THURSDAY, OCTOBER 23, 1873

LIST OF SCIENTIFIC SOCIETIES

AND FIELD CLUBS

IN GREAT BRITAIN AND IRELAND.

The following list has been compiled mainly from information recently sent us by the Secretaries of the various Societies named. For obvious reasons the Chartered London Societies have been omitted, and in the meantime we have omitted the scientific societies connected with the public schools, a list of which we hope to be able to give in an early number. Corrections of the following list and any additional information are requested by the Editor. The letter (E) denotes that the number of members has been taken from the list appended to Sir Walter Elliot's Address to the Edinburgh Botanical Society (November 1872); *a* denotes that the Society is also a Field Club; and *b* that it issues regular or occasional publications.

County and Title of Society.	When founded.	No. of members.
ENGLAND AND WALES		
Berkshire		
Reading Microscopical Society	1860	72
*ab*Newbury District Field Club	1870	98(E)
Buckinghamshire		
High Wycombe Nat. Hist. Soc.	1865	70(E)
Cambridgeshire		
*b*Cambridge Philosophical Society	1819	557(E)
a ,, Field Naturalists' Club and Entomological Society	1852	40(E)
Cambridge Natural Science Club	1872	12
Cheshire (*See* Lancashire)		
*a*Chester Society of Nat. Sci.	1871	454
Cornwall		
Cornwall Royal Geological Society (Penzance)	1814	163(E)
*ab*Royal Institution of Cornwall (Truro)	1818	214(E)
*b*Cornwall Royal Polytechnic Soc. (Falmouth)..	1833	400
*b*Penzance Nat. Hist. and Antiquarian Soc. ...	1839	60(E)
Cumberland		
*a*Keswick Literary Society	1869	70
Devonshire		
*ab*Plymouth Institution and Devon and Cornwall Statistical Society	1812	153(E)
Torquay Natural History Society	1844	104
*ab*Teign Naturalists' Field Club	1858	123
Association for Advancement of Science, Literature, and Art	1862	174(E)
*ab*Exeter Naturalists' Club and Archæol. Assoc...	1862	165(E)
Dorsetshire		
*b*Purbeck Society	1855	30(?)
Durham (*See* Newcastle)		
*a*Seaham Nat. Hist. Club	1861	50(E)
Glamorganshire		
*b*Royal Institution of S. Wales (Swansea) ...	1835	255(E)
*ab*Cardiff Naturalists' Society	1867	289
Gloucestershire		
Bristol Microscopical Society	1843	33(E)
*ab*Cotteswold Naturalists' Field Club (Stroud) ...	1846	100(E)
*ab*Bristol Naturalists' Society	1862	204
*ab*Cheltenham Naturalists' Association	1867	32(E)
Hampshire		
*b*Isle of Wight Philosophical and Scientific Soc.	1850	103
*ab*Winchester and Hampshire Scien. & Lit. Soc.	1869	125
Bournemouth Nat. Hist. & Antiquarian Soc....	1870	
S. of England Lit. & Phil. Soc. (Southampton)		115(E)
Herefordshire		
*ab*Woolhope Naturalists' Field Club	1851	174(E)
Kent		
*ab*East Kent Natural History Soc. (Canterbury)...	1859	109
*ab*Folkestone Natural History Society	1868	150
*ab*Maidstone and Mid-Kent Natural History and Philosophical Society	1869	80
*ab*West Kent Natural History, Microscopical and Photographic Society		135
London, Counties included in		
Geological Association	1858	297
*ab*Quekett Microscopical Club	1865	570
Old Change Microscopical Society	1865	
*ab*Croydon Microscopical Club	1870	135
South London Micros. and Nat. Hist. Club ...	1870	200
,, ,, Entomological Society	1872	
*a*New Cross Micros. and Nat. Hist. Soc.... ...	1872	
Sydenham and Forest Hill Micros. Club... ...		
Bethnal Green Clubs		
Lancashire		
*b*Manchester Literary and Philosophical Society (including Microscopical section)	1781	222
*b*Liverpool Literary and Philosophical Society...	1812	198
*b*Lancashire and Cheshire Historical Society ...	1831	257(E
*ab*Liverpool Naturalists' Field Club	1860	500
*ab*Manchester Field Naturalists' Society	1860	180
a ,, Scientific Students' Association ...	1860	140
a ,, Lower Mosely Street School Nat. Hist. Soc. ... ... about	1863	
*a*Lunesdale Naturalists' Field Club (Lancaster)..	1868	80(E)
,, Entomological Society		
ab ,, Geological Society		
Warrington Literary and Philosophical Society		96
Leicestershire		
*b*Leicester Literary and Philosophical Society ...	1835	238(E)
Norfolk		
*a*Norwich Geological Society	1864	
*ab*Norfolk and Norwich Naturalists' Society ...	1869	118
,, Microscopical Society		
Northamptonshire		
*a*Northamptonshire Field Club	1866	50(E)
Northumberlandshire		
Newcastle-on-Tyne Lit. and Phil. Soc.	1793	1500
b ,, ,, Antiquarian Soc.	1813	
,, ,, Entomological Soc.	1870	35(E)
*b*Northumberland, Durham, and Newcastle Nat. Hist. Soc. (Newcastle-on-Tyne)	1829	130
*ab*Tyneside Naturalists' Field Club	1846	600
Nottinghamshire		
*a*Nottingham Naturalists' Society	1852	45
,, Literary and Philosophical Soc....	1864	271
Oxfordshire		
Ashmolean Society (Oxford)	1828	
Shropshire		
*b*Ludlow Natural History Society	1833	70(E)
*b*Shropshire and N. Wales Natural History and Antiquarian Society	1835	86(E)

