have no doubt that for a professor the duty of teaching is indispensable, but we agree with the witnesses whom we have examined that original research is a no less important part of his functions. The object of an university is to promote and to maintain learning and science, and scientific teaching of the highest kind can only be successfully carried on by persons who are themselves engaged in original research. If once a teacher ceases to be a learner it is difficult for him to maintain any freshness of interest in the subject which he has to teach; and nothing is so likely to awaken the love of scientific inquiry in the mind of the student as the example of a teacher who shows his value for knowledge by making the advancement of it the principal business of his life.

"It has been, to a certain extent, a complaint against the School of Natural Science in Oxford that hitherto it has produced but very few original workers. The complaint (if well founded) may, perhaps, be accounted for by the circumstance that the school has not been long in existence; but there can be no question that it is of the utmost importance to impress upon teachers and learners alike that one, and perhaps the chief criterion of success in the teaching of Science is its leading to new discoveries. To promote this end the Universities probably can do nothing more useful than to increase the number of persons employed, under whatever name, in the teaching of Science, taking care at the same time that while such duties are assigned to them as may prevent their offices from being sinecures, they shall be left with time and energy enough to carry on original work. We consider this to be a point of great importance, and we should regret to see any scientific office whatever established in either of the Universities without its being understood that it is expected from the holder that he shall do what is within his power, not only for the diffusion, but also for the increase of scientific knowledge.

"It has been stated in some parts of the evidence which we have taken, that the duties of lecturing and teaching which are required from the professors are such as seriously to interfere with their leisure for original investigation, and a wish has therefore been expressed that the provisions of the Professorial Statutes as to the number of lectures to be given should be relaxed. We cannot concur with this suggestion. In estimating the amount of teaching and lecturing which can properly be required from a professor, we do not forget that he is expected to keep himself well acquainted with all the latest advances in some very wide department of knowledge, a task which, at the present rate of scientific productiveness, is no light one. But, on the other hand, we cannot leave out of sight that the University duties of a professor last for only six months, and that he has thus the invaluable privilege of being master of his own time for fully one half of the year. It is, therefore, only reasonable that during the University Terms he should devote a fair proportion of his time to the work of teaching. And we feel it to be our duty to say that, in recommending, as we have done, the foundation of a considerable number of new Scientific Professorships, our intention is that duties of a very substantial kind should be attached to each of these offices, with a view to the establishment of an efficient and complete course of instruction."

From the limited scope of the functions of the various existing administrative bodies, as well as from the constitution of one of them, the Commissioners consider that they cannot be regarded as representing, in any adequate manner, the Scientific Faculty of the University. They then add, "We are of opinion that the best mode of providing for this important object would be to replace them by a Single Administrative Body, representing every department of Science, and having wider but still definite powers entrusted to it. Without attaching any importance to the name, we shall, for the purposes of the present Report, designate this proposed administrative body as 'the University Council of Science.'

"The duties of the Council would, we conceive, be twofold—educational and financial."

(To be continued.)

HARMONIC ECHOES

ACCORDING to Dr. Brewer * "The harmonic echo repeats in a different tone or key the direct sound. The harmonic is generally either the third, fifth, or tenth of the tonic. . . . On the river Nahe, near Bergen, and not far from Coblentz, is an echo thus described by Barthius:—It makes seventeen repetitions at unequal intervals. Sometimes the echo seems to approach the listener, sometimes to be retreating from him; sometimes it is very distinct, at others extremely feeble; at one time it is heard at the right, and the next at the left; now in unison with the direct sound, and presently a third, fifth, or tenth of the fundamental. Occasionally it seems to combine two or more voices in harmony, but more frequently it resembles the voice of a single mimic.

"At Paisley, in Scotland, there is a somewhat similar echo in the burying-place of Lord Paisley, Marquis of Abercorn. Musical notes rise softly, swell till the several echoes have reverberated the sound either in unison or harmony, and then die away in gentle cadence.

"At the Lake of Killarney, in Ireland, is a very celebrated harmonic echo, which renders an excellent *second* to any simple air played on a bugle. †

"There was formerly, according to the authority of Dr. Birch, an harmonic echo no less remarkable, seventeen miles above Glasgow, near a mansion called Rosneath. If a trumpeter played eight or ten notes, the echo would repeat them correctly a third lower. After a short silence another repetition was heard, still lower than the former; and after a similar pause the same notes were repeated a third time, in a lower key and feebler tone, but nevertheless, with the same undeviating fidelity. This echo no longer exists."

It is difficult to believe that these descriptions are accurate, but that they have a basis of truth there can be little doubt. My attention was first drawn to the subject

* "Brewer on Sound and its Phenomena." (1864.) P. 305.

† This must be a near connection of the equally celebrated Irish echo, which in reply to "How do you do?" answers, "Very well, thank you."—R. Or of that celebrated echo at Shoreditch Station, illustrated by poor Leech in *Punch*, where, to the old gentleman's call of "Porter," is replied "Don't you wish you may get him."—ED.

by an echo at Bedgebury Park, the country residence of Mr. Beresford Hope. The sound of a woman's voice was returned from a plantation of firs, situated across a valley, with the pitch *raised an octave.* The phenomenon was unmistakeable, although the original sound required to be loud and rather high. With a man's voice we did not succeed in obtaining the effect.

At the time I had no idea that such an alteration of pitch had ever been observed, or was possible; but it soon occurred to me that the explanation was similar to that which I had given of the blue of the sky a year or two previously (Philos. Mag., Feb. 1871). Strange to say, at the very time of the observation I had in my portfolio a mathematical investigation * of the problem of the disturbance of the waves of sound by obstacles which are small in all their dimensions relatively to the length of the sound waves. In such a case (precisely as in the parallel problem for sight) it appears that the reflecting, or rather diverting, power of the obstacle varies inversely as the fourth power of the wave-length. When a composite note, such as that proceeding from the human throat, impinges on the obstacle, its components are diverted in very different proportions. A group of small obstacles will return the first harmonic, or octave, sixteen times more powerfully than the fundamental. After this, it is not hard to understand how a wood, which may be considered to be made up of a great number of obstacles, many of which, in two or three of their dimensions, are small in comparison with the wave-length, returns a sound which appears to be raised an octave.

The increased reflection is, of course, at the expense of the direct sound. If we conceive a group of small obtacles to act on a train of plane waves of sound, the effect will be a *diffused* echo, which may be heard on all sides, appearing to proceed from the group, and the direct waves which maintain their direction. If the original sound be composite, the diffused echo contains the higher elements in excessive proportion, and for the same reason the direct wave, being shorn of these higher elements, will appear duller than the original sound. It is well known that pure tones are liable to be estimated an octave too low, and thus it may be possible that a note in losing its harmonies may appear to fall an octave.

What is here called the direct sound may itself be converted into an echo by *regular* reflection. For example, if a plane wall were covered with small projections, there would be a diffused echo, due to the projections in which the higher elements preponderated, and an ordinary echo, obeying the law of reflection, in which the wave elements would preponderate.

I shall be much obliged if any one under whose observations echoes of this description may happen to fall, would communicate particulars of them to NATURE.

RAYLEIGH

LEITH-ADAMS' "FIELD AND FOREST RAMBLES"

Field and Forest Rambles. By A. Leith-Adams, F.R.S. (Henry S. King & Co.)

ONCE, on our expressing surprise to a friend at the fact of his having forsaken his usual line of study for another of a very different character, he remarked, "Well, you see it does not matter much what I take up, for whatever it may be, I am sure to make some discovery of value." The reply was sufficient to enable anyone to form an idea of the results that might be expected. He was an assiduous and earnest worker, but there was a certain deficiency in the quality of all he produced.

Mr. Leith-Adams is an assiduous and earnest worker; his opportunities in connection with his military avocations, have been considerable, and he has used them well. He has already given us the results of his experience in India and elsewhere in his "Wanderings of a Naturalist in India," as well as in the "Natural History and Archæology of the Nile Valley and Maltese Islands," and in the work before us he takes us to New Brunswick, vividly portraying the beauties of its short summers and the discomforts of its dreary winters. An intense love for natural history has led him to make careful and prolonged observations as to the habits of most of the animals inhabiting the province of which he treats, together with the dates and direction of migration of the numerous migratory birds which are there met with. He has also paid considerable attention to the fish, and the geology of the district.

Our author, in endeavouring to obtain an accurate account of the past history of the native Indians of New Brunswick, found the task of more than ordinary difficulty, "inasmuch as, even apart from their persistent indifference to treat on any subject connected with their past history or present condition, there would seem to be an absolute incapacity to comprehend the meaning of such inquisitiveness on the part of the interrogator." Drink is the ruination of the remnant of this doomed race, a race so little advanced in the scale of humanity, that when it has disappeared, there will not be left a trace even of written or monumental record; "indeed, were it not for implements of the chase picked up occasionally, we should have few other data to establish the existence of the human inhabitants of the region, previous to the arrival of the first European travellers." The European colonist, as long as he is the possessor of the *mens sanus in corpore sano*, however, stands a better chance of surviving; nevertheless leprosy produces painful ravages among the original French settlers, on the north-east frontier of the province.

No explanation is attempted of the fact quoted from Dr. Gilpin, that many of the wild animals, as the bear, racoon, and beaver, which were driven from their haunts on the clearing of the forests, are again returning to the same districts, "to cultivated fields instead of primitive forests, to corn and maize, instead of wild fruits and berries." We cannot help thinking that this does not say much for the present assiduity of the farmers.

Albinism and Melanism, the tendency for certain individuals of a species to be white or black, is one of Mr. Adams' favourite subjects, and he gives it as his opinion that the reason why they in the wild state do not continue to propagate their peculiarity is because "the very decided difference as regards outward appearance would be sufficient to forbid intercourse between them and the typical individuals."

There is a want of point in many of the author's attempts at explanation of the various phenomena which

* Since communicated in an amplified form to the Mathematical Society.

excite his curiosity. In considering the fact that the Cat-bird (*Mimus carolinensis*) has a strongly marked antipathy against the animal whose name it bears, he says, "I have often wondered if this inherited distrust of the cat could be explained in any way with reference to the imitative peculiarities of the bird. In other words, is it possible that some ancestor began to mew like a cat whenever it saw the wild cat in his haunts, and that in process of time it came to be an established habit?" Again, the answer given to the question, why such migratory birds as the ruby-throated Hummer (*Trochilus colubris*) are not content with the eternal summer of the south? is equally inconclusive: "All that we can say is that some inherited instinct is at work, perhaps to them as precious as is the longing for the holidays to the schoolboy, full of pleasant reminiscences, which of course would grow by experience." And we do not feel any nearer the truth as to the reason why the peculiarity of the beak of the Cross-bill is so well marked, when we know that in the bird's attempts to extract the seeds from the red spruce and other cones, "the bill, which is not so strong and conical as that of the pine bullfinch, became curved, until at length the condition became hereditary and transmissible."

An interesting remark is made, which illustrates how very susceptible the animal body is to the influence of slowly-acting external circumstances. For it is the popular belief in New Brunswick that the severity of an ensuing winter may be predicted by the amount of fat present on the intestines and omenta of animals, whether wild or domesticated; and as the coldness of the winter must depend on the previous climatic condition, that may reasonably be supposed to affect the constitution in a manner favourable to the individual.

In conclusion, we think that both sportsmen and naturalists will find this work replete with anecdote and carefully recorded observation, which will entertain them; at the same time they will not put down the book without feeling that they have acquired much new information on the physical geography and natural history of New Brunswick.

HOEFER'S "HISTORY OF PHYSICS AND CHEMISTRY"

Histoire de la Physique et de la Chimie. Par Ferdinand Hoefer. (Paris: Hachette, 1872.)

MORE than twenty years ago M. Hoefer published a History of Chemistry, the first which had appeared since the publication of Dr. Thomas Thomson's History. M. Hoefer has since been known to us as the author of the biographies of various scientific men in the *Nouvelle Biographie Générale*, and of a small work entitled *La chimie enseignée par la biographie de ses Fondateurs.* The volume before us is one of a series which treats of universal history, and is published under the direction of M. V. Duruy. The works which it comprises are intended to be used in colleges and schools, and M. Hoefer's volume has no doubt been included, because the promoters of the series have wisely considered that the history of matter, and of motion, are as worthy the attention of the rising generation as the history of languages numbers, peoples, faiths.

Out of the 553 pages which the work contains, no less than 314 are devoted to the history of Physics, while the remainder contain in a condensed form the substance of M. Hoefer's larger *Histoire de la Chimie.* The History of Physics is divided into two books, entitled respectively "Matter" and "Motion," the former including—1. The immediate properties of matter (weight, volume, density, elasticity, compressibility); 2. The terrestrial atmosphere; 3. Liquefaction and solidification of gases; 4. Hygrometry; 5. Acoustics.

The second book on Motion includes—1. Gravity; 2. Heat; 3. Light; 4. Electricity and Magnetism.

We feel bound to take exception to this arrangement, which is both immature and ill-considered. For why has M. Hoefer classed *weight* with *matter*, and *gravity* with *motion?* and why *liquefaction and solidification of gases* with *matter*, when they are operations distinctly connected with motion? But, worse than all, why has he classed *acoustics* with *matter?* Again, he has omitted all mention of certain sciences which were among the earliest—Statics, Dynamics, Hydrostatics, Hydrodynamics. These sciences, from their antiquity, lend themselves with great facility to the apt illustration of the various phases of the history of science. Archimedes has received an altogether insufficient amount of notice: we may not forget that several of our sciences actually owe their origin to him; and how M. Hoefer, with Peynard's fine edition of the works of Archimedes in his own language, can have overlooked him, we are quite at a loss to understand Then the Archimedian screw, the pumps of Ctesibius, the Δυναμεις of Hero of Alexandria, should all have full mention in the work. And if it be urged that space did not permit mention of these things, we would reply that they are of far more importance than Hygrometry, which finds mention in the book. Also such sections as "Pèse-liqueur d'Hypatie," "Manomètre," "Hygromètre condenseur," "Porte-voix," "Clavecin et carillon electrique," "La beatification de Bose," might all have been replaced with advantage by more important matters.