County and Title of Society.	When founded.	No. of members.
*ab*Oswestry and Welshpool Naturalists' Field Club and Archæological Society	1857	45
*a*Severn Valley Naturalists' Field Club (Bridgenorth)	1863	243 (E
*a*Caradoc Field Club (Shrewsbury)	1863	71 (E
a ,, Field Club	1868	60 (E
Somersetshire		
Royal Literary and Scientific Institution (Bath)	1823	215
*b*Somersetshire Archæological & Nat. Hist. Soc.	1849	365 (E)
*ab*Bath Nat. Hist. and Antiquarian Field Club	1855	94
Staffordshire		
*ab*North Staffordshire Naturalists' Field Club	1865	280
*a*Tamworth Natural History, Geological, and Antiquarian Society	1871	100
Suffolk		
*ab*Suffolk Institute of Archæology and Nat. Hist. (Bury St. Edmunds)	1848	147
Surrey (*See* London)		
*ab*Holmesdale Nat. Hist. Club (Reigate)	1857	105 (E)
Sussex		
*ab*Brighton and Sussex Nat. Hist. Soc.	1854	180
*ab*Lewes and East Surrey Nat. Hist. Soc.	1864	105
*b*Eastbourne Nat. Hist. Soc.	1868	95
Warwickshire		
*b*Warwickshire Nat. Hist. and Archæological Soc.	1836	97 (E)
ab ,, Naturalists' and Archæologists' Field Club	1854	50 (E)
Birmingham Nat. Hist. and Microscopical Soc.	1858	
Leamington Philosophical Society	1866	
Wiltshire		
Wiltshire Archæological and Nat. Hist. Soc.	1853	320
Worcestershire		
*b*Worcestershire Nat. Hist. Soc.	1833	200 (E)
a ,, Naturalists' Field Club	1846	120
*ab*Malvern Field Club	1853	60
*ab*Dudley and Midland Geological and Scientific Society and Field Club	1862	172 (E)
Yorkshire		
*b*Leeds Philosophical and Literary Society	1820	650
*b*Hull Literary and Philosophical Society	1821	371
Sheffield Literary and Philosophical Society	1822	241 (E)
Whitby Literary and Philosophical Society	1822	58
*b*Yorkshire Philosophical Society	1822	459 (E)
*b*Scarborough Philosophical Society	1829	66 (E)
*b*W. Riding Geological and Polytechnic Society	1838	
*ab*Yorkshire Naturalists' Club	1849	98 (E)
*a*Halifax Naturalists' Society	1857	41 (E)
*a*Leeds Natural History Society	1862	61 (E)
*ab*West Riding Consolidated Naturalists' Society including:—	1862	
*a*Huddersfield Naturalists' Society	1847	125
*a*Heckmondwike ,, ,,	1861	36
*a*West Clayton ,, ,,	1862	24 (E)
*a*Ovenden ,, ,,	1865	36 (E)
*a*Barnsley ,, ,,	1867	47
*a*Stainland ,, ,,	1868	
*a*Rippenden ,, ,,	1871	
*a*Holmforth ,, ,,	1871	
*a*Wakefield ,, ,,	1871	
*a*Liversedge ,, ,,	1872	
*a*Rostrick ,, ,,	1873	
*a*Birkby ,, ,,	1873	
*b*Ripon Scientific Society	1862	50 (E)
*a*Richmond and N. Riding Naturalists' Field Club	1863	147
*a*Norland Naturalists' Society	1863	17 (E)
*ab*Cleveland Literary and Philosophical Society	1863	160 (E)

County and Title of Society.	When founded.	No. of members.
*a*Bradford Philosophical Society	1865	
*a*Bolton Scientific Students' Society	1865	
*a*Leeds Naturalists' Field Club and Scientific Association	1870	66
Bolton Literary and Scientific Society	1871	100
*a*The Denny Club (Leeds)		
*a*Morley Naturalists' Society		13 (E)
SCOTLAND		
Aberdeenshire		
Aberdeen Philosophical Society	1840	83 (E)
ab ,, Nat. Hist. Soc.	1863	80 (E)
Berwickshire		
*ab*Berwickshire Naturalists' Club	1831	249 (E)
Clackmannanshire		
*ab*Alloa Nat. Science and Archæology Soc.	1862	110
Dumfriesshire		
*ab*Dumfriesshire Nat. Hist. and Antiquarian Soc.	1862	100 (E)
Fifeshire		
*a*Largs Field Naturalists' Soc.	1863	60
Forfarshire		
*b*Montrose Nat. Hist. and Antiquarian Society	1836	190 (E)
*a*Dundee Naturalists' Field Club	1869	12
Inverness-shire		
Inverness Literary Institute		60
Lanarkshire		
*b*Glasgow Philosophical Society	1802	570
ab ,, Nat. Hist. Society	1851	221
ab ,, Geological Society	1858	202
Morayshire		
Elgin and Morayshire Lit. and Scien. Assoc.	1836	100
Nairn		
Nairn Naturalists' Club		
Orkney		
Orkney Nat. Hist. Soc.	1837	17
Perthshire		
Perth Literary and Antiquarian Society	1784	
*ab*Perthshire Society of Natural Science	1867	150
Renfrewshire		
Paisley Field Club (recently formed)		
Roxburgh		
Tweedside Physical and Antiquarian Society	1834	60 (E)
*b*Hawick Archæological Society	1856	158
Selkirk		
Galashiels Society (recently formed)		
IRELAND		
Antrim		
*b*Belfast Nat. Hist. and Philosophical Society	1821	
ac ,, Naturalists' Field Club	1863	242
Cork		
Royal Institution (Cork)	1807	
Cork Literary and Scientific Society	1819	
Cuvierian and Archæological Society (Cork)	1835	
Londonderry		
*ab*Derry Nat. Hist. and Philosophical Society	1870	80

LOCAL SCIENTIFIC SOCIETIES

I.

WE have devoted part of our space this week to a kind of Census of our Local Scientific Societies. It will be seen that in these Islands we already muster a goodly number, but no friend of Science would consider the number satisfactory; it does not, we are sure—seeing that there are twenty counties in England and Wales, and a much larger proportion in Scotland and Ireland, which appear not to boast of any such society—represent the true activity of the different regions from which, so to speak, the societies are fed. We do not suppose that our list is accurate; indeed our present purpose in printing it is to gather information. We hope that many societies exist which are not in our list; we fear that some have already ceased to exist since the time that Sir Walter Elliot, with infinite pains, compiled some of the data on which we have had to rely in the absence of information forwarded by the officers of the societies themselves.