We notice with regret a tendency to attribute discoveries to men who were not first in the field. Thus, although Boyle discovered his law of the compression of gases, no less than *fourteen years* before Mariotte, it is called *Loi de Mariotte.* Again, M. Hoefer says, "Gassendi paraît s'être le premier occupé de la question de la vitesse du son, sans préciser les résultats auxquels il était parvenu." But if M. Hoefer will read Lord Bacon's *Historia Soni et Auditus*, he will find a good deal of valuable and suggestive matter, among other things, a suggestion for determining the velocity of sound.

Let us turn to the comprehensive little treatise on the history of chemistry, beginning with Hermes Trismegistus, nay, with Moses, and ending with Wurtz, Williamson, Frankland, and Kölbe. This part of the work, as derived from M. Hoefer's larger treatise, is altogether more matured than the preceding; yet it is not without evidence of hasty selection and ill-considered statements. We cannot agree with M. Hoefer when he tells us that the word chemistry was used in the fourth century, and that we are to trace it to χυϊκὸν and χίω. Neither, for various reasons, which we have stated elsewhere, can we accept the Greek MSS. attributed to Zozimus, Pelagius, Olympiodorus, Democritus, Mary the Jewess, and Synesius, as exact evidences of date or knowledge. In regard to more modern matters we regret to find no account of Robert Hooke's important theory of combustion. We are glad to observe that M. Hoefer does not echo the Wurtzian aphorism: "La chimie est une science Française, elle fut instituée par Lavoisier d'immortelle memoire." More liberally our author says, "Tout en suivant chacun une route différente, trois chimistes ont fondé, vers la fin du dix-huitième siècle, la chimie moderne: Priestley, Scheele, et Lavoisier, un Anglais, un Suédois, et un Français."

We should be glad to see in our own country the history of matter and of motion studied side by side with the history of languages and of numbers. Prof. Kopp lectures on the History of Chemistry in the University of Heidelberg, and no doubt his example is followed in other of the German universities. M. Hoefer's work is in many ways suitable for use as a text-book; it is cheap, it is anything but dull, and whatever the errors of arrangement may be, it contains a great deal of information.

G. F. RODWELL

OUR BOOK SHELF

An Essay on the Physiology of the Eye. By S. H. Salom. (Published by the Author.)

THAT the study of formal logic is not in itself conducive to sound reasoning will be acknowledged by many, but it is seldom that the truth of the statement is so fully illustrated as in the short work before us. The author has studied the writings of Hamilton, Mill, Bain, and others, and with a creditable enthusiasm endeavours to employ the new powers he thinks he has thereby acquired, in developing a hypothesis of his own to account for the phenomenon of vision more satisfactorily than those already accepted. An outline of the arrangement, which is partly disguised at first sight by the many technicalities and circumlocutions employed, will be almost, if not quite, sufficient for most of our readers. Commencing with a notion broached by Erasmus Darwin, that visual perception ensues from retinal motion derived through the motile force of light, the author hopes, "by turning the light of modern histological discovery on Darwin's theory of involuntary animal action, to succeed in convincing associational psychologists that this theory must henceforth be included in the creed of *à posteriori* thinkers." With this as a basis, the doctrine promulgated may be thus summarised. The eyeball being in a constant state of reflex action on account of the light acting dynamically on the retina, the motion thus produced exerts in the muscles surrounding the eye feelings of muscularity similar to those excited when we voluntarily determine ocular direction, and consequently without any voluntary effort, we are constantly aware of visual space properties. To prove this novel hypothesis the structure of the retina has to be fully entered into, and in a most ingenious manner solid fact is distorted to satisfy unsubstantial theory. Taking a single example of the reasoning employed, we find that it is necessary for the theory that the fovea centralis of the retina should be elastic; that it is so is evident from the following considerations:—"In the copious index of that exhaustive anatomical work, 'Quain's Anatomy,' under the heading 'yellow,' we find, in addition to 'yellow spot,' four substances *only*, namely—

Yellow cartilage,
„ fibres of areolar tissue,
„ ligaments of the vertebræ,
„ tissue.

And on referring to the pages of the book in which these subjects are treated, we discover that *they have the common property of being elastic.*" From this on one of Newton's rules for philosophising "we are bound to frame the following physiological induction,—*all yellow anatomical substance is elastic*" We can hardly think that the author is not attempting to fool us.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Atoms and Ether

ATTEMPTS to dispense, in physics, with the ideas of direct attraction and repulsion, however interesting, lead generally to a *petitio principii*, and I fear Prof. Challis's view, to which attention is called in NATURE of August 7, cannot be received as an exception.

For an ether of which the density can be varied is a substance that can be compressed and expanded, and what idea is in our minds when we speak of compression and expansion in a really continuous substance? Continuity implies space, and space that is full. Can space be more than full? When we say that a fluid is compressible and elastic, do we mean anything else than that it is made of parts which can be pushed closer together, and which, being so pushed, will push each other back? But this is repulsion and action at a distance. We do not alter the fact by calling the substance ether, and relieving it from the influence of gravitation.

Is a continuous substance, which is capable of compression, conceivable? I think not; or if it is, the conception is at once more difficult and more opposed to sensible experience than that of attraction and repulsion.

The substance of a bar of iron is not continuous. If I draw one end of it towards me, why does the other end follow? What can be the relation between the movement of my end of the bar and the ethereal vibrations which must propel the other end and all intermediate parts in the same direction?

Liverpool, Aug. 9 ALBERT J. MOTT

Instinct

Sense of Direction

THE perusal of the correspondence published in the February and March numbers of NATURE now to hand, and also your article on "Perception and Instinct in the Lower Animals," in the number of March 20, has induced a belief in my mind, that I may perhaps be able to contribute some evidence bearing upon the question at issue; and also that it may have some value from having been obtained from a field of observation not generally accessible, and from the fact that cattle and horses in Australia are subject to very different conditions to those obtaining in England.

I may commence by stating that the question, whether animals have or have not a peculiar power of finding their way from place to place, suggested itself to my mind very shortly after I first went into the Australian bush, now more than twenty years ago. It was not long before I satisfied myself that in many horses this faculty was strongly developed, but yet unequally in different individuals. I afterwards ascertained that it also existed in cattle.

Not only did I find that horses had extensive memories for places, being enabled to recollect a track they had followed some time previously, but also to remember the way from one place to another where no track existed. I found that not only had horses this exact memory, but that they possessed another gift which at first appeared to me inexplicable. This was, that when ridden through the bush, many horses would never, for a moment, as it were, lose the recollection of home, but "bear away" in its direction. I remarked this not only in a district with which the horse might be acquainted from grazing in it, but also when travelling and absent for the day from my camp, and from the other horse or horses, the "mates" of the one I rode.

Further than this, I also found that as regarded myself, I never lost the distinct perception of the direction in which my home, or camp, or starting-point for the day was situated, and in endeavouring to trace out and analyse this feeling, I at last came to the clear perception that it depended upon an unconscious action of the memory thus recording the alterations of the courses I had followed, and which by an effort of the memory I could recall. On this point I feel quite clear, for from the practice of paying especial attention during constant explorations to the course travelled, both for the purpose of keeping a correct dead reckoning, as also for the delineation of the features of the country passed over, I have found the faculty intensified, and the process more evident to myself. I may say that during the course of those twenty years' experience, I have never found the faculty at fault.

I believe in this lies the explanation of the power possessed by cattle and horses of finding their way from one place to the other irrespective of the road they may have gone.

I now propose to record some instances showing how cattle and horses in this district have endeavoured to reach the places where they were reared, and the truth of which I do not in the least question. To show how frequently such cases are met with here, where horses and cattle are bred in a half wild state at large in the bush, I may note that on determining to make this communication, I spoke to the first persons I met with who were likely from their pursuits to have noticed instances of the nature I required; of these persons, four at once gave me the particulars I am about to relate. But before doing so I must further remark, as bearing perhaps not remotely upon the question, that I have not met with aboriginal natives, either as savages or as "tame blacks," who possessed any power of finding their way from place to place differing in its nature, though perhaps in its degree, from that to be found in every good "bushman" among the whites. Their knowledge of country is entirely local—special as regards the district belonging to their tribe or family—general as regards the country of the neighbouring tribes. They know it thoroughly because they have been born in it and have roamed over it ever since. Out of their own locality I have found them to be inferior to a good white "bushman," in so far that they are unable to reason out any problem relating to the features of the country, and my experience has shown that out of their local knowledge I could never rely upon one of them in preference to my own judgment. I have remarked also that very few could, even in their own districts, travel straight from one place to another, say at twenty miles' distance. I now refer especially to the aborigines of that part of the interior of the continent lying on each side, north and south, of Sturt's Desert and including Cooper's Creek. As a rule they would "give and take" some 30° on each side of the course, correcting the direction from time to time as they recognised the "lay of the country" from rising ground.

In order that the instances I shall now quote may be more clear, it will be necessary to say in the first place that all the localities mentioned below will be found named in the maps published by the Surveyor-General of Victoria, and no doubt also in others. The only exception is Deadcock Creek, which is however shown as a small stream falling into the Mitchell River, on the west side below Cobbannah Creek. All cattle and horses brought down from the Maneroo table-land in New South Wales to the Gippsland market, travel by one road *viâ* the Black Mountain, Buchan, Bruthen, Bairusdale, and Stratford; the distance from the centre of Maneroo district, say where the 149th meridian crosses the Snowy River, to Stratford, is about 180 travelled miles, and the number of cattle brought down annually may be about 12,000; of these a certain percentage escape and make their way back to the place where they were bred unless recovered on the way or hindered by natural obstacles. There is no other way from Maneroo into Gippsland excepting the one mentioned, and the country northward between that road and the Great Dividing Range is occupied by high and rugged mountains, dense forests, and thick scrubs. The road from Maneroo crosses the rivers flowing from the Great Dividing Range.

1. About four months ago a mob of cattle was brought down from O'Rourke's Station, the Black Mountain, Snowy River, and sold at Stratford. After being two months on the Bushy Park run near Stratford, fourteen bullocks escaped from the paddocks, and on search being made were recovered at the junction of Deadcock Creek with the Mitchell River. The line they had taken if carried out would go near the Black Mountain.

2. A horse bred by Mr. Sheen of Omeo was taken down *via* Bruthen, Bairusdale, and Stratford, and sold; was broken into harness, and worked by Mr. McFarlane, a contractor; was lost near Stratford, and on search being made was found at the junction of the Wentworth and Mitchell rivers. The line taken in this case is direct for Omeo.

3. Mr. Dougald McMillan of Stratford some little time back bought a mare from a Maneroo "mob." About a month ago she was lost from near Stratford in hobbles and was seen a day or two afterwards crossing "Iguana Creek still in hobbles and as fast as she could go." The people from the Glenalladale Station (Iguana Creek) being then engaged gathering some wild horses at Deadcock Creek, found her with them. This line taken was the usual one, and if carried out would cross the centre of Maneroo.

These three cases were related to me by the stock-keeper at Glenalladale Station.

4. A year or two back Mr. Kreymborg of Bairusdale purchased a mob of horses from O'Rourke Station, Black Mountain, and sold one, a black mare, broken to lead to a person named Gee, living at Cobbannah Creek. The mare remained with Gee's horses for some time, but was then missed from Lower Cobbannah Creek and next heard of at Tabberabberah, and was recovered on Pettersen's Station, at the foot of Mount Baldhead.

This line bears a little away from the Black Mountain, but the nature of the country is such that the Mount Baldhead and Notch Hill tier of mountains form the end of a *cul de sac*, of which the open country at the junction of the Wentworth and Mitchell rivers is the mouth. This tract of forest country fenced in by mountains a few years ago swarmed with stray cattle and their progeny; three hundred bulls were shot by the then proprietors in, I believe, about two years.

5. Mr. Freitag, who follows the occupation of packing up goods to the Crooked River gold-workings, tells me that he is in the habit of buying Maneroo horses at Stratford and breaking them in for use in his pack-train. He finds that for the first few trips they require watching carefully when camped at Iguana Creek, where the road to Crooked River turns northward, as they are very apt to make away at that place. When recovered they are usually found either at Deadcock Creek or up the river towards Tabberabberah, thus conforming strictly to the direction taken by cattle and horses in other instances.

6. Thomas Dowling, employed in the stations of Messrs. Degraves, at Omeo, bought a mare from Mr. McKeachie, of Delegete in Maneroo. The mare was kept in the Hinnomungie paddock (Omeo) for two or three years. Being then taken to Bindi, about twelve miles distant, she escaped, and after being seen at Nannyong, was recovered at Gelantipy, on the Snowy River. Nannyong is a small open piece of country on the summit of the mountain east of Bindi, and the country crossed over, fifty miles, is very difficult, the mountains being some 4,000 to 5,000 ft. in altitude, and almost unknown even now except to stock-men. I came through, last summer, nearly in the line the mare must have taken. It is almost direct for Delegete.

7. A bullock-driver named Richardson purchased a working bullock which had been sent down from Maneroo by the usual road for sale. He sold the bullock at Omeo—going up there with loading—to Mr. Lewis, the manager of Messrs. Degraves' stations. The bullock was kept in the Hinnomungie paddock, but got out two or three times, and in each case made away across country direct for Maneroo, being recovered by the Messrs. Pendergast, of Mt. Leinster, and sent back to Mr. Lewis.

These cases I have obtained from Mr. Lewis, and they are remarkable as showing the length of time during which cattle and horses retain the recollection of their native places, and also as showing, in even a more marked manner than those quoted first, that they return homewards without any regard to the track by which they have reached their place of departure. The cases from Stratford, on the other hand, illustrate the distances from which cattle will start for home.

8. Mr. Mackintosh, of Dargo, informs me that about two years ago, when gathering wild cattle on the Avon River, he got away from his men down that river for many miles before he ascertained that he was astray. Finding, then, that his horse persisted in going in a certain direction, he gave him his head, and the horse went in a straight line to the place where the camp was fixed, a distance of some ten miles through a scrubby country, and without a track.

I could continue quoting examples still further, but I fear that

I have already trespassed too much on the columns of NATURE, and I shall conclude by saying that these instances are not thought extraordinary here, and that the belief that cattle and horses can find their way "straight" is firmly held by all bushmen. I have heard similar instances at Lake Torrens, the Darling River, and Maneroo.

I am aware that they do not affect the question as to how a cat finds her way home when conveyed shut up in a bag, but I conceive that they bear out the view suggested by Mr. Darwin, and with which my own experience coincides.

A. W. HOWITT

Bairusdale, Gippsland, Victoria, May 21

Ingenuity in a Pigeon

THE following facts (having been witnessed by myself) may, perhaps, be considered worthy of insertion in your journal, as bearing on the subject of "Perception and Instinct in the Lower Animals," which has lately been brought into such prominent notice.

On the Richmond road (Surrey), at about a mile from the town, stands an old roadside inn, yclept "The Black Horse," owned by one R. Ketley. Attached to the house are a number of domestic pigeons of various breeds, chiefly "Pouters."

Having occasion to wait for my pony to be harnessed at this inn a few years since, my attention was directed by a gentleman (a resident of the neighbourhood) with whom I was acquainted, to the strange conduct of one of these birds.

A number of them were feeding on a few oats that had been accidentally let fall while fixing the nose-bag on a horse standing at bait. Having finished all the grain at hand, a large "Pouter" rose, and flapping its wings furiously, flew directly at the horse's eyes, causing that animal to toss his head, and in doing so, of course shake out more corn. I saw this several times repeated; in fact, whenever the supply on hand had been exhausted.

I leave it to your readers to consider the train of thought that must have passed through the pigeon's brain before it adopted the clever method above narrated, of stealing the horse's provender.

Was not this, indeed, something more than mere instinct?

RICHARD H. NAPIER

Upton Cottage, Bursledon, Southampton, Aug. 13

The Origin of Nerve Force

I NOTICE in NATURE for July 21 a paper by A. H. Garrod, suggesting that nervous force has its origin in thermo-electric currents due to the difference of temperature between the surface and interior of the body. Without presuming to any opinion from the physiological point of view, I venture to mention one or two obvious difficulties.

Although, as the writer observes, "in cold weather the impulse to act is much more powerfully felt than in summer, when the air is hot, and therefore the temperature of the surface is higher," yet even 98° F. (the internal temperature of a healthy body) is not uncommon for the air in tropical climates, where the natives can undergo great exertions. But, according to the thermo-electric hypothesis, the nerve force must in this case be *nil*. Again, temperatures of 140° to 160° F. are easily sustained for a considerable time in the Turkish Bath. Under these conditions the direction of the current should be reversed; and, even supposing that positive and negative currents both acted in the same sense on the muscles and nervous ganglia, it would seem that there must be an instant of transition when the two should be balanced, and nervous force at zero, and the powers both of sensation and motion lost with it.

The thermo-electric theory is not required to explain the cases to which Mr. Garrod alludes. We have only to consider that the body must be kept at a constant temperature of about 98° F., while heat is being continually evolved internally by nervous and muscular action, to see that the surface of the body must be cooler than the interior in order to get rid of the superfluous heat without consumption of work in increased perspiration and evaporation. At high external temperatures there will naturally be disinclination to muscular exertion; not only because it produces heat which tends to upset the equilibrium of temperature, but because the force that would have been expended in it is consumed in increased action to get rid of the heat. That the exhausting effect of hot water is much greater than that of hot air is accounted for both by its greater conductivity and specific heat, and still more because it checks evaporation, which is one of the most powerful outlets for waste heat. It must be familiar to everyone that rapid exhaustion is produced by immersion not only in hot water but in that of almost any temperature. Taking 70° as an average external temperature, we shall find that immersion in water at 30° would be quite as rapidly destructive of nervous energy as in that of 110°; and that while air of the latter temperature could be sustained by the naked body for long without inconvenience, that of 30° would be rapidly fatal unless the temperature was kept up by violent exercise.

Supposing the brain to be really colder than the blood, I shall be glad if some physiologist will inform me if this is not due to the consumption of heat in building up the complicated and unstable matter of the brain from the comparatively stable and simple constituents of the blood, and in this case, if there is any difference of brain temperature between times of rest and nutrition (sleep) and those of active exertion.

Knowing as we do that chemical action is constantly going on in the body and that electrical disturbance is an almost constant result of such action, it seems hardly necessary to look further for the *source* of nerve force, though we are in almost complete ignorance of the details of its production.

HENRY R. PROCTER

The Flight of Birds

YOUR correspondent, J. Guthrie (vol. viii. p. 86), has struck a note which will, I think, echo. The question he raises is one which has exercised more minds than one. It has been present to me individually almost ever since I was able to reason. The opportunities enjoyed by exiles, especially in tropical countries, for the study of the phenomenon of a body, poised in mid-air, with no apparent support, is considerable, owing to the boldness and number of kites and birds of that class. I have watched them from the point of view—figuratively speaking—of your Cape correspondent, scores of times, and sometimes under peculiar conditions: but I am unable to add anything *certain* to the bare statement that birds of prey *can* maintain a position of absolute apparent rest.

It is some fourteen or fifteen years since I first watched an eagle in a telescope, with a view to test an explanation—the same as that suggested by Mr. Guthrie—hazarded as a conceivable possibility by my father, long before. Since that day I have had innumerable opportunities for close watch—some of which I will describe—and never have I seen anything to support it.

Not to go back too far, as I must trust to memory, I was, two or three years ago, on the summit of a long-backed solitary hill, 500 or 600 ft. high, in the Coimbatore plains of Southern India. There was a light breeze blowing, and I saw an eagle stemming it, on the leeward side of the hill, which was steep. Sometimes he was within (say) fifty yards, and having a good glass at hand, I rested it on a stone heap, and watched him. It was frequently possible to see him thus, stationary in a motionless field of view, at an apparent distance of 10 or 12 ft. Not a feather quivered: the head was turned from side to side as he scrutinised the hill-side: occasionally a foot was brought up to the beak: the roll of the eye was perceptible: but otherwise he was *at rest* to all appearance. Of course the tips of the wings came in for a share of my scrutiny. They may have been quivering, but they looked as steady as those of a stuffed specimen. And here I may observe, that for this appearance to be compatible with an unperceived vibration, the position of rest must have existed alternately with successive excursions, and the time occupied by the latter must have been insignificant as compared with the duration of rest. I find it impossible to accept this explanation, even as a first step, and need not inquire how it would produce the supporting effects. The tail, I should mention, was not at rest. It was frequently feeling, as it were, the passing breeze.

It is to be understood that in the course of frequent changes of general position, I had the bird under examination from different directions—not always of course so favourably.

On another occasion I spent a fortnight on the summit of a peculiar hill in this neighbourhood, with nothing to do but recruit as fast as possible. The hill resembles a dish-cover at top, and being the resort of fugitives from the dust and drought and heat of Bangalore in April and May, who occupy every available dwelling on a very restricted space, there is plenty to attract the kites from far and wide, to say nothing of vultures. There are two or three kinds of kite, but for the present subject they are all the same—fine, powerful, bold birds, with a stretch of three or four feet of wing—who will swoop and take meat from a basket on a man's head, any day, or even from his hand. A score or two of these circling about the kitchen and outhouses, may be watched with advantage from the house-top, as is evident. The difficulty is to reproduce, in description, anything definite, from the copiousness of the evidence. I can therefore only express distinctly the conclusions I formed :—(1) that it was utterly incomprehensible ; (2) that there *must* be some unperceived source of motion ; (3) that it *might* be (and probably was), a subtle utilisation of the varying air currents met with or sought for. This conclusion lands one in a new set of perplexities, it is true ; but it is the least opposed to reason, however ill it may accord with some of the facts as interpreted by us.

Vultures are large heavy brutes, with comparatively little wing-power, and their flight is far slower and heavier. They very commonly rest on the ground, doing nothing, and if disturbed, the effort to rise is evidently a toilsome one. Nevertheless, they too possess, and largely exercise the power, of sustaining themselves in mid-air without apparent *action*. Not that they ever rest motionless, but they sweep about in endless paths with hardly ever a beat of the wing except on occasion, in this respect seeming to husband their strength much more than the kites, who are always on the move, and wheel in much sharper curves.

I was a good deal impressed, at one time, with the notion that the secret lay in slants of wind taken advantage of, but the more I see the less I like it. It is impossible to conceive upward currents as commonly strong enough to support a *dead* bird similarly extended. And though I am not prepared to assert that I have ever seen birds floating motionless where there was *no* wind, yet if we are to take the vertically resolved portion of wind, considered as essential, as the supporting agency, what becomes of the horizontal force? Given a sufficient momentum, one could conceive an economic expenditure of it, but not enough to explain the endless wheelings of vultures, much less the long continued poising without forward or backward movement of eagles.

In fine, I can only echo Mr. Guthrie's appeal for further explanation ; but I beg that we may have no nonsense about "bones filled with air." One is tempted to ask in that case if death *solidifies the bones*, to account for the undeniable weight and density of a goose. J. HERSCHEL

Bangalore, July 6

Earthquakes in the Samoan Islands, South Pacific

ON two former occasions I have contributed to NATURE notices of the earthquakes experienced in these islands. I will now continue my list from the commencement of 1872.

On March 22, at 1.25 P.M., there was a shock from N.E., motion horizontal. Vibration continued 15 seconds. For several seconds before the motion was felt, and during the whole time of vibration, there was a noise like distant thunder.

On April 8, at 3.10 P.M., there was a slight shock, horizontal.

May 11, at 10.20 A.M., we had a double shock. This was rather severe. Motion horizontal ; interval between shocks, 15 seconds ; total duration, 25 seconds.

May 28, at 10.30 P.M., a slight horizontal shock.

Sept. 9, at 10.20 P.M., double, horizontal shock from N.E. ; interval 25 seconds. This was a more severe shock than we usually feel here.

Nov. 12, at 5.10 A.M., a slight horizontal shock.

Dec. 3, at 9.20 P.M., a slight horizontal shock.

Jan. 2, 1873, at 7.40 A.M., a shock which, in these islands, is considered very severe. The motion was horizontal. The main undulation was followed by rapid oscillations for 45 seconds, followed by a sea-wave.

I regret that I cannot give full and definite information respecting this earthquake. I was away from home at the time, staying at the inland residence of the British Consul, on the island of Upolu, where I was unable to note with precision any of the accompanying phenomena. The Consul's residence is a wooden building with a ground floor only. It stands due east and west. This shook very severely with the rapid undulations of the earth-waves, apparently, longitudinally from east to west. I at once thought the centre of impulse was to the east of my position. Of this, however, I am by no means certain ; in fact, I have reason to doubt whether my observation on this point was correct. The sea-wave was almost entirely confined to the south coast of the islands of Upolu and Saraii. On the island of Tutuila (forty miles to the east of Upolu) it rose equally on the south and north sides. I have at present no information from Manua (three islands about sixty miles east of Tutuila) except that both earthquake and sea-wave were felt there. None of those who saw the sea-wave noticed particularly the time which elapsed between the earthquake and the rolling inland of the sea-wave. All my informants from Saraii (the most westerly island) agree that the one followed the other almost immediately. They felt the earthquake and almost immediately afterwards saw the reef bare, much lower than it is at low tide. The tide was at about half-ebb at the time. Following closely on this efflux came the reflux in a large wave which rolled inland and flooded the sites of villages lying low at the back of deep bays. This wave rose about 6 ft. above high-water mark during spring tides. The rise and fall during spring tides in this group being about 4 ft. 6 in. The first great wave was followed by a number of smaller waves, and the oscillation continued for some time. No efflux of the sea was noticed, as far as I can learn, on Upolu or Tutuila. At the latter island the sea-wave rolled inland more than half-an-hour after the earthquake, and rose about 6 ft. above high-water mark. No damage of importance was done by the wave.

Two days after the above earthquakes, we had three others in rapid succession, and three more have followed them on different days since, viz. :—

On Jan. 4, at 10.45 A.M., we had a heavy horizontal shock, or rather a succession of shocks, two of which were severe. These continued 55 seconds, and were accompanied by great rumbling and a hissing noise.

Four minutes afterwards, viz., at 10.50 A.M., we experienced another sharp shock, accompanied by similar noises. The vibrations of this shock continued 15 seconds. We had scarcely recovered our equilibrium and quieted our nerves after this second shock when, at 10.57 A.M., we were startled by another, the oscillations of which lasted 20 seconds. This also was accompanied by great rumbling.

No damage was done by these earthquakes. The buildings in these islands are all low, and nearly all are built with wood, so that only a very severe earthquake could do much injury.

On Jan. 8–9, at midnight, another slight horizontal shock was felt.

On Jan. 13, at 8.45 A.M., we had another which was also slight.

On Jan. 14, at 5.24 A.M., there was another slight horizontal shock.

The Samoan Islands owe their existence to volcanoes, as they consist almost entirely of volcanic rock. There has, however, been no eruption for a very long period until in 1867, when, it will be remembered, a submarine volcano burst out between Taù and Olosenga, two of the Manua islands in the eastern end of the archipelago. This subsided after a fortnight's activity. A few months afterwards I was on board H.M.S. *Falcon* when soundings were taken over the spot where the volcano had been. We found a cone 180 feet above the bed of the surrounding ocean : the average depth of the sea around it being 120 fathoms, while the depth on the apex of the cone was only 90 fathoms. There has been no further eruption from this volcano up to the present time. Almost ever since this has been quiet, there has been great activity in the volcano of Nina Foou, in the neighbourhood of the Friendly group of islands.

Samoa, S. Pacific S. J. WHITMEE

THE ARITHMOMETER

MOST of our readers who have anything to do with calculations have heard of the above calculating machine, the invention of M. Thomas de Colmar. A few remarks, therefore, on its construction and operation may be of interest to those who have not seen this really useful calculating machine.

The instrument is of small size, the one which we are about to describe being only 22 in. long, 6½ in. wide, and 3½ in. deep.

We can best give an idea of the great saving of time effected by this instrument when we state that with it eight figures (tens of millions) can be multiplied by eight figures in eighteen seconds, sixteen figures be divided by eight figures in twenty seconds, and a square root of sixteen figures be extracted, with the proof, in less than two minutes.