On the whole, however, all lovers of Science and advocates for the spread of scientific education among all classes, ought to feel greatly gratified at the rapid increase during recent years, of local scientific societies and field-clubs indicated by the dates of foundation to be found in our list. No more unmistakeable sign of a general elevation of taste, of the spread of the scientific influence and of a desire for scientific knowledge, can, we think, be obtained, than this starting-up, in all parts of the country, of societies for the express purpose of scientific work in one form or another, and that generally as a means of recreation. By far the greater number of the societies have had their birth within recent years. With one or two exceptions, the older societies are not very prominenly scientific, while as a rule the recently founded ones bear on their very front the declaration that they have been established solely for the pursuit of Science.

This is indeed very encouraging, more especially when we reflect that this result is no outcome of any temporary burst of enthusiasm, of any exciting scientific "revival" agitation, but is simply the natural fruit of the slow but sure development of the scientific spirit in our country.

From the information which has been kindly sent us by the secretaries of the various societies many interesting facts might be presented, and many curious and valuable inferences drawn. It will be seen from the list, that the societies are very unequally distributed over the country, quite a busy hive of them being clustered around the border counties of England and Scotland, while not a few counties in both countries, as well as in Ireland, are quite unrepresented, and many large counties by but a single society. Why should this be? Is it to be attributed to the backward state of intelligence and education in the unrepresented districts? We do not think so; we believe that in every county in the three kingdoms, men and women will be found with an intelligent love of Science, a desire for scientific knowledge, and a wish for the spread of scientific education. Such people only require to be roused to perceive the advantages of the establishment of scientific societies and field-clubs in their midst; if only some one would take the initiative and start such societies where they do not at present exist, we have no fear, if judicious means be used, that ample success will follow. From the large number of members belonging to many of the societies members belonging to all classes of society, it will be seen that it is now considered honourable to be connected with such an association; and although in most societies there is only a small nucleus of working members, still while efforts should be made to engage all in the work, the non-working majority should be considered as, at least by their subscriptions and good-will, they help on the good cause.

Into these and other details we hope to enter in one or more future articles, founded partly on the statistics we possess. At the present time, when a Committee of the British Association is considering the whole question of our local Societies, we think it useful to point out the extreme importance of an increased activity in this direction. The recent action of the Government in aiding the establishment of Science Schools has enormously increased the advantages which such local associations may confer on outsiders, while at the same time it has greatly widened the recruiting ground. And it is in this double capacity that the formation, encouragement, and extension of such societies should be the care of all, whether scientific in their tastes or not; while, to friends of Science it is crucial, for Government aid, under existing arrangements, can only come where there are Science Classes; and without Government aid, in nine cases out of ten, the thing will fall to the ground altogether, or drag on an existence of second-rate utility.

If there then be any Scientific Societies without Science Classes attached to them, let them be assured that their museums are comparatively valueless; and further, that their museum must always remain as it is, for though it is clear to many that the Government must soon supply typical collections to museums which are available for teaching purposes, it is equally clear that there is no reason why they should do so to museums the utility of which is limited merely to members of a society.

Again: If there be any Scientific Societies without Science Classes attached to them let them be assured that their courses of lectures will prove of the least possible value; for mere lectures to those anxious to learn, but who are debarred from more serious study, are more than disappointing, they are hurtful.

In the ordinary course of things the Lecture should be the precursor of the Science Class. The Science Class should drive the student to the Museum, and from the zealous students the society should be recruited.

There is one point in which all will acknowledge our local societies have of late made considerable progress, and here again the British Association has been helpful to them—we refer to the more general establishment of courses of lectures, and the more general engagement of competent men of science, to place things new and strange before their members. Let not such lecturers forget that their duty is almost a sacred one; though he may not be a Davy, there may yet be a Faraday among the audience, one who may be gained or lost to Science according as the lecturer does his allotted work well or ill.

This brings us to another point. Why should not physical and chemical apparatus available for high-class experimental lectures be occasionally seen in our museums or in rooms adjoining them? Why should the stuffed crocodile and curious weapon of some southern race of savages have it all their own way to the extent that they do? Here, no doubt, our Government has been greatly at fault, for after all, humble local museums, *parvis componere magna*, are little British Museums, and there is no help provided by the government for any physical, or chemical, or astronomical students in the British Museum. But though our government is behind the age in London, the South Kensington authorities are alive to the weak point in the armour, as regards the provinces, and if a local society will only establish a Science Class, travelling collections of the most important modern scientific instruments are to be had for the asking; and we may hope that ere long there may be a model museum at South Kensington, doing for physical science what is done for it in Paris by the magnificent *Conservatoire des Arts et Métiers*, a museum in which the applications of Science, and the implements for the teaching of Science hold the first place.

FARADAY ON SCIENTIFIC LECTURING

AT a time when the lecture season is commencing, we believe we shall be doing good service by placing before those of our readers who are not already acquainted with them in Dr. Bence Jones' "Life of Faraday," the opinions of that great man on many points connected with lectures on Science.

They were written to a friend when Faraday was but 21 years of age, but we believe he would have changed little though he might have added much if he had revised them in his later years. He commences by explaining that:—

"The subject upon which I shall dwell more particularly at present has been in my head for some considerable time, and it now bursts forth in all its confusion. The opportunities that I have latterly had of attending and obtaining instructions from various lecturers in their performance of the duty attached to that office, has enabled me to observe the various habits, peculiarities, excellencies, and defects of each of them as they were evident to me during the delivery. I did not wholly let this part of the things occurrent escape my notice, but when I found myself pleased, endeavoured to ascertain the particular circumstance that had affected me; also, whilst attending Mr. Brand and Mr. Powell in their lectures, I observed how the audience were affected, and by what their pleasure and their censure were drawn forth.

"On going to a lecture I generally get there before it begins; indeed, I consider it as an impropriety of no small magnitude to disturb the attention of an audience by entering amongst them in the midst of a lecture, and, indeed, bordering on an insult to the lecturer. By arriving there before the commencement, I have avoided this error, and have had time to observe the lecture-room."

He dwells on the form of the lecture-room, and then indicates how important a matter ventilation is.

"There is another circumstance to be considered with respect to a lecture-room of as much importance almost as light itself, and that is ventilation. How often have I felt oppression in the highest degree when surrounded by a number of other persons, and confined in one portion of air! How have I wished the lecture finished, the lights extinguished, and myself away merely to obtain a fresh supply of that element! The want of it caused the want of attention, of pleasure, and even of comfort, and not to be regained without its previous admission. Attention to this is more particularly necessary in a lecture-room intended for night delivery, as the lights burning add considerably to the oppression produced on the body."

He then goes on:—

"Having thus thrown off, in a cursory manner, such thoughts as spontaneously entered my mind on this part of the subject, it appears proper next to consider the subject fit for the purposes of a lecture. Science is undeniably the most eminent in its fitness for this purpose. There is no part of it that may not be treated of, illustrated, and explained with profit and pleasure to the hearers in this manner. The facility, too, with which it allows of manual and experimental illustration, places it foremost in this class of subjects. After it come (as I conceive) arts and manufactures, the polite arts, belles lettres, and a list which may be extended until it includes almost every thought and idea in the mind of man, politics excepted. I was going to add religion to the exception, but remembered that it is explained and laid forth in the most popular and eminent manner in this way. The fitness of subjects, however, is connected in an inseparable manner with the kind of audience that is to be present, since excellent lectures in themselves would appear absurd if delivered before an audience that did not understand them. Anatomy would not do for the generality of audiences at the R. I. (Royal Institution), neither would metaphysics engage the attention of a company of schoolboys. Let the subject fit the audience, or otherwise success may be despaired of."

Now for the lecturer:—

"A lecturer may consider his audience as being polite or vulgar (terms I wish you to understand according to Shuffleton's new dictionary), learned or unlearned (with respect to the subject), listeners or gazers. Polite company expect to be entertained not only by the subject of the lecture, but by the manner of the lecturer; they look for respect, for language consonant to their dignity, and ideas on a level with their own. The vulgar—that is to say in general, those who will take the trouble of thinking, and the bees of business—wish for something that they can comprehend. This may be deep and elaborate for the learned, but for those who are as yet tyros and unacquainted with the subject must be simple and plain. Lastly, listeners expect reason and sense, whilst gazers only require a succession of words.

"These considerations should all of them engage the attention of the lecturer whilst preparing for his occupation, each particular having an influence on his arrangements proportionate to the nature of the company he expects. He should consider them connectedly, so as to keep engaged completely during the whole of the lecture the attention of his audience.

"I need not point out to the active mind of my friend the astonishing disproportion, or rather difference, in the perceptive powers of the eye and the ear, and the facility and clearness with which the first of these organs conveys ideas to the mind—ideas which, being thus gained, are held far more retentively and firmly in the memory than when introduced by the ear. 'Tis true the ear here labours under a disadvantage, which is that the lecturer may not always be qualified to state a fact with the utmost precision and clearness that language allows him and that the ear cannot understand, and thus the complete action of the organ, or rather of its assigned portion of the sensorium, is not called forth; but this evidently points out to us the necessity of aiding it by using the eye also as a medium for the attainment of knowledge, and strikingly shows the necessity of apparatus.

"Apparatus, therefore, is an essential part of every lecture in which it can be introduced; but to apparatus should be added, at every convenient opportunity, illustrations that may not perhaps deserve the name of apparatus and of experiments, and yet may be introduced with considerable force and effect in proper places. Diagrams, and tables too, are necessary, or at least add in an eminent degree to the illustration and perfection of a lecture. When an experimental lecture is to be delivered, and apparatus is to be exhibited, some kind of order should be observed in the arrangement of them on the lecture table. Every particular part illustrative of the lecture should be in view, no one thing should hide another from the audience, nor should anything stand in the way of or obstruct the lecturer. They should be so placed, too, as to produce a kind of uniformity in appearance. No one part should appear naked and another crowded, unless some particular reason exists and makes it necessary to be so. At the same time, the whole should be so arranged as to keep one operation from interfering with another. If the lecture-table appears crowded, if the lecturer (hid by his apparatus) is invisible, if things appear crooked, or aside, or unequal, or if some are out of sight, and this without any particular reason, the lecturer is considered (and with reason too) as an awkward contriver and a bungler.

"The most prominent requisite to a lecturer, though perhaps not really the most important, is a good delivery; for though to all true philosophers science and nature will have charms innumerable in every dress, yet I am sorry to say that the generality of mankind cannot accompany us one short hour unless the path is strewed with flowers. In order, therefore, to gain the attention of an audience (and what can be more disagreeable to a lecturer than the want of it?), it is necessary to pay some attention to the manner of expression. The utterance should not be rapid and hurried, and consequently unintelligible, but slow and deliberate, conveying ideas with ease from the lecturer, and infusing them with clearness and readiness into the minds of the audience. A lecturer should endeavour by all means to obtain a facility of utterance, and the power of clothing his thoughts and ideas in language smooth and harmonious, and at the same time simple and easy. His periods should be round, not too long or unequal; they should be complete and expressive, conveying clearly the whole of the ideas intended to be conveyed. If they are long, or obscure, or incomplete, they give rise to a degree of labour in the minds of the hearers which quickly causes lassitude, indifference, and even disgust.

"With respect to the action of the lecturer, it is requisite that he should have some, though it does not here bear the importance that it does in other branches of oratory; for though I know of no species of delivery (divinity excepted) that requires less motion, yet I would by no means have a lecturer glued to the table or screwed on the floor. He must by all means appear as a body distinct and separate from the things around him, and must have some motion apart from that which they possess.

"A lecturer should appear easy and collected, undaunted and unconcerned, his thoughts about him, and his mind clear and free for the contemplation and description of his subject. His action should not be hasty and violent, but slow, easy, and natural, consisting principally in changes of the posture of the body, in order to avoid the air of stiffness or sameness that would otherwise be unavoidable. *His whole behaviour should evince respect for his audience, and he should in no case forget that he is in their presence.* No accident that does not interfere with their convenience should disturb his serenity, or cause variation in his behaviour; he should never, if possible, turn his back on them, but should give them full reason to believe that all his powers have been exerted for their pleasure and instruction.