Our illustration shows a top view of an arithmometer the lid of the box being removed. It is constructed chiefly of a brass plate, A, furnished with eight slots, as shown; directly under these slots are mounted eight drums, each having nine elongated cog teeth of successively decreasing length; over each drum, and between it and the slot, is mounted a square shaft, on which slides a pinion wheel so as to catch any number of teeth on the drum. Each of these pinion wheels is moved by a button, *a*, of which there is one in each slot, the figures at the sides of the slots showing the proper position of each button *a*, for any work to be performed by the instrument.

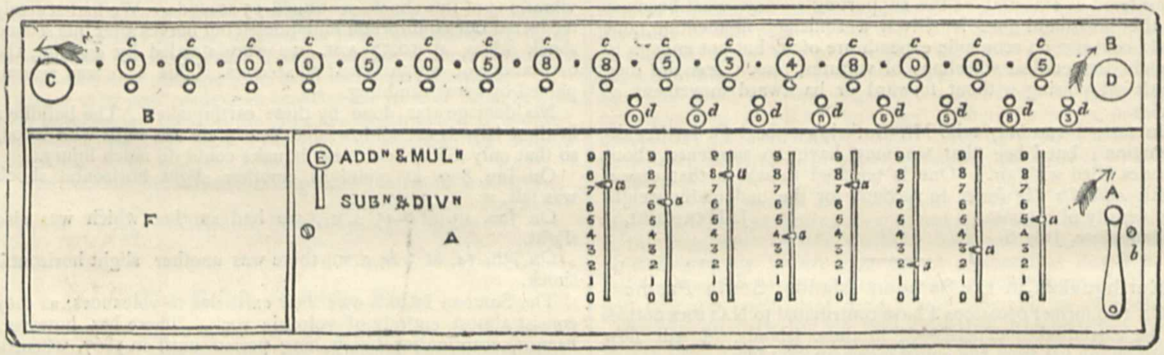
The cogged drums gear by bevil wheels with a long horizontal shaft, which is also in gear with the vertical shaft moved by the handle *b*, by which the instrument is worked. B is a moveable brass plate, which can turn and slide on a round bar-hinge at the back; in this plate there are sixteen holes, *c*, under each of which is a moveable disc numbered from 0 to 9, and arranged so that any one figure of each disc may be brought under its corresponding hole *c*. These discs have bevil wheels which gear with bevil wheels on the before-mentioned square shafts. The moveable plate B is also furnished with the holes *d*, having discs numbered from 0 to 9 underneath, and are for showing the number of turns of the handle, giving by this means the quotient in division, and showing the multiplier in multiplication. The knobs C and D are for bringing the figures under the holes *c* and *d* to zero before commencing an operation, and the knob E is for setting the instrument to work addition and multiplication, or subtraction and division. F is a small slate for memoranda.

Before further describing the working of the machine, we would remark that, if the knob E be placed at Add^{n}, each turn of the handle will carry the figures marked by the buttons *a*, under the indicator-holes *c*, or add them to the figures already under the holes *c*, while if the knob be placed at Sub^{n}, each turn of the handle will subtract from the figures under the holes *c*, the numbers marked by the buttons *a*.

Such being the general construction and principle of the machine, we will now proceed to give an example of its operation for multiplication, the operations for addition and subtraction being sufficiently explained in the preceding paragraph.

Thus, to multiply 76847235
by 6583

Mark the multiplicand on the plate A by the buttons *a*, as shown in the illustration; set the knob E at Add^{n} and Mulp^{n}, then turn the handle *b* three times for the unit figure of the multiplier, and three times the multiplicand, viz. 230541705, will appear under the holes *c* in the moveable plate B; this plate must now be raised, and moved one figure or station to the right, and the handle turned eight times for the second figure of the multiplier, and



Colmar's Arithmometer

6378320505 will appear under the holes *c*; move the plate B again to the right, and turn the handle five times for the third figure of the multiplier, and 44801938005 will be brought under the holes *c*; and finally, by moving the plate B once more to the right, and turning the handle six times for the last figure of the multiplier, the total product, 505885348005, will appear under the holes *c*, and the figures of the multiplier, viz. 6583, will appear in the holes *d*.

In division the operation is as simple as for multiplication, and is performed as follows: thus, to divide 414591904 by 4768, set up the dividend on the plate B, and the divisor on the plate A, commencing with the unit figure in each case to the right hand; place the knob E at Sub^{n} and Div^{n}, and move the plate B to the right until the second figure (from the left) of the dividend is over the first figure (4) of the divisor; turn the handle eight times, and 8 will appear in the quotient holes *d*, and will give the first figure of the quotient, while the dividend will now show 33151904, having been reduced by eight times the divisor, as in ordinary arithmetic; move the plate B one place to the left, and turn the handle six times for the second figure of the quotient, and the dividend will be further reduced by six times the divisor, and will mark 4543904; again move the plate, and turn the handle nine times, and after moving the plate B, and turning the handle five times and three times respectively, the holes *c* will all show noughts, and the quotient holes *d* will show 86953, which is the quotient required; if there had been any remainder, it would have appeared in the holes *c*.

Although by the ordinary limits of the machine a product of 16 places of figures and a quotient of 9 places of figures only can be obtained, yet by an intermediate record by the operator these limits may be virtually doubled for multiplication; while for division, provided the divisor does not exceed eight places of figures, the dividend and the quotient may be unlimited.

The use of the arithmometer in actuarial and other calculations has been shown in the papers read by Major-General Hannyngton and Mr. Peter Gray, F.R.A.S., F.R.M.S., respectively at the Institute of Actuaries (see the Journal of the Institute of Actuaries, p. 224, vol. xvi., and p. 249, vol. xvii.); and Mr. Thomas T. P. Bruce Warren, in a paper read before the Society of Telegraph Engineers, has shown the application of the instrument to electrical computations.

The Arithmometer is now, we believe, used in many Government Offices, in nearly all the Life Insurance Offices in England, in several Observatories; Sir W. Thompson, Prof. Tait, Prof. Galbraith, and Dr. Ball, also use them in the Universities and Colleges with which they are respectively connected.

The instrument can be seen, and all information obtained, of Mr. W. A. Gilbee, of 4, South Street, Finsbury, who, we understand, is sole agent for the Arithmometer.

ON THE SCIENCE OF WEIGHING AND MEASURING, AND THE STANDARDS OF WEIGHT AND MEASURE *

III.

Imperial Standard Pound

THE standard unit of imperial weight is the avoirdupois pound of platinum, constructed under the superintendence of the Commission for Restoration of the Standards. The mode of constructing this new standard

FIG. 4.—Form and size of the lost Standard Troy Pound.

of weight, together with full details of all the scientific processes employed, have been described by Prof. W. H. Miller, to whom its construction was more immediately entrusted. A drawing of the imperial standard pound has already been shown in Fig. 1.

For constructing this standard, the first point to be

FIG 5.—Queen Elizabeth's Standard Troy Pound of eight and four ounces

determined was the exact weight of the lost standard Troy pound, from which the weight of the new standard Avoirdupois pound was to be derived. Upon investigation, this proved to be the most difficult problem to be solved by the Commission. The old standard had been constructed in 1758, together with two similar pounds, under the direction of the Parliamentary Committee of that year. It is stated to have been composed of gun metal, but unfortunately no record exists of its volume or density, and it is not probable that it was ever weighed in water. An accurate drawing of the lost standard pound had been made in 1829 by Captain Nehus, who measured its dimensions with the greatest care. (See Phil. Trans. 1836, p. 361.) It very nearly resembles a Troy pound now in the Standards Department, which was constructed at the same time, and is said to be the original from which the lost Standard was made. Its form and size are shown in Fig. 4.

When the Troy pound was constructed under the direction of the Committee of the House of Commons in 1758, it was made as nearly as possible of the genuine weight of the Troy pound according to the ancient Standard. For this purpose comparisons were made of the Exchequer Troy Standards with each other, and with other Troy standards belonging to the Mint and the principal scale-makers. At the period when the Troy pound of 1758 was constructed, there existed no distinct Standard Troy Pound at the Exchequer. The Exchequer Troy Standards of Queen Elizabeth, which were the legal standards in 1758, consisted of a binary series of Troy

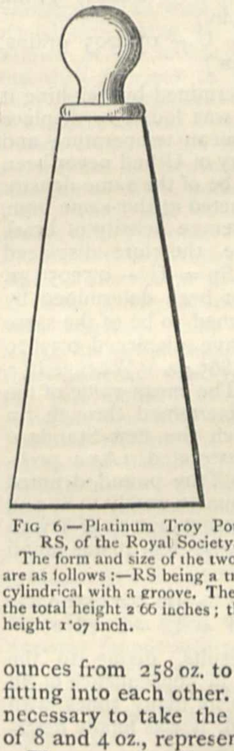


FIG 6.—Platinum Troy Pound, RS, of the Royal Society.

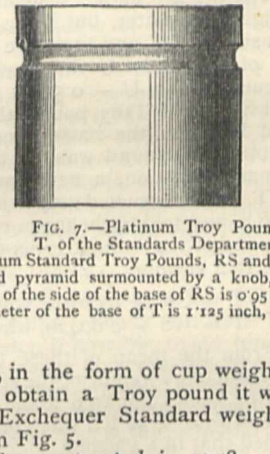


FIG. 7.—Platinum Troy Pound, T, of the Standards Department.

The form and size of the two platinum Standard Troy Pounds, RS and T, are as follows:—RS being a truncated pyramid surmounted by a knob, T cylindrical with a groove. The length of the side of the base of RS is 0·95 in., the total height 2·66 inches; the diameter of the base of T is 1·125 inch, the height 1·07 inch.

ounces from 258 oz. to $\frac{1}{8}$ oz., in the form of cup weights, fitting into each other. To obtain a Troy pound it was necessary to take the two Exchequer Standard weights of 8 and 4 oz., represented in Fig. 5.

The two other Troy pounds constructed in 1758 were found by the Commission to be in existence, as well as two similar Troy pounds made at the same time and bearing similar marks, though all differed slightly in their dimensions, as well as in volume and weight. They were all in good preservation and were carefully examined by Prof. Miller, but there was no satisfactory evidence of their having been accurately compared with the lost standard so as to identify its weight, and thus to render them available for determining the proper weight of the new standard. One of the two last-mentioned pound weights (denoted as O by Prof. Miller) is shown in Fig. 4. This weight was purchased by the Commission, and is now deposited in the Standards' Department. It differs very slightly in its dimension from the lost standard, as shown above, and its weight in air was computed by Prof. Miller to be 5759·85625 grains of the lost standard.

For ascertaining the exact weight of the lost standard

* Continued from p. 309.

pound, the following weights, which had been accurately compared with it, were examined :—

The brass Troy Exchequer Standard pound, constructed in 1824 under the superintendence of Capt. Kater, and legalised as the official Standard ;

Three similar brass pounds, constructed for the Cities of London, Edinburgh, and Dublin ;

A platinum Troy pound and two brass pounds belonging to Prof. Schumacher ;

The platinum Troy pound of the Royal Society.

It was found, however, from examining the results of several weighings of the brass Troy pounds that great discrepancies existed, attributable to the effect of oxidation or other causes. It was consequently resolved to rest entirely for evidence of the weight of the lost standard on the comparisons of the two platinum Troy pounds ; denoted by Prof. Miller as Sp and RS. These two platinum weights had been constructed in 1829, and were intended to be equal to the lost Standard (denoted as U) when weighed in air. Each of them had been compared with V by Capt. Nehus at Somerset House in 1829, with the following results :—

Mean of 300 observations, Sp = U − 0·00857 grain, (mean t = 65° 62 F. b = 29·722 in.)

Mean of 140 observations, RS = U − 0·00205 grains, (mean t = 65·73 F. b = 29 806 in.)

The density of Sp had been determined by weighing it in water, to be 21·1874, and it was found to displace 0·32544 gr. of air of the stated mean temperature and atmospheric pressure. The density of U had never been determined, but it was assumed to be of the same density as one of the Troy pounds constructed at the same time, viz. 8·151, which is nearly the average density of brass and bronze weights, and to have therefore displaced 0·84646 gr. Whence in a vacuum Sp = U − 0·52959 gr.

The density of RS also had not been determined by weighing in water, but it was assumed to be of the same density as Sp, and therefore to have displaced 0·32629 gr. of air, whilst U displaced 0·84865 gr. Whence in a vacuum RS = U − 0·52441 gr. The mean value of the lost Standard Troy pound thus determined through Sp and RS, was the basis upon which the new Standard Avoirdupois pound was to be constructed. As a preliminary operation, a new platinum Troy pound, denoted as T, was constructed very nearly equal in weight to Sp and to RS, and taking the mean of 286 comparisons of T with Sp, and of 122 comparisons of T with RS, it was found that in a vacuum

T = Sp + 0·00105, whence T = U − 0·52851
T = RS − 0·00429, whence T = U − 0·52870

From the mean of these two results, giving to the first twice the weight of the second, in consequence of Sp having been compared about twice as many times with U and with T as RS was compared, it was finally determined that in a vacuum

T = U − 0·52857 gr., or = 5759·47143 grs.

It was also found that in air t = 65° 66 F. b = 29·753° which was the mean of the comparisons of Sp and RS with U, and was adopted by Prof. Miller as the standard air,

T = U − 0·00745 gr.

It should be observed that all the standard Troy pounds were intended to be of their true weight in ordinary air, whilst the new standard imperial avoirdupois pound was to be made of its true weight when weighed in, or reduced to, a vacuum.