"Some lecturers choose to express their thoughts extemporaneously immediately as they occur to the mind, whilst others previously arrange them, and draw them forth on paper. Those who are of the first description are certainly more unengaged, and more at liberty to attend to other points of delivery than their pages; but as every person on whom the duty falls is not equally competent for the prompt clothing and utterance of his matter, it becomes necessary that the second method should be resorted to. This mode, too, has its advantages, inasmuch as more time is allowed for the arrangement of the subject, and more attention can be paid to the neatness of expression.

"But although I allow a lecturer to write out his matter, I do not approve of his reading it; at least, not as he would a quotation or extract. He should deliver it in a ready and free manner, referring to his book merely as he would to copious notes, and not confining his tongue to the exact path there delineated, but digress as circumstances may demand or localities allow.

"A lecturer should exert his utmost effort to gain completely the mind and attention of his audience, and irresistibly to make them join in his ideas to the end of the subject. He should endeavour to raise their interest at the commencement of the lecture, and by a series of imperceptible gradations, unnoticed by the company, keep it alive as long as the subject demands it. No breaks or digressions foreign to the purpose should have a place in the circumstances of the evening; no opportunity should be allowed to the audience in which their minds could wander from the subject, or return to inattention and carelessness. A flame should be lighted at the commencement, and kept alive with unremitting splendour to the end. For this reason I very much disapprove of breaks in a lecture, and where they can by any means be avoided, they should on no account find place. If it is unavoidably necessary, to complete the arrangement of some experiment, or for other reasons, leave some experiments in a state of progression, or state some peculiar circumstance, to employ as much as possible the minds of the audience during the unoccupied space—but, if possible, avoid it.

"Digressions and wanderings produce more or less the bad effects of a complete break or delay in a lecture, and should therefore never be allowed except in very peculiar circumstances; they take the audience from the main subject, and you then have the labour of bringing them back again (if possible).

"For the same reason (namely that the audience should not grow tired), I disapprove of long lectures; one hour is long enough for anyone, nor should they be allowed to exceed that time.

"A lecturer falls deeply beneath the dignity of his character when he descends so low as to *angle for claps*, and *asks for commendation*. Yet have I seen a lecturer even at this point. I have heard him causelessly condemn his own powers. I have heard him dwell for a length of time on the extreme care and niceness that the experiment he will make requires. I have heard him hope for indulgence when no indulgence was wanted, and I have even heard him declare that the experiment now made cannot fail from its beauty, its correctness, and its application, to gain the approbation of all. Yet surely such an error in the character of a lecturer cannot require pointing out, even to those who resort to it; its impropriety must be evident, and I should perhaps have done well to pass it.

"Before, however, I quite leave this part of my subject, I would wish to notice a point in some manner connected with it. In lectures, and more particularly experimental ones, it will at times happen that accidents or other incommoding circumstances take place. On these occasions an apology is sometimes necessary but not always. I would wish apologies to be made as seldom as possible, and generally, only when the inconvenience extends to the company. I have several times seen the attention of by far the greater part of the audience called to an error by the apology that followed it.

"An experimental lecturer should attend very carefully to the choice he may make of experiments for the illustration of his subject. They should be important, as they respect the science they are applied to, yet clear, and such as may easily and generally be understood. They should rather approach to simplicity, and explain the established principles of the subject, than be elaborate and apply to minute phenomena only. I speak here (be it understood) of those lectures which are delivered before a mixed audience, and the nature of which will not admit of their being applied to the explanation of any but the principal parts of a science. If to a particular audience you dwell on a particular subject, still adhere to the same principle, though perhaps not exactly to the same rule. Let your experiments apply to the subject you elucidate, do not introduce those which are not to the point.

"Though this last part of my letter may appear superfluous, seeing that the principle is so evident to every capacity, yet I assure you, dear A., I have seen it broken through in the most violent manner—a mere alehouse trick has more than once been introduced in a lecture, delivered not far from Pall Mall, as an elucidation of the laws of motion.

"Neither should too much stress be laid upon what I would call small experiments, or rather illustrations. It pleases me well to observe a neat idea enter the head of a lecturer, the which he will immediately and aptly illustrate or explain by a few motions of his hand—a card, a lamp, a glass of water, or any other thing that may be by him; but when he calls your attention in a particular way to a decisive experiment that has entered his mind, clear and important in its application to the subject, and then lets fall a card, I turn with disgust from the lecturer and his experiments. 'Tis well, too, when the lecturer has the ready wit and the presence of mind to turn any casual circumstance to an illustration of his subject. Any particular circumstance that has become table-talk for the town, any local advantages or disadvantages, any trivial circumstance that may arise in company, give great force to illustrations aptly drawn from them, and please the audience highly, as they conceive they perfectly understand them.

"Apt experiments (to which I have before referred) ought to be explained by satisfactory theory, or otherwise we merely patch an old coat with new cloth, and the whole (hole) becomes worse. If a satisfactory theory can be given, it ought to be given. If we doubt a received opinion, let us not leave the doubt unnoticed, and affirm our own ideas, but state it clearly, and lay down also our objections. If the scientific world is divided in opinion, state both sides of the question, and let each one judge for himself, by noticing the most striking and forcible circumstances on each side. Then, and then only, shall we do justice to the subject, please the audience, and satisfy our honour, the honour of a philosopher."

We trust that during the ensuing session, these opinions of Faraday may be in the minds of every lecturer on Science.

ECKER'S "CONVOLUTIONS OF THEB RAIN"

On the Convolutions of the Human Brain. By Dr. Alexander Ecker, Professor of Anatomy and Comparative Anatomy in the University of Freiburg, Baden. Translated, by permission of the author, by John C. Galton, M.A., Oxon., M.R.C.S., F.L.S., &c., &c. Translator of Prof. Roser's "Manual of Surgical Anatomy," &c. (London: Smith, Elder, & Co., 1873.)

OF late years the topographical anatomy of the surface of the brain has deservedly attracted considerable attention; and the recent able investigations of Hughlings Jackson and Ferrier have shown the importance, in fact the absolute necessity of a correct and generally recognised description and enumeration of the cerebral convolutions. Mr. Galton therefore deserves the thanks of all interested in the subject, for having introduced to us in English dress this valuable monograph by Prof. Ecker of Freiburg.

There are two methods by which the complex human brain may be analysed and reduced to its simpler elements, two paths that lead to the same goal; the one is by a careful examination and comparison of the brains of the lower animals, and especially of apes, which latter in their higher groups present a "sketch map" as it were, which is filled in and completed in man only. This has been carried out with great success by Gratiolet primarily, and in England it has been followed amongst others by Huxley, Marshall, Flower and Rolleston. The other method is by tracing the development of the fœtal brain, and observing which fissures, and therefore which convolutions, are the first to make their appearance, and so are of primary importance, and how these subsequently undergo farther evolution and complication. Tiedemann and Reichert have hitherto been our authorities on this point, and it is by this method chiefly that Prof. Ecker arrives at his conclusions.

In this country the admirable little treatise of Prof. Turner has been welcomed and the classification therein adopted is now generally accepted, and taught in several of our anatomical schools. Prof. Ecker in the main follows Prof. Turner, although the nomenclature, of course, is that of the German school, and so differs occasionally from ours, which follows rather Gratiolet and the French school. The synonyms are, however, in all cases faithfully given.

The author insists upon the essential difference between the Sylvian fissure and the other sulci, these being mere indentations of the cortex, whilst that is formed by the folding of the temporo-sphenoidal lobe on the fore part of the brain during its development. The anterior or ascending branch of this fissure is here correctly described as being short and arrested by the hinder end of the lower frontal convolution, whilst that described as such by Prof. Turner is a distinct sulcus (præcentral) terminating close behind the ascending ramus. The gyrus connecting the inferior and ascending frontal (anterior central) convolutions is always present, although it is not always superficial, being occasionally concealed by the over-lapping of those convolutions. Instead of the orbital lobule usually described on the under surface of the frontal lobe, the three frontal convolutions are traced round the apex to the orbital surface. The narrow ridge internal to the olfactory sulcus (gyrus rectus) is regarded as the continuation of the first, the gyrus between that and the orbital sulcus as the second, and outside the last as the third. We should rather consider all internal to the orbital sulcus as first frontal, which is grooved by a special olfactory sulcus, and the second as ending posteriorly between the anterior branches of the triradiate orbital sulcus. The marginal convolution is regarded as simply the inner surface of the superior frontal.

In the parietal lobe the supra-marginal and angular convolutions are amongst the most difficult in the brain to indicate and circumscribe. Prof. Ecker describes the supra-marginal convolution as arching over the end of the fissure of Sylvius and joining the upper temporo-sphenoidal convolution, and the angular as folding over the hinder end of the parallel fissure and joining the middle temporo-sphenoidal convolution. This description, and it is supported by our experience, is not quite in accordance with that of some other anatomists; for instance, in Mr. Marshall's well-known essay on the brain of the bushwoman, the supra-marginal convolution is correctly defined thus, whilst the angular would require the anterior enlarged portion of the third annectent gyrus, as marked in the figure, to complete its bend and unite it to the second temporal gyrus. Similarly, in the idiot boy's brain, the angular gyrus would be a large folded convolution, there indicated as the bifurcated anterior extremity of the second annectent convolution; and in the idiot woman the parallel fissure extends so far back that it quite cuts off the angular gyrus from the temporo-sphenoidal, and the convolution is represented by the straight, also bifurcated fore part of the second annectent gyrus in the figure. The intra-parietal fissure of Turner is here called less correctly inter-parietal.

In the occipital lobe, a tolerably constant transverse depression, into which the intra-parietal fissure often debouches is appropriately named "occipital sulcus." Prof. Ecker regards the bridging, or annectent convolutions, as unworthily distinguished by special names in the human brain, since they do not bridge over any fissure as in the lower apes. He carefully points out their homology with those gyri in the ape, yet deprecates the transference of the names from the Simian to the human brain. But this comparison and correspondence of nomenclature is precisely what we require for the satisfactory determination of the cerebral functions, and the homological significance of a part is quite sufficient to justify the application of the same name to it. So also, on the inner surface, the lower annectent gyrus is described as the "gyrus cunei," and the occasional presence of the upper annectent gyrus is alluded to, of which we have now seen several examples. The operculum of the ape's brain is discussed, but the same term is unfortunately here applied to quite a different part of the human brain, viz. the united lower ends of the ascending frontal and parietal convolutions which overhang the island of Reil.

The middle convolution on the under surface of the occipito-temporal lobes is regarded, not without precedent, as the direct continuation of the gyrus fornicatus, and the uncinate gyrus of Huxley thus comes to be divided into three parts, the "lingual lobule" behind the union of the two gyri, the "convolution of the Hippocampus" immediately below the dentate fissure, and the recurved hook or "uncinate lobule"; but the connection between the gyrus fornicatus and this convolution is small and narrow, whilst that between it and the lingual lobule is large and direct; further, the author points out, after Gratiolet, that in many apes the calcarine is prolonged into the dentate fissure and cuts off the arched from the uncinate gyrus; surely this shows the essential unity of the uncinate convolution, and that the junction with the gyrus fornicatus is a superadded and secondary element in the human and certain Simian brains.

The translator has generally performed his work well; there are, however, one or two slips; for instance, the dentate fissure is said to produce an eminence in the floor of the *posterior* corner of the lateral ventricle; the parieto-occipital fissure also is described correctly as being concave forwards, whilst in the diagram it is represented as convex: the figures are exceedingly clear. Prefixed is an exhaustive bibliography by the translator, which adds materially to the value of the work; and finally, we can cordially recommend it as an accurate and lucid guide to a somewhat difficult study.

G. D. T.

OUR BOOK SHELF

The Zoological Record for 1871. Edited by Prof. Newton. (J. Van Voorst, 1873.)