The next process was to determine the weight of the new avoirdupois standard pound, of 7,000 grains from the Troy pound T of 5,760 gr., and for this purpose four new platinum weights of 1,240 gr. each were constructed, all accurately verified in terms of T, and by employing other platinum weights of 800, 500, 400, 80, and 40 gr., the true weight in a vacuum of each of the 1,240 gr. weights was separately determined by numerous comparisons with T and with each other as follows :—

Grains.
A = 1239·88622
B = 1239·88605
C = 1239·88597
D = 1239·88580

Mean = 1239 88601
T + Mean = 6699·35744

It thus required only a weight of 0·64266 gr. to make up the full weight of 7,000 gr. The approximate weight 0·645 gr. was obtained from T in the following manner. By comparisons with the 40 gr. platinum weights, two platinum weights of nominally 20 gr. each, were found to weigh 19·998 gr. each, from which were derived W = 12 901 gr., V = 6·0451 gr. From V was derived Q the mean of ten weights of platinum wire, and equal to 0 645 gr. very nearly. It will be shown, hereafter, in describing the mode of weighing with a scientific balance, that small differences between two Standard pound weights of less than 0·1 grain are ascertained by the index scale of the balance. Means were thus afforded of determining the exact weight of 7,000 gr., which was the weight in a vacuum of the new standard pound, constructed of platinum, and denoted as PS. or Parliamentary Standard.

The weight of PS was actually determined by the mean results of 80 comparisons with each of the following sets of weights :—

	gr.		°	mm.
PS ≏ T + Q + A	− 0 002936	in air t. =	19·47 C. b. =	758·38
PS ≏ T + Q + B	− 0·001731	,,	19·19	759·31
PS ≏ T + Q + C	− 0·001621	,,	18·83	754 38
PS ≏ T + Q + D	− 0·000774	,,	19·63	764·43

Mean of all,

PS = T + Q + ¼(A + B + C + D) − 0·00177 gr. in air t. = 19°·28 C. b. = 759·12

The density of PS was determined by weighing in water to be 21·1572, and that of T and the smaller platinum weights to be 21·1661. PS consequently displaced 0·397 gr. of air, and T + Q + A displaced 0 39727 gr. Hence

PS = 7000·00093 grains of which U contained 5760.

Having arrived at this very close approximation to the desired weight of the new standard, it was resolved by the Commission that PS should be constituted the new Imperial Standard pound, and be consequently deemed to contain 7000·00000 grains of the new standard.

Four similar platinum pounds were also constructed, and their weight in terms of the new standard PS accurately determined. These were intended as auxiliary Standards of Reference, with the view that either of them might replace PS, in case of its destruction or damage. They were termed Parliamentary Copies (P.C.), and were deposited as follows :—

PC, No. 1, at the Royal Mint.
PC, No. 2, with the Royal Society.
PC, No. 3, in the Royal Observatory at Greenwich.
PC, No. 4, immured in the New Palace at Westminster.

Thirty-six other standard pounds of bronze gilt were also constructed, and their standard weight, both in a vacuum and in the standard air, adopted by Prof. Miller, was accurately determined, as well as the densities of all the new standard pounds. These gilt bronze pounds were distributed amongst different countries and public institutions of this country.

All the numerous weighings, both in air and in water, of the new standard pounds for determining their weights and densities were made by Prof. Miller himself, and full details of all these operations are given by him in his "Account of the Construction of the new National Standard of Weight."

The new imperial standard pound is of the true weight of an avoirdupois pound when in a vacuum. The principal advantage of the metal of which it is composed (platinum), consists in its not being affected by oxidation, which would unavoidably alter its absolute weight. But platinum has this disadvantage, if used as the material of a standard for regulating ordinary weights of precision made of brass, viz. that when weighed in air against a brass or bronze standard weight of so much greater volume, although of equal weight in a vacuum, its apparent weight is always about half a grain greater than that of the brass or bronze standard. To obviate this disadvantage, the weight in standard air of all the bronze Standard pounds verified by Prof. Miller were computed by him, *not in terms of the platinum standard pound, but of an ideal brass commercial standard pound, denoted by him as W.* He assumed W to be of the same density as the lost standard, and of the average density of brass or bronze. In standard air, $t. = 65°·66$, $b. = 29·75$ in. PS with a density of 21·1572 displaced 0·39644 grain of air, and W was assumed to displace 1·03051 grain. And as the official standard weights, by reference to which all commercial weights are verified, are made of brass or bronze, it was intended that they also should be regulated by their weight in air when referred to the brass commercial standard W. This has in fact been done. The only change since made has been under the sanction of the late Standards Commission, by which the standard air recited in the Act of 1824 for determining the weight in air of a cubic inch of water, viz. $t. = 62°$ F., $b. = 30$ in. has been substituted for that adopted by Prof. Miller in consequence of its being the air in which the weight of the lost standard pound had been most accurately determined. The object of this change was to adopt one uniform normal temperature and barometric pressure for all standard purposes. In the new standard air ($\log \triangle = 7·0852825 - 10$), PS displaces 0·40282 gr., and W, with a density of 8·1430, displaces 1·04706 grain of air.

H. W. CHISHOLM

(*To be continued.*)

THE TUSCAN MEMORIAL TO GALILEO

VILLARI, in speaking of Savonarola, and the men of his time, says :—"The world stood aghast at this new race of Titans, who arose to fight with the old idols, and it soon began to oppress them ; but it worships their remains and lingers in their footsteps." And this is literally the case : the descendants of those Italians who burnt Savonarola at the stake, preserve, with religious care, the cell in which he wrote, morsels of his monkish garments and of his hair, his manuscript notes, indeed every memorial that remains of him. The custodian who showed us these remains, together with a picture representing Savonarola at the stake in his own Piazza della Signoria, of Florence, abused Alexander VI. and the Inquisitors, and the whole body of ecclesiastics concerned in the matter, so roundly and so fiercely, that we were led to wonder what manner of Catholic he could be ; and to compare the Catholicism of 1872 with that of 1472. Thus, too, Galileo, persecuted during his lifetime, is now almost worshipped : the Tuscans have built him a shrine worthy of a saint ; in the inscription on his house at Arcetri, they call him *Divinus Galilæus ;* and in the shrine itself they have preserved, after the manner of a saintly relic, one of his forefingers which was detached from his body when it was removed from the chapel of SS. Cosmo and Damianus to Santa Croce. This relic is preserved in a small reliquary urn, upon the base of which is the following inscription written by Thomas Perelli :—

"Leipsana ne spernas digiti quo dextera cœli
Mensa vias nunquam visos mortalibus orbes
Monstravit, parvo fragilis molimine vitri
Ausa prior facinus cui non Titania quondam
Sufficit pubes congestis montibus altis
Ne quidquam superas conata ascendere in arces."

Again we have *Via Galileo* and *Biblioteca Galileina.* The Pisans point with pride to the *Lampada Galileina* in their Cathedral, and honour his statue in their University ; and these are the descendants of the men who paid Galileo tenpence a day for his services in the University ; who made him abandon his professorship because he proved that Aristotle was not infallible ; and who said derisively to his followers—"Ye men of Galilee, why stand ye gazing up into heaven ?" or, as Ponsard has it :—

"Ecoutez ce que dit l'Apôtre : *Dans les cieux*
Pourquoi Galiléens, promenez-vous vos yeux ?
C'est ainsi que d'avance il lançait l'anathème
Contre toi, Galilée, et contre ton système."

The Tuscan Memorial to Galileo is in Florence, in the *Museo di Fisica e di Storia Naturale.* It is entirely the work of Tuscans, and is said to have been constructed at a cost of 1,000,000 lire (nearly 40,000*l.*) It consists simply of a vestibule, from which opens a small rectangular hall, with a semicircular tribune, in which is placed the statue of Galileo, by Prof. Costoli. The interior of the hall is entirely lined with white marble, and with frescoes in admirable taste. The frescoes in the vestibule represent Leonardo da Vinci in the presence of Ludovic Sforza, Duke of Milan, to whom he is making known some of his great inventions. Apropos of this, there exists in the Ambrosian Library, in Milan, a large folio full of MSS. notes, and drawings, by Leonardo da Vinci, which the courteous director of the library is always willing to place in the hands of interested strangers, and which well repays the most careful examination. Some of the sketches of hydraulic apparatus, appeared to us to be worthy of minuter study than they appear to have received. The opposite fresco of the vestibule represents Volta explaining his invention of the pile to the members of the French Institute, in the presence of the first Consul, Napoleon, and Lagrange. In the vestibule are also placed marble medallions of Leo Baptista Alberti, and Baptista della Porta. A fresco in the hall by Bezzuoli, represents Galileo lecturing in Pisa, on the laws of falling bodies. This is a really striking and well-conceived painting : Galileo in his professorial toga stands by the long inclined plane, showing his results to his colleague, Mazzoni. In the foreground is a professor in a monastic habit, kneeling near the inclined plane, and counting the time of descent of the falling body, by the beats of his pulse. Young students are pressing round Galileo, in order, if possible, to aid him in his experiments ; while on another side the Aristotelian professors are looking on with derision, and searching in vain in the writings of the Peripatetic for explanations of the new facts. In the background appear the cathedral and the leaning tower. The whole conception is noble and spirit-stirring, and one longs for a similar treatment of other great discoveries in science :—Davy discovering potassium, Faraday obtaining the first magneto-electric spark, and magnetising a ray of light. The opposite painting represents a meeting of the *Accademia del Cimento :* the patron of the Society, the Grand Duke Ferdinand II., is eagerly watching an experiment which is being made by Redi, Viviani, and Borelli, on the apparent (to them real) reflection of cold by a parabolic mirror :—one of the rough spirit thermometers recently invented by the Academy, is placed in the focus of the mirror, and a block of ice is used as the source of cold.

The three frescoes in the Tribune immediately around the statue of Galileo, represent three notable events of his life : in the first he is seen intently watching the swinging of a lamp in the Cathedral of Pisa ; in the second we see him in the act of presenting his telescope to the Venetian Senate; and in the third he is represented as an old man, in his house at Arcetri, dictating the geometrical demonstration of the laws of falling bodies to his disciples Torricelli and Viviani. On the arch above the statue, the astronomical discoveries of Galileo—the Italians claim for him the Milky Way, the Nebula of Orion, the Phases of Venus, the Mountains of the Moon, the Satellites of Jupiter, the Solar Spots, and the Ring of Saturn—are represented very effectively on a blue ground. Bas-reliefs in marble on the pillars of the arch represent his terrestrial discoveries—his countrymen claim for him the Pendulum, the Hydrostatic Balance, the Thermometer, the Proportion Compass, the Keeper of Magnets, the Telescope, and the Microscope. Beneath the frescoes and around the statue are niches, containing some of Galileo's instruments, his telescope, an objective made by the astronomer himself, a proportion compass, and a magnet, with a keeper which he constructed for it. Immediately surrounding the statue we notice the busts of his most celebrated followers, Castelli, Cavalieri, Torricelli, and Viviani. In the hall there are six cases containing old apparatus, chiefly that of the Academy of Cimento. The various thermometers figured in the "Saggi di Naturali esperienzi" of the Academy are here to be seen; the vessels they used for showing the incompressibility of water; hygrometers; together with astronomical and geodesical instruments. Here, also, is the large burning-glass constructed by Bregaus of Dresden, employed by Averani and Targioni in their experiments on the combustion of the diamond, and afterwards employed by Sir Humphry Davy. The various inventions and discoveries of the Academy are shown in bas-relief on the pillars of white marble.

The memorial is altogether worthy of the man, and of the fine taste of the Florentines. It is, perhaps, the only *sanctuaire scientifique* which exists, but we may hope that the example of the Florentines will be followed in this and other countries. The Milanese have recently bought the collection of apparatus and the MSS. of Volta (for a sum, we believe, of 100,000 lire); a suitable museum for them will, no doubt, soon be fitted up. It is much to be wished that Faraday's apparatus could be collected together in one place, as a memorial to the man. This reminds us that soon after the death of Faraday a subscription was set on foot for the purpose of providing some suitable memorial, but we are unable to remember whether the designs of the committee were fully carried out, and whether the subscription attained the desired amount; if not, it is to be hoped that the matter will be kept well before the public.

We have spoken above of the discoveries attributed to Galileo by his countrymen. We are inclined to think that some of his claims have been pressed too far; but on such a subject an almost endless controversy might be carried on, for we may remember that even the invention of the telescope has been claimed for others of his own countrymen (Antonio de Dominis and Baptista Porta), and by the Dutch; and the invention of the thermometer has been attributed to Cornelius Drebbel, Sanctorio of Padua, and others. But if we put all this aside, Galileo still stands out pre-eminently as one of the fathers of experimental philosophy: he did not create it, but he introduced a taste for it, and enlarged it, and he possessed in an eminent degree the true spirit of philosophical inquiry, the ardent love of research, the "Provando et Riprovando" which the Academy of Cimento adopted as its motto.

G. F. RODWELL

THE SPHYGMOGRAPH AND THE PULSE

THERE are few valuable instruments or methods of research which have been brought before the scientific world under circumstances less auspicious than one, the inventor of which, the illustrious M. Marey, has quite recently visited this country. The sphygmograph, shortly after its first construction, was introduced into this country as an instrument which gave promise of being an invaluable aid in diagnosis, and of such universal applicability as the stethoscope and thermometer. Nevertheless, after an existence of more than ten years, it may be said that the general impression respecting it is that it is a failure, that it has not answered its expectations, and that it may as well be put aside, together with other curiosities of the physiological laboratory. How this result has come about is not difficult to discover. The instrument is a complicated one, and its indications are even more so. The stethoscope, when introduced, gave results at first sight palpable to the most ordinary minds, and the amount of mechanical knowledge necessary for the comprehension of some of its most striking results scarcely exceeded that of the principle of the common pump. But with the sphygmograph the case is different. Its indications are so detailed and so precise that before they can be understood, it is absolutely essential that several intricate and elaborate problems of hydrodynamics and physiology should be thoroughly investigated, and more than one of these have not, we are surprised to say, yet left the hands of the mathematicians in any decided form. How then is it to be expected, as it has been by many, that the sphygmograph should be found a valuable assistance in the diagnosis and prognosis of disease, before the physicist and physiologist can give an explanation of the language in which it appeals to them? There is no doubt that the instrument must be in the hands of the student of the healthy body for some time to come before its true value in the elucidation of disease will be appreciated; and all additions to our knowledge concerning it must be carefully weighed.

In a thesis for the M.D. Cantab.,* Dr. Galabin has published several results of his sphygmographic work in the study of renal disease, and what is more to the point on the present occasion, he gives his own ideas as to the analysis of the same trace in health. The fact of the author's being an accomplished mathematician, as well as a student of biology, gives more than ordinary weight to his remarks, and enables him to put several points in a light which is clearer and more precise than usual.