THE birth of true biological science is of so recent origin, and its development has been so rapid that until lately many of the necessary steps in the furtherance of its proper progress have remained beyond the cognizance of its most enthusiastic followers. The difficulties connected with, and the unmanageableness of the large number of facts accumulated day by day on all branches of zoology, and recorded by observers in all parts of the civilised world, have until lately been scarcely realised. Only by those who, from the disappointment which they have experienced on finding that observations which have cost them incalculable time and labour, have been previously undertaken and exhausted by others before them, either in their own or some other country, appreciate fully the necessity for an easily accessible, accurate, and not over ponderous account of the labours of previous workers.

It is only the full appreciation of the advantage to future science students which stimulates the authors of the several parts of the work before us to continue and commence their contributions to this, what may be truly termed, labour of love. The labour involved in obtaining a complete and condensed account of the gist of each zoological paper published here or elsewhere throughout a year, is so great, and the smallness of the class who are disposed to purchase the work when produced, so necessarily restricted, that at first sight it is evident that it is only with the assistance of donations from scientific bodies, or from contributions of one kind or another on the part of amateurs in the subject, that the necessary expenses can be covered and the staff maintained.

These considerations will recommend this valuable work to the consideration of all interested in zoological progress.

LETTERS TO THE EDITOR

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

On the Equilibrium of Temperature of a Gaseous Column subjected to Gravity

SINCE reading Principal Guthrie's first letter on this subject (vol. viii. p. 67), I have thought of several ways of investigating the equilibrium of temperature in a gas acted on by gravity. One of these is to investigate the condition of the column as to density when the temperature is constant, and to show that when this is fulfilled the column also fulfils the condition that there shall be no upward or downward transmission of energy; or, in fact, of any other function of the masses and velocities of the molecules. But a far more direct and general method was suggested to me by the investigation of Dr. Ludwig Boltzmann* on the final distribution of energy in a finite system of elastic bodies. A sketch of this method as applied to the simpler case of a number of molecules so great that it may be treated as infinite, will be found on p. 535. Principal Guthrie's second letter (vol. viii. p. 486) is especially valuable as stating his case in the form of distinct propositions, every one of

* Studien über das gleichgewicht der lebendigen Kraft zwischen bewegten materiellen Punkten. Von Dr. Ludwig Boltzmann. Sitzb. d. Akad. d. Wissensch, October 8, 1868 (Vienna).

which, except the fifth, is incontrovertible. He has himself pointed out that it is here that we differ, and that this difference may ultimately be traced to a difference in our doctrine as to the distribution of velocity among the molecules in any given portion of the gas. He assumes, as Clausius, at least in his earlier investigations, did, that the velocities of all the molecules are equal, whereas I hold, as I first stated in the *Phil. Mag.* for Jan. 1860, that they are distributed according to the same law as errors of observation are distributed according to the received theory of such errors.

It is easy to show that if the velocities are all equal at any instant they will become unequal as soon as encounters of any kind, whether collisions or "perihelion passages" take place. The demonstration of the actual law of distribution was given by me in an improved form in my paper on the Dynamical Theory of Gases, "Phil. Trans." 1866, and *Phil. Mag.* 1867, and the far more elaborate investigation of Boltzmann has led him to the same result. I am greatly indebted to Boltzmann for the method used in the latter part of the sketch of the general investigation (see p. 535) which was communicated in a condensed form to the British Association on Sept. 20, 1873.

J. CLERK-MAXWELL

Mallet-Palmieri's Vesuvius

As I am assured that it would be most undesirable as well as unbecoming of me to continue a scientific controversy in the tone of Mr. Mallet's letter which appeared in NATURE of October 9, I would only beg those who have perused it to remember that my remarks were altogether directed to the assertions contained in Mr. Mallet's introductory sketch, and not comments upon his theory of volcanic energy of which, as he himself admits, we as yet know little or nothing. I would then ask them to compare its contents with the substance of my letter in NATURE, Sept. 4, and judge for themselves whether so far from its being any answer to my arguments, it does not, on the contrary, furnish additional "evidence of his confounding chemical constitution with percentage composition, &c.," the very keynote of this discussion.

Mr. Mallet writes—"Mr. Forbes appears to think that chemists, mineralogists, and geologists are the sole arbiters" of such questions; a remark he could not have made had he read some of my publications; yet I am quite willing to admit that I do place more faith in them collectively, than in any one physicist or mere mechanician whether theoretical or practical; and I believe I am correct in asserting that no theory of volcanoes will be accepted by the scientific world until its doctrines are proved to be fully in accordance with the facts brought forward by these sciences.

When the reasons for my delay in answering Mr. Mallet's criticisms were fully stated, is it not, to say the least, most unjust of him to harp on this string, after having already taken more than a month to produce a rejoinder the reverse of an answer, and the style of which, peculiar to himself, is in complete harmony with that of his introductory sketch, of which one of his favourable reviewers writes—"We do not cordially approve of his method of dealing with other writers. There is, if we may be excused the expression, a tone of bitterness all through his writing which gives the reader a most uncomfortable sensation, and leads a person altogether unbiassed to imagine a feeling of jealousy on the part of so distinguished a writer as Mr. Mallet which we are sure cannot exist in reality. After giving a sketch of the various authors who have ventured to give different and erroneous opinions on the subject of vulcanicity," &c. Another reviewer remarks that—"While objecting to most of the views of geologists, which, however, he frequently distorts, Mr. Mallet claims the character of physical truth for his own ideas," and adds, "what we chiefly object to in this portion of the volume is the assumption on Mr. Mallet's part of a conscious superiority to others, and a freely expressed contempt for all previous observers, especially for geologists." Need I add more?

DAVID FORBES

11, York Place, W. Oct. 20

Oxford Science Fellowships

As Mr. Perry's letter, in the last number of NATURE, contains assertions calculated to impede the progress of science here by deterring persons, not graduates of Oxford, from competing for appointments in colleges, and also involves charges of, to say the least, discourtesy to himself, I trust you will find space in your next number for the following explanation.