The author does not enter fully into the reasons in favour of his views, and does little more than simply state them; but as they differ in some respects from those generally accepted, they present features of interest to workers on the subject. He is one of those who consider the trace as it appears on the recording paper as a decidedly duplicate phenomenon, resolving it into the true pulsation, together with the oscillations of the lever, which necessarily result from the momentum acquired by its sudden movement. This he illustrates by superimposing on an ordinary pulse curve, as taken by the sphygmograph, an ideal one, such as, according to his conception, it would be if the instrument correctly followed the changes in the diameter of the artery under observation; the latter being little more than a uniform rapid rise followed by a similar but slower fall, that is slightly broken by the "dicrotic" wave, which is produced by the closure of the aortic semilunar valves. The excessive height of the primary rise is supposed to be due to the powerful impulse given to the lever at the commencement of the flow of fluid in the artery; and the small secondary, or "tidal" wave, which occurs just before the "dicrotic," is supposed to indicate the true arterial expansion, which the lever meets on falling from the height of its impulse. We quite agree with part of this explanation, being fully convinced, from many reasons, that the primary rise, or so-called "percussion" wave, is not a percussion wave at all in the ordinary

* "On the Connection of Bright's Disease with Changes in the Vascular System." By A. L. Galabin, M.A. M.D., Fellow of Trinity Coll, Camb.

acceptation of the term; in other words, that it does not result from the shock produced by the opening of the aortic valve, but that it is coincident with the flow of liquids, one reason being, as the author remarks, that the most violent impulse in an artificial model or schema of the circulation so communicated, as not to cause any flow of liquid, produces no upstroke, but only a slight quivering of the lever. However, that the primary oscillation of the lever in a sphygmograph trace is not, in a great measure, a genuine representation of the movements in the artery, it is equally impossible to believe, for in very slow pulses, where the main rise is not very decided, this wave is particularly pronounced, being gradual in its rise, and more gradual and paraboloid in its fall. It is also seen equally clearly by employing a reflecting sphygmoscope, in which the ray of light which acts as the long arm of the lever, has no weight, and consequently cannot produce any oscillation. Another great objection is that the notch between the first and second (the percussion and the tidal) waves always occurs at the instant at which the aortic valve closes at the heart,* the time it appears after the commencing pulsation *varying* with the length of the pulse-beat. In fact, the tendency of all observations is to make it evident that the second or tidal wave is a post-systolic act, being the oscillatory indication of the secondary tidal wave, which appears as such in the dicrotic rise, and originates from the closure of the aortic valve, as Dr. Galabin agrees with most in thinking; though Dr. Sanderson holds the very different view that the second beat is a restoration of equilibrium which takes place by increase of pressure towards the heart and diminution towards the periphery, a consequence of the sudden projection towards the capillaries of the blood during the systole.

Dr. Galabin remarks that, "if the sphygmograph used have a secondary spring to keep down the long lever, the tidal wave may be replaced by two or even by a jagged line. Such a spring is better omitted, because it is apt to introduce oscillations of its own." It is this idea which has misled him. Tracings taken as he proposes appear much in favour of his explanation, but they are so because they are in reality less truthful than they might be. We have never seen the least indication of any imperfections caused by the employment of the small spring, but we have seen the "percussion" wave divided into two by it in very slow pulses, the former being a small true shock-rise, and the latter the real primary rise.

In conclusion, we cannot refrain from quoting a remark of Dr. Galabin, which, from the precise way in which it sets the question referred to at rest, is worthy of being quoted in every text-book. Referring to the rhythmical contraction observed by Wharton Jones and Schiff in the wing of the bat and the ear of the rabbit, and its supposed influence in assisting the circulation of the blood, he remarks, "Now a peristaltic wave in a tube would tend to produce a current in the liquid of its own velocity, and it would, therefore, accelerate a slower current, but retard a quicker one. Therefore, no peristaltic wave could accelerate the arterial stream, unless it travelled with the velocity of the pulse-wave. It is thus evident that no such slow rhythmical motions as have been observed could assist the arterial flow. And it is inconsistent with the usual character of involuntary muscle to suppose it capable of transmitting a very rapid wave of contraction. The arteries themselves indeed, when made to contract by artificial stimulus, do so slowly and gradually."

A. H. G.

AMERICAN EXPLORING EXPEDITIONS IN THE GREAT WEST

THERE are several important expeditions more or less employed upon scientific work in the least known portions of the Western territories. From some of these parties, a considerable amount of fragmentary information comes at irregular intervals; but in other cases the explorers prefer to withhold details as to their movements and work, whether scientific or otherwise, till after their return, when their report can be prepared officially. There is, however, a general and widespread interest taken in these explorations. It seems desirable for the sake of a clear understanding of news from time to time received, that a general *résumé* of the status and work of at least the more prominent expeditions should be presented.

What is known as the Yellowstone Expedition will first be mentioned, because in size it is much the most formidable. It proceeds through a region where it is deemed advisable to strike terror among hostile savages, and with that view has a military force of 1,900 men. Its movements also have reference to the establishment of two new military posts in the north-west, for which purpose Congress has appropriated 200,000 dollars. The force serves as an escort to surveying parties of the Northern Pacific Railroad, with reference to its completion from the town of Bismarck on the Missouri River in Dakota—about the centre of that territory, and near the 101st parallel west of Washington—to the Rocky Mountains; a distance of between 500 and 600 miles, on a line drawn in general east and west, and south of 47° N. lat.

This line may be divided into three parts; (1) from the Missouri River to the Yellowstone, about 200 miles, coming into the territory of Montana; (2) along the Yellowstone River about 100 miles; (3) thence west-ward, reaching the Rocky Mountains south of the town of Helena. At the date of latest advices, the expedition had passed over the first division, and was on the banks of the Yellowstone. The navigability of that river had just been demonstrated by the successful ascent of a steamboat, built at Pittsburg for the purpose, which brought supplies from Fort Buford.

Of the scientific party accompanying the Yellowstone Expedition, the following names may be mentioned:—Dr. J. A Allen, of Cambridge, Mass., in charge of zoology, botany, and palæontology, and chief of the scientific party; Dr. L. R. Nettre, mineralogist and geologist; W. R. Pywell, of Washington, photographer; E. Konipucky, of the Museum at Cambridge, artist; and C. W. Bennett, taxidermist.

The Hayden Expedition, as that under the management of Dr. F. V. Hayden is generally termed, might be more properly designated as the United States Geological and Geographical Survey. It has a much larger scientific staff than any of the other expeditions. Its history dates from 1867, when what was then the territory of Nebraska was the subject of a survey by the United States, Prof. Hayden being appointed chief geologist to the survey under the Act of Congress by which the undertaking was authorised. The next year the survey was extended into Wyoming Territory, and in 1869, into Colorado and New Mexico. In 1870, a more careful survey of Wyoming Territory was made; and in 1871, portions of Montana, including the natural wonders of the Yellowstone region, became the subjects of exploration; ultimately resulting in the setting apart as a public pleasure-ground of the Yellowstone National Park, a district of 3,575 square miles. The survey of 1872 reached the region of the Yellowstone by separate routes of two divisions, of which one proceeded from Fort Ogden, Utah, and passed up the Valley of the Snake River in Idaho Territory; the other started from Boseman, a town in Montana near the Rocky Mountains, and on one of the Upper Forks of the Missouri River. The appropriations for this series of surveys have been increased year by year, starting with 5,000 dollars in 1867, and rising to 75,000 dollars for the survey now taking place.

* See Proc. Roy. Soc., 1871, p. 320.

The district of this year's operations may be specified as the eastern half of mountainous Colorado, includes about 32,000 square miles, and is bounded east by long. 104° 30′, north by lat. 40° 25′, west by long. 107°, and south by the southern boundary of Colorado, lat. 37°. It is divided for the purposes of the survey into three parts by latitude lines 38° 30′ and 39° 30′; the northermost being called the "Middle Park Division," the middle one the "South Park Division," and the southern one the "San Luis Division." The examination of the gold and silver mines of the region, and the measurement of its mountains, are among the more important duties of the survey. Unusual prominence is given to procuring pictures by photographs and otherwise.

The camp was organised at Denver College in May; the expedition started thence July 1, numbering 41 men. The season has been unusually favourable, the streams being low and but little snow or rain falling. The location of the camp at the latest advices was on the eastern slope of the Rocky Mountains, at the head-waters of the Platte, Arkansas, and Blue Rivers. Accurate measurements of some of the more prominent peaks, among which are Pike's, Long's, Evan's, Gray's, Lincoln's, and the Holy Cross, have been obtained. The views from these summits where the snow melting on one side flows to the Atlantic, and on the other to the Pacific, are of vast scope and magnificence. There were in sight from one point by actual count, 150 peaks of not less than 13,000 ft., and at least 50 of 14,000 ft. in height. By the middle of July 150 stereoscopic views, and 50 11 × 14 in. negatives of this scenery had been secured. The mountains have, very generally, at a depth of 50 to 200 ft. from their surface, a limestone stratum 30 to 50 ft. thick, containing silver and lead, yielding on the average in the best mines 250 to 300 ounces of the former metal, to the ton of ore. The carboniferous and silurian rocks identified are said to contain rare fossils. The entomologists of the expedition have classified no less than 227 different kinds of grasshoppers. The direction of march projected at last accounts was to be toward the valley of the Upper Arkansas River and the unexplored region beyond.

There are more than 20 scientists taking actual part in the expedition: among them may be mentioned Dr. F. V. Hayden, geologist-in-chief; Mr. J. T. Gardner, chief geographer, who has attained great reputation in his connection with previous geodetic surveys in Colorado and on the Pacific coast; Mr. Marvine, geologist of the Middle Park Division; Mr. Henry Gannett, meteorologist and astronomer, and topographer, in charge of the South Park Division; Mr. W. H. Jackson, in charge of the photographic party; Dr. Endlich, geologist; Lieut. W. L. Carpenter, naturalist; Mr. Seward Cole, ornithologist; Mr. J. M. Coulter, botanist; Dr. A. C. Peale, geologist; Prof. W. D. Whitney, of Yale College, who is writing a series of interesting letters concerning the work, to the *New York Tribune.*

On some accounts the expedition of Prof. O. C. Marsh, sometimes known as the Yale College Expedition, because the fossils collected are sent to that institution, ranks next in importance. This is purely a private undertaking, at the expense of the persons composing the expedition. The United States Government furnishes a small but sufficient military escort. The reports are published under Government auspices. This is the fifth of a series of expeditions similarly undertaken by Prof. Marsh, has no reference to surveying or topography, and is devoted exclusively to research for the remains of extinct vertebrates in the tertiary and cretaceous formations. The districts explored hitherto with such remarkable success will probably supply the fields of the present undertaking. The directions previously taken were as follows:—

First expedition, in 1868, to Lake Como, Wyoming Territory. Second, in June, 1870, to the Loup Fork River, in Nebraska; the Bad Lands east of the Black Hills and between the North and South Forks of the Platte, in Wyoming and Colorado; and the Great Basin of the Green River, southward from Fort Bridger, bordering Utah. There were also minor trips during this expedition to Green River, in Wyoming, and to the Smoky River, in Kansas, which were productive of valuable results. The third expedition started in the summer of 1871, and again explored the Smoky River region in Kansas, the Green River Basin, above mentioned, and investigated two basins, likewise of the Tertiary age, one in Idaho and the other in Oregon. The fourth was a trip with a comparatively small party in the autumn of 1872. It concentrated at St. Louis, went to Fort Wallace by way of Kansas City, and, receiving escort, proceeded to Smoky Hill Fork. On this expedition some explorations were made near Cheyenne, and several days were spent in researches, with varying success, at Crow's Creek, Colorado.

At the most recent dates the present expedition, leaving North Platte Station on the Union Pacific Railroad, had made a nine days' march through a desert country, undergoing great hardships; had reached the Niobrara River, made investigations on both its banks for more than 100 miles below the mouth of Rapid River, and had returned, laden with fossils, to Cheyenne, expecting to make the next start from Fort Bridge in Wyoming Territory. This expedition may extend its researches, as Professor Marsh informed the writer, to the Pacific Coast, and is not expected to return till late in the autumn.

The expedition known as the Wheeler Exploration Party is under the management of the U.S. War Department, Bureau of Engineering. Its chief is Lieut. G. M. Wheeler, of the U.S. Engineers. The operations of the present season will consist of exploration and survey west of the 100th meridian and south of 40°, principally in New Mexico and Arizona, down to the borders of Mexico. The following are named amongst the scientific force:—Messrs. Henry Leubbers, G. Thompson, J. J. Young, and E. Somer, topographers; G. R. Gilbert, E. E. Howell, J. J. Stevenson, and Oscar Loew, geologists; H. W. Henshaw and John Wolfe, naturalists; B. Gilpin, meteorologist; J. H. Clarke, Dr. F. Kampf, W. W. Marryatt, and Prof. H. B. Herr, astronomical observers. The establishment of an astronomical observatory, substantially built of brick, having three observing-rooms, at Ogden, Utah, will form part of the labours of this expedition, which concentrated its forces to start from Denver in June last.

There is an expedition under command of Capt. W. A. Jones, of the U.S. Engineers, which started from Omaha on the 2nd of June. Its objects are mainly topographical, having direct reference to the Yellowstone National Park; but it may be extended to the Big Horn country, a wild region imperfectly known, and said to be fabulously rich in minerals, situated south of 44°, and between meridians 106 and 108. Among the scientific men attached to this party are Lieut. S. E. Blunt, astronomer; P. Le Hardy, topographer; Dr. C. C. Parry, botanist and mineralogist; and Mr. T. B. Comstock, of New York, geologist.

Whether there is a surveying party under Mr. Clarence King, geologist, still in the Wasatch Mountains, at work on the line of the 40th parallel; whether that of Major J. W. Powell has returned from its investigations having principal reference to the cañons of Colorado; and whether a party that went from Philadelphia—consisting principally of Prof. Joseph Leidy, palæontologist, Dr. Henry Chapman, zoologist, Mr. Joseph Willcox, mineralogist, all of that city, and Prof. Porter, of Easton, Pennsylvania, botanist—is still in the wilds of Wyoming and Colorado, the writer is unable, at the present date, to determine.

New York, Aug. 8

NOTES

FROM a private letter just received from Prof. Wyville Thomson, we learn that the *Challenger* left St. Vincent, Cape Verde Islands, on August 2, for Bahia, for the purpose of making her fourth section across the Atlantic. As it is now the middle of the rainy season, and as part of the course of the *Challenger* lies along the coast of Africa to the southward, the members of the expedition expect to be very uncomfortable for a time. On July 15 a very successful month's cruise from Bahamas was completed, some of the details of which we expect to be able to publish next week. "We are getting on first rate," the letter says; "the arrangements continue very complete and satisfactory."

THE French Association for the Advancement of Science opens to-day at Lyons, under the presidency of M. de Quatrefages.

THIS year's meeting of the Iron and Steel Institute opened on Monday at Liège, where the members received a most enthusiastic reception. The first meeting was held at the Academic Hall of the University, when Mr. Lowthian Bell, the President, delivered a speech, in which he warmly thanked the Belgian ironmasters for their friendly reception, and then spoke at length on various technical matters. On Tuesday a second meeting was held, when several papers were read. It was announced that the members were invited to hold their meetings next year in the United States. Many fêtes, receptions, and other entertainments have been got up for the members, who are also to visit the principal mines and iron foundries of the district. To-day the members are to be received by the King of Belgium at the Royal Palace in Brussels.

THE British Archæological Association commenced its yearly meetings at Sheffield on Monday, under the presidency of the Duke of Norfolk, who entertained the members, and others, at dinner in the evening. The members received a hearty welcome from the town, and have been visiting several places of interest in the neighbourhood. On Tuesday evening several papers were read in the Cutlers' Hall on Yorkshire archæological and antiquarian subjects. Among these was a paper by Mr. J. R. Planche, Somerset Herald, on "The Early Lords of Holderness," and one by the Rev. Dr. Gatty, on "The Town and Parish Church of Sheffield."

THE twenty-fifth annual meeting of the Somersetshire Archæological and Natural History Society commenced at Wells on Tuesday. The opening meeting was held at 12 o'clock at the Town Hall, the retiring president, Mr. W. A. Sanford, of Minehead Court, taking the chair. After a brief speech he resigned the presidency to Lord Hervey, the Lord Bishop of the diocese. In the report of the Council, the following subjects, among others, were referred to :—The druidical circles of Stanton Drew, the chambered tumulus of Stoney Littleton and Cadbury Camp have, through the influence of the Council, been enumerated in Sir John Lubbock's Bill for the preservation of public monuments. It is proposed to purchase the castle of Taunton as a museum for the rapidly growing collections of the society; 3,000*l*. are wanted. Mr. Ayshford Sanford, in urging the purchase of Taunton Castle, mentioned that it is the oldest fortress of English origin in the west of which the date is certain. It was built by King Ina, about the year 700, and has a Norman keep, and specimens of architectural additions of every date down to the Perpendicular. The earthworks are in good preservation. Mr. E. A. Freeman, D.C.L., in speaking on the question whether the next meeting should be held out of Somersetshire, said the study of the Church architecture of the district was incomplete unless it included Sherborne Minster at one extremity and St. Mary Redcliffe, Bristol, at the other. Sherborne, too, was the old bishopric out of which Wells was carved. After some routine business, the Bishop gave his address. He pointed out some peculiarities of Somersetshire as a county, its many double-named places, its number of small holders, and the absence of any old baronial seats.

THE *Gazette d'Augsbourg* contains some interesting details in connection with the recent meeting at Copenhagen of the Scandinavian Scientific Congress. This is the oldest of the many northern societies, having been instituted at Gothembourg in July 1839. Among the original members are the names of E. H. Œrstedt, J. F. Schouw, Forchhammer, E Fries, Nilson, Berzelius, Hansteen, all men of the highest eminence in their own departments. The meetings of this Association are held alternately at longer or shorter intervals, in each of the three Scandinavian kingdoms, at Copenhagen, Stockholm, and Christiania, the kings of the countries always showing an active interest in the doings of the Association. At the recent—the eleventh—meeting at Copenhagen, the number of members was 400, the President being M. Steenstrup, who delivered the opening address in the presence of the King and Crown Prince of Denmark. The meeting was divided into ten sections, in each of which many papers were read; general meetings were also held, and several excursions made to places in the neighbourhood.

MR. SMITH, the leader of the *Daily Telegraph* Assyrian Expedition, gives in the *Telegraph* of Tuesday a number of interesting details of his work. He gives a translation of the tablet which relates the curious legend of the descent of Ishtar, the "daughter of Sin" (the moon-god), into the infernal regions. The boxes containing the more portable of the treasures exhumed by Mr. Smith have, after many hazardous adventures, safely reached this country. These, with several very valuable memorials purchased in Mesopotamia by Mr. Smith, and the expense of which the proprietors of the *Telegraph* have very generously charged themselves with, are now safely lodged in the British Museum. The heavier articles are expected to arrive in this country very shortly.

THE following among other exhibitors have received diplomas of honour at the Vienna Exhibition :—In the Mining Department: the Geological Survey Office, Calcutta. In Group 22: the South Kensington Museum, London. Educational matters: the National Educational Bureau, Washington; Dr. Leitner, Lahore, India; the Government of Massachusetts; and the Smithsonian Institution, Boston, U.S.

MR. G. F. RODWELL, Science Master in Marlborough College, has resigned the Lectureship on Natural Philosophy in Guy's Hospital.

WE should advise all connected with Science teaching in schools connected with the Science and Art Department, to obtain a copy of the new syllabus in the following subjects, just issued by the Department :—Subject XIV., Animal Physiology; XV., Zoology; XVI., Vegetable Anatomy and Physiology; XVII., Systematic and Economic Botany. From the Syllabus it will be seen that (*a*) Subject XIV, Animal Physiology, is altered in certain details. (*b*) Subject XV., has now become "Elementary Botany," being a modification of the former Subject XVII., Systematic and Economic Botany. (*c*) Subjects XVI. and XVII. together now form a new subject, Biology, into which the former subjects of Zoology and Vegetable Anatomy and Physiology are absorbed. The elementary stage is the same for both Subjects XVI. and XVII, the advanced stages of these subjects being respectively Animal Morphology and Physiology, and Vegetable Morphology and Physiology. As respects the existing qualifications of teachers for earning payments on the results of instruction, the deductions in those payments on account of the previous success of the pupil, and the prizes to the pupils—(*a*) Subject XIV., Animal Physiology, will be in no way affected by the change now made in the syllabus. (*b*) Subject XV., Elementary Botany, will be treated as if it were the same as the former Subject

XVII., Systematic and Economic Botany. (*c*) Subjects XVI. and XVII. will be treated as perfectly new subjects, except that all persons will be qualified to earn payments on results in those subjects who are now qualified in Subject XV., Zoology, and Subject XVI., Vegetable Anatomy and Physiology, and also all those persons who have obtained a class at the courses in Biology and Botany respectively for teachers at South Kensington. (*d*) As the elementary stage of Subjects XVI. and XVII. is the same, payments can only be made on account of a pupil's success in one or the other, and not in both. Payments for the advanced stage and for honours can be obtained in both.

THE following are the regulations for exhibiting Recent Scientific Inventions and Discoveries of all Kinds, at the International Exhibition of 1874:—Division III. Recent Scientific Inventions and Discoveries will consist of objects the excellence and novelty of which are considered by the Committee of Selection to be so great as to render it undesirable that their introduction to the public should be delayed until the proper year for the exhibition of their Classes of Manufacture in Division II. No objects will be admitted into Division III. which have been shown in previous International Exhibitions of this series, unless very important alterations or improvements have been added to them since the date of their previous exhibition. The latest day appointed for receiving objects in this Division is Wednesday, March 11, 1874.

THE Birmingham Natural History and Microscopical Society propose to undertake a novel and commendable enterprise in the shape of a marine excursion. The sub-committee appointed to consider the practicability of the proposal are of the opinion that if such an excursion be properly carried out, it cannot fail to be productive of interest and enjoyment to the members. Taking all matters into consideration, the sub-committee are of opinion that the South Coast of Devon is the most favourable for the proposed excursion; and if Teignmouth be selected as headquarters, it will allow of dredging and shore collecting in the vicinity, and in Tor Bay, and off Berry Head, as well as botanical and geological excursions in the neighbourhood, and (if time permits) visits to the wilds of Dartmoor and the beautiful and picturesque scenery of the River Dart, Holne Chase, Lustleigh Cleave, Becky Falls, &c. It is proposed that the excursions commence on Monday, September 1, which would allow six clear days dredging in the neap tides after the August new moon, and some shore collecting during the September full moon. A first-class yacht, with two men and a boat, can be hired for a very moderate sum, and the Midland Railway Company offer return tickets at very moderate rates with the privilege of staying in Devonshire for 17 days. Various members have undertaken to superintend the dredging, botanical, microscopical, and geological work, and altogether the arrangements proposed are very complete and seem likely to make the excursion a success. We hope it will prove so, and that the example of the enterprising Birmingham Society will be followed by others, either singly or in combination. Inquiries should be addressed to Mr. W. G. Blatch, Hon. Secretary, Green Lane, Small Heath, Birmingham.

THE Brighton and Sussex Natural History Society has determined to collect facts in connection with the Natural History of Sussex, for the purpose of verifying existing Lists, and preparing (with a view to ultimate publication) an authentic systematic record of the land and marine fauna and flora of the county. The Society will be much obliged to all who can render assistance in any or all of the following ways:—(1) By forwarding to the Society lists of such species as may have fallen under one's own *personal* notice; (2) by contributing facts relating to such points as *approximate* locality (in order to prevent the extirpation of rare species, the approximate, and not the exact, locality is asked for); whether rare, local, or common; accidental variations; apparent extinction and re-appearance; times of appearance; any noteworthy matters connected with the life history of species; and (3) by sending specimens to be deposited in the Brighton Free Museum or other Museums in the county. Communications will be thankfully received by Mr. R. Glaisyer, Honorary Curator, Dispensary, Queen's Road, Brighton; or by T. W. Wonfor, and Jno. Colbatch Onions, Hon. Secs.

SCHIAPPARELLI has recently published two very interesting memoirs, the one an elaborate historical monograph on "The Precursors of Copernicus," and the other on "Falling Stars."

SIGNOR AUGUSTO RIGHI, Demonstrator of Physics in the University of Bologna, has published a very interesting memoir, *Sul Principio di Volta* (Bologna: Tipi Gamberini e Parmeggiani, 1873). In this he discusses at great length Volta's theory of electrical excitation. A number of original experiments are given, and photographs of a new apparatus employed for them.

ENGINEERS have been busy on the estate of Mr. W. Gilford, at Dalby-on-the-Wold, aad other places in Leicestershire, investigating the allegation that the Midland coal measures extend in an almost direct line from near Leicester to Melton Mowbray, and through the Vale of Belvoir, embracing an area of many square miles. As the reports made are of a highly favourable character, and as the importance of having a coal-field close to the town of Leicester can scarcely be over-estimated, it is proposed to bore to a depth of 1,000 ft., and to divide the expense *pro ratâ* amongst the landowners. Several of those most interested have signified their desire to have the problem solved in the only practical manner. Mr. Harrison, of the Mining School, Nottingham, is of opinion that "coal exists under East Notts and East Leicestershire, there being an anticlinal fault throwing out all the measures in the western part of Notts, and throwing them all in on the eastern side. From this and other considerations" he is convinced "that there is an immense coal-field stretching along the county of Nottingham, by Bingham, through the Vale of Belvoir, as far as Melton Mowbray, and will be found at a workable depth."

AT the last monthly meeting of the council of the Victoria Institute, it was announced that seventy-nine new members had joined during the past seven months. It was also reported that in accordance with a resolution passed at the previous meeting the Institute had joined in the application made to the Government for adequate aid to the expeditions to observe the transit of Venus, more especially those so strongly urged by the Greenwich board.

THE valuable library of Conchological and other Natural History books belonging to the late Mr. Thomas Norris, of Preston, was sold by auction on July 30, by Mr. J. C. Stevens, for 322*l*. Mr. Stevens also sold, on Aug. 7, the library of the late D. H. Beaumont Leeson, F.R.S., of Bonchurch, for 580*l*.

THE recent earthquake in South America extended, it is stated, over 30,000 square miles.

THE following is from the *Gardener's Chronicle*:—"We learn that Baron von Mueller is about to retire from the directorship of the Botanic Garden, Melbourne. On scientific grounds this is much to be regretted, for no one has done so much as the Baron to forward the interests of Botanical Science and practical applications in Australia as he has done. We cannot profess to judge the circumstances which may have led to this step; but if, as is alleged in some of the Melbourne papers, 'the gardens are henceforth required more as an ornamental adjunct to the Viceregal domain than as the centre of Botanical Science and experiment in Australia,' then undoubtedly the authorities manifest an ignorance of the proper functions of a botanic garden which is, unhappily, not confined to Australia. Everyone must desire that the garden should not be a 'cheerless' 'scientific desert' at the same time it is equally clear that it should not be transformed merely into 'a pleasure-ground worthy of the name.' It is satisfactory, however, to learn that the Baron's services to the State will not be lost, that he will not suffer in pocket by the change, and that additional and much needed assistance will be given him."

THE *Canadian Ornithologist* is the name of a serial started last month, "with the object of making a monthly depository of facts, theories, and anecdotes relating to our feathered friends." Dr. Ross of Toronto is the editor. The first number leaves much room for improvement in its successors.

THE last number of the *Journal of the Society of Arts* contains a report by Dr. R. J. Mann, on "Recent Scientific Inventions and New Discoveries at the International Exhibitions."

THE following is the list of candidates successful in the competition for the Whitworth Scholarships, 1873:—Samuel Dixon, 23, draughtsman, Manchester; Roger Atkinson, 20, analytical chemist, Crewe; Joseph Amscow, 22, chemist, Crewe; W. R. Bousfield, 18, student, Cambridge; W. H. Warren, 21, engineer, Wolverton; William Barber, 20, draughtsman, Nottingham; William H. Fowler, 19, engineer, Oldham; Thomas Sugden, 23, mechanic, Oldham; Cyrus Bullock, 22, millwright, Worsley, near Manchester; John Lockie, 20, engineer, Glasgow.