First, as to Mr. Perry's general assertion respecting fellowships. From the fact that a graduate of Belfast is ineligible for a Fellowship in *Merton College*, Mr. Perry infers that "outsiders are ineligible for *Oxford* Fellowships in Physical Science." This is clearly illogical, and it is also untrue.

Secondly, as to the special case of Mr. Perry.

The ordinances of Merton College state that "no person shall be eligible" for a fellowship "who shall not have passed all the examinations required by the University for the degree of Bachelor of Arts." It appears a possible interpretation that Cambridge and Dublin B.A.'s, who can at any time incorporate in this University, may be candidates. If this be so, the reply of the Warden of Merton, as Mr. Perry gives it (of the actual correspondence I know nothing), may be correct, though perhaps not sufficiently explicit. This, however, is a legal question, and the college is taking steps to obtain the opinion of an eminent counsel.

Mr. Perry was not left, as his letter would naturally lead readers to infer, without warning as to this difficulty; for in July I wrote to Mr. Perry strongly expressing my doubt as to his eligibility, but as I was away from Oxford I could not quote the words of the ordinance; I advised him to consult the sub-warden, but I believe he did not follow my advice.

Mr. Perry received my letter, and replied to it on July 27.

The great difficulties which Mr. Perry asserts to have been thrown in his way, simply arose from the fact that he only proposed to come to Oxford during the vacation. Now it is not to be expected that I should allow any person who chooses to apply to overhaul the physical apparatus of the University in my absence, and it is unreasonable to suppose that, to suit the convenience of such a person, I must give up engagements made long before, in order to assist him in a candidature for an office of emolument in a college.

It must be borne in mind that there are nineteen colleges, any one of which may at any time offer a fellowship for proficiency in physics, and consequently to have to be at the service of outsiders, who may wish to be candidates, during the long vacation (the only time I have for real study) might become a serious matter, and to ask for such assistance seems to me to make a most unreasonable request.

I must add that if Mr. Perry imagines he would have been at any appreciable disadvantage by not knowing the particular instruments in the University cabinet (which it is by no means certain would be used for a college examination), either he assumes that the examiners would be guilty of the absurdity and unfairness of puzzling candidates by new or peculiar apparatus, or he feels very uncertain about his own practical knowledge.

A Cambridge B.A. is a candidate for the Merton Fellowship, and I have every reason to think that he found the Oxford candidates on exactly equal terms with himself in the practical examination.

H. B. CLIFTON

Oxford, Oct. 18

P.S.—Since writing the above I have been informed that a Cambridge graduate has been elected to a Science Fellowship in Magdalen College, Oxford. This is a proof of the inaccuracy of Mr. Perry's statement as to the ineligibility of outsiders for Oxford Fellowships.

Harmonic Echoes

I BELIEVE the echo observed by W. J. M. is of a different nature from mine and more analogous to one described by Oppel (Pogg. Ann. xciv. 357, 530). Each bar of the railing, when struck by the aërial pulse, diverts a small portion, which is scattered in all directions, much as if the bar were itself the source of sound. These derived pulses reach the ear of the observer at approximately equal intervals, and accordingly blend into a musical note, whose pitch, however, may not be quite constant. Oppel discusses the effect of different positions of the original source and the observer with respect to the grating, on which alone the pitch and its variations depend. It is evident that an echo formed in this way is in no sense *selective*.

I have been asked several times how the Bedgebury echo would be affected by the *character* of the original sound. Of course, if my theory is correct, the octave could not be returned, unless it were originally present; but the intensity of the echo was too feeble to give any promise of a successful observation with such an instrument as the clarinet. The experiment would be most interesting if a more powerful echo of the same class can be found.

RAYLEIGH

Terling Place, Witham, Oct.

Deep-sea Soundings and Deep-sea Thermometers

We feel sure you will not deny us space in your valuable periodical, when we tell you that, however unconsciously on your part, you, as well as other scientific authorities, are the means of doing us injustice and much professional injury, by the frequent allusions to the so-called Casella-Miller Thermometer, now used in deep-sea investigations. We are certain that we have only to call your attention to the real facts of the case for you to set the matter right before your readers.

1. We beg to state that in the year 1857 we invented, made, and supplied the Meteorological Department of the Board of Trade with upwards of fifty instruments of this description.

2. This thermometer we called the Double Bulb Deep Sea Thermometer, and a notice of it was published in the first number of the Meteorological Papers for the year 1857.

3. This thermometer, identical in every respect (except in its size), has been, after a lapse of some twelve years, *re-invented* and ushered before the scientific world with all the prestige of having a paper read upon it by the Vice-President of the Royal Society, Dr. Miller, who declared that he had just invented the instrument, in which task (of inventing an instrument well-known to all leading instrument makers, and Mr. Casella among the number) the learned doctor says he was assisted by Mr. Casella. (See Proceedings of the Royal Society, No. 113, page 482).

4. Annexed is an extract from Dr. Miller's paper describing the instrument, and by its side we give an extract from a treatise published by us in the year 1864, called "A Treatise on Meteorological Instruments."

Extract from "The Proceedings of the Royal Society," vol. xvii. page 483. Paper read June 3, 1869, by Dr. Miller.	Extract from "Negretti and Zambra's Treatise on Meteorological Instruments," published 1864, page 90:—
"The expedient adopted for protecting the thermometer from the effects of pressure consisted simply in enclosing the bulb of such a Six's thermometer in a second or outer glass tube, which was fused upon the stem of the instrument. "This outer glass tube was nearly filled with alcohol, leaving a little space to allow of variation in bulk due to expansion. "The spirit was heated to displace part of the air by means of its vapour, and the outer tube and its contents were sealed hermetically."	"The usual Six's thermometers have a central reservoir or cylinder containing alcohol. This reservoir, which is the only portion of the instrument likely to be affected by pressure, has been in Negretti and Zambra's new instrument superseded by a strong outer cylinder of glass containing mercury and rarefied air; by this means the portion of the instrument susceptible of compression has been so strengthened that no amount of pressure can possibly make the instrument vary."

5. We leave your readers to draw their own conclusions