THE following gentlemen have passed in the First Division on the First B.Sc. Examination for 1873, in the University of London:—P. Bedson, E. B. Cumberland, T. F. Harris, S. A. Hill, W. Hudson, J. Viriamu Jones, O. Lodge, J. G. MacGregor, W. R. Parker, T. S. Tait, C. M. Thompson, A. T. Wilkinson, B.A.

THE "Proceedings of the Geologists' Association," for July, is almost wholly occupied with an account of the interesting and instructive excursions of the Association during the summer months of last year. It contains, besides, a paper by Mr. John Paterson, "On a Visit to the Diamond Fields of South Africa," and another by Mr. John Curry, "On Columnar Basalts."

THE "Mineral Statistics of Victoria for 1872," are made up as usual of a host of tabulated details of all kinds, relating to the minerals and mines of that colony. Owing to changes in the law it seems to be more difficult than heretofore to collect accurate statistics as to the quantity of gold raised, many mine-owners being unwilling to furnish returns. According to returns furnished by the Commissioners of Trade and Customs, the quantity of gold exported in 1872 was 1,160,554 oz. 19 dwts., the estimates of the Mining Registers being 1,331,377 oz. 18 dwts.

A SPECIAL Report on Emigration by the American Government has been sent us, containing a great amount of information likely to prove very valuable to intending emigrants, as well as to statisticians. Not only does it contain statistics as to the number, nationalities, &c. of emigrants during the last few years, but much information as to rent of land, staple products, kind of labour in demand, wages to be earned at various trades and occupations, &c.

THE additions to the Zoological Society's Gardens during the past week include a Silvery Gibbon (*Hylobates leuciscus*) from Java, two Slow Loris (*Nycticebus tardigradus*) and a Binturong (*Arctictis binturong*) from Malacca, a Tiger (*Felis tigris*) from India, presented by Sir Harry Ord, C.B.; a Malay Bear (*Ursus malayanus*) from Borneo, presented by Mr. A. C. Crookshank; a common Marmoset (*Hapale jacchus*) and a Black-eared Marmoset (*H. penicillata*) from Brazil, presented by Mr. J. Stanley; a Cornish Chough (*Fregilus graculus*), presented by Mr. G. Holford; a Gazelle (*Gazella dorcas*) from Muscat, presented by Major C. B. E. Smith; two Blue-headed Pigeons (*Starnaenas cyanocephala*) from Cuba, a White-headed Saki (*Pithecia leucocephala*) from Demerara, and a Hawk-headed Parrot (*Deroptyus accipitrinus*) from Brazil, deposited.

SCIENTIFIC SERIALS

THE *Zoologist* for this month commences with an interesting paper by Mr. T. H. Potts, who is paying so much attention to the birds of New Zealand, on the habits of the Night Parrot of that country (*Stringops habroptilus*). One of its favourite foods is the younger part of the fern *Asplenium bulbiferum*, called Piki-piki, which, being only partly digestible, forms large pellets of excreta on the floor of their tunnel homes. All those who have kept a bird of this species as a pet, agree in testifying to its intelligence and companionableness.—Mr. Cecil Smith, among his ornithological notes from Somersetshire, records experiments, suggested by Prof. Newton, with a view of ascertaining how far birds in general, and especially some of the foster-parents of the cuckoo, have any objection to eggs of a different colour being placed in their nest. In nearly every case the exchange was perfectly successful.—Mr. Gatcombe had an opportunity of examining a Night Heron obtained near Ivybridge, in Devon; he also records other ornithological notes.—A specimen of *Scyllarus arctus* is mentioned by Mr J. S. Bowerbank, as having been obtained by him at St. Leonard's (it was five inches long), as well as an Angel Fish.—Mr. A. G. Butler finds, as one of the effects of the Wild Birds Protection Act, that farmers employ boys to collect and break up all the eggs on their grounds, as they are now deprived of the satisfaction of destroying the birds.

SOCIETIES AND ACADEMIES

LEEDS

Naturalist's Field Club and Scientific Association, Aug. 5.—Mr. Louis C. Miall read a paper on "The Permian Rocks of the Neighbourhood of Leeds." He first described the base of the Permian System. The carboniferous rocks having been disturbed, thrown into anticlinals and faulted, were greatly denuded, and the Permian rocks were then deposited upon the new surface thus produced. The conditions of deposit of the magnesian limestone were then considered. The abundance of mineral salts, exclusive of carbonate of lime, the scantiness of animal life and the dwarfed state of the mollusca, all point to deposition in an inland sea or confined basin similar to the Caspian, Dead Sea, or Great Salt Lake of the present day. In parts of he Triassic period the previous marine surface appears to have become, in part at least, terrestrial or fresh water. At a much later period the Permian rocks, with others of subsequent formation, were denuded extensively, and reduced to the state in which they now occur. The Permian series of the neighbourhood of Leeds were then specially referred to. The Lower New Red Sandstone of South Yorkshire (the Pomfret Rock of Smith) does not appear to be present, at all events in a conspicuous state, in this district. The so-called Lower New Red Sandstone of Plumpton is undoubtedly of carboniferous age. The Upper and Lower Magnesian Limestone are well displayed. Various sections of these rocks at Rigton, East Keswick, Collingham, Whin Moor, and Knaresborough, were described in the paper. Remarks on the colour of the soil produced by underlying Permian rocks on the few fossils which have occurred at Garforth and Cold Hill, near Sherburn, and on the superficial drift, concluded the paper.

VIENNA

Imperial Academy of Sciences, April 24.—Dr. Wiesner presented a work on the influence of temperature on the development of *Penicillium glaucum*. Germination of spores takes place between 1·5° and 43° C.; development of mycelia between 2·5° and 40°; and formation of spores between 3° and 40°. These processes attain maxima of rapidity, the first and third at 22°, the second at 26°.—Dr. Hause gave a paper on the decrease of heat with the height in Asiatic monsoon countries. The decrease is less on the windy side than on the lee. The yearly average decrease is not less in the tropics than in central Europe.

May 8.—Dr. Thin presented a memoir on the structure of touch bodies.

May 15.—Dr. Boué read a paper on petrified bodies which have been forced from their place of deposition; and another on the formation of the dolomitic Alpine Breccias, as compared with some tertiary mountains in Lower Austria, which resemble them, but are quite distinct in origin.

May 23.—A communication from Prof. Horsford, of Cambridge, U. S., treated of the reduction of carbonic acid to carbonic oxide through phosphate of iron.—MM. Hlasiwetz and Habermann concluded their account of researches on protein-stuffs. They find the decomposition-products of casein to be, exclusively, these: glutamic acid, aspartic acid, leucin, tyrosin, and ammonia.—Dr. Heitzmann gave a paper on the relation between protoplasm and ground substance in animal bodies.

June 13.—Dr. Basch presented a note on the retardation of intestinal motion through the nervus splanchnicus.

June 19.—M. Fritsch presented the third part of his normal flower-calendar for Austro-Hungary.—Prof. Maley described researches made along with Dr. Donath on the chemistry of bones. One chief object was to ascertain whether the substance of bones is a combination of calcic phosphate with the lime-furnishing mass, in chemical sense, or whether it is not rather an intimate mechanical mixture of the two constituents. They adopt the latter view.—Prof. Töpler described two applications of the principle of air friction to measuring instruments. A suspended magnet has, connected with it below, and in the same plane, a vertical plate, moving in a closed case, the vertical section of which it nearly fills. By inserting cross walls in the case, the motion of magnet and plate may be deadened by air friction; and that in proportion as the cross plates are pushed far in or not. The other application is for levelling purposes. The observer looks through a telescope at a little square mirror suspended by two threads in a glass case scarcely larger than it. The mirror moves as if in a viscous liquid.—Prof. Suess presented a memoir on the earthquakes of Lower Austria. Two lines of direction are distinguished.—Dr. Holetschek discussed the path of the first comet of 1871.—Dr. Heitzmann described experiments in which he had fed carnivorous animals with lactic acid, and also injected it subcutaneously; the result being arthritis and osteomalacia.

June 26.—Dr. Heitzmann read a paper on the life phases of protoplasm.

July 10.—M. Simony gave the principal results of a large theoretical work occupying him, in which a new molecular theory will be developed, requiring only one matter and one principle of force.—Dr. Böhm gave a note on the germination of seeds in pure oxygen gas. In such gas, of ordinary density, seeds did not get beyond the first stages; but, curiously, if the gas was diluted with $\frac{4}{5}$ of its volume of hydrogen, or rarified to a pressure of 150 mm. they germinated as in air.—Dr. Heitzmann read a paper on the development of periosteum, bone, and cartilage.

July 17.—Dr. Böhm presented a note on the influence of carbonic acid on the verdure and growth of plants. In an atmosphere containing only 2 per cent. CO_2 the formation of chlorophyll was retarded; while 20 per cent. suppressed it entirely in most cases. The gas was also found prejudicial, in various degrees to the germination of seeds.—Dr. Sigmund Mayer described some experiments on direct electrical stimulation of the heart in mammalia.—Prof. Suess gave a paper on the formation of mountains in central Europe, and Dr. Heitzmann one on inflammation of periosteum, bone, and cartilage.

Göttingen

Royal Society of Sciences, June 14.—M. Waitz read a note on some lost Mayence Annals.—M. Benfey presented a philological paper on the suffixes *anti*, *âti*, and *ianti iâti*, in Sanscrit, Latin, and Greek; also a notice of some Mongolian and Cingalese legendary fragments; and sketched the design of a treatise on "eye-speech," pantomime, gestures, and modulations of the voice, phenomena which he urges travellers to make careful note of, and grammarians to study more than previously, as throwing light on the development of speech and languages.—M. Quincke described a new method of observing circle divisions in telescopic work.—Dr. Voss communicated mathematical notes on the simple transformation of plane curves, and the geometry of surfaces.—Dr. von Brunn described certain smooth muscular fibres found in the suprarenal bodies, accompanying the larger veins, and forming cylindrical or flat bundles.—M. Enneper presented a second note on orthogonal surfaces.—M. Bjerknes made some historical observations on Dirichlet's problem of a ball at rest in an agitated, unelastic, infinite liquid, and generalised some results previously obtained on the subject.—M. Klinkerfues made some remarks on the method of determining parallax by radiants; the results of this method, for Sirius, agree pretty closely with observation.—M. Lolling contributed a lengthy memoir on the topography of Athens. From local study, and the Greek authors, he seeks to determine the position and nature of the Pnyx, the Bema, the cave of Apollo in the Acropolis, and the Metroon. He is now prosecuting these inquiries further.

July 5.—M. Benfey made some remarks on the dual nominative "âsmritadhrû" occurring in the Rigveda.—Fr. Wieseler gave a description of certain valuable specimens of early Grecian sculpture and other antiquities obtained in the East.—Dr. Riecke discussed Weber's fundamental law of reciprocal electric action in its application to the unitarian hypothesis, instead of the dualistic, which Weber adopted; and points out some differences these hypotheses involve in their results.—Dr. Voss read a paper on the geometry of Plücker's line forms.—Dr. von Brunn communicated a short note on ossification of cartilage.

Paris

Academy of Sciences, Aug. 11.—M. de Quatrefages, president, in the chair.—The following papers were read:—A reply to M. Tacchini's new objections, by M. Faye. The author answered the observations and objections lately published by that observer, of whom he said that "the facts which he cites are in contradiction with the theories which he attributes to me, but not with those which I have really published."—On the Cyanides, by M. Berthelot.—On the re-solution of precipitates, by M. Berthelot.—On the palms of New Caledonia, by M. Ad. Brongniart.—On the carpellary theory applied to the *Ranunculaceæ*, by M. Trécul.—M. Elie de Beaumont frunished some further descriptive matter on the detailed geological map of France.—M. A. Ledieu read the fifth portion of his paper on thermo-dynamics.—On the movements of the tide on the coasts of France, change in the time of high water at Havre since the embankment of the Seine, by M. L. Gaussin.—On the passage of gases through colloidal vegetable membranes, by M. A. Barthélemy.—Note on the methods employed for the analysis of the natural phosphates employed in agriculture, by M. C. Mène. The author strongly advocated the use of the bismuth process, which, he says, never admits of a greater error than 0·25 per cent.—On a cave of the period of the reindeer, at Lortet, Hautes-Pryrénées, by M. E. Piette. The author announced the discovery beneath a deep layer of stalagmite, which covered reindeer remains, of a quantity of prehistoric human relics, and upwards of 500 cubic metres of ashes. The human relics include a drawing, on rein-deer horn, of a heath-cock.—Analytical solution of curve traces of several centres by means of Perronet's geometrical process, by M. Revellat.—On fluorene, by M. Barbier. This is the name given to a hydrocarbon exhibiting great fluorescence, and occurring in coal-tar boiling between 300° and 340°.—On the action of platinum and palladium on the hydrocarbons, by M. Coquillion.—On the variations of hæmoglobin in various diseases, by M. Quinquaud.

CONTENTS

Errata.—Vol. viii. p. 299, col. 2, at bottom, Equation (6), should read:—

$$2\left(\frac{1}{D_{12}}\right)^{\frac{1}{2}}\left(\frac{1}{w_1}+\frac{1}{w_2}\right)^{\frac{1}{4}} = \left(\frac{\rho_1}{v_1}\right)^{\frac{1}{2}}\left(\frac{2}{w_1}\right)^{\frac{1}{4}} + \left(\frac{\rho_2}{v_2}\right)^{\frac{1}{2}}\left(\frac{2}{w_2}\right)^{\frac{1}{4}} \quad (6)$$

The calculations were not made by means of this equation, either in its right or wrong form, but from the values of δ given in Table I.—J. Clerk-Maxwell.

P. 300, 1st col. equation (7) should be $l = \frac{1}{\sqrt{2\pi s^2 N}}$, &c.

P. 309, transfer top line of col. 1 to top line of col. 2, p. 308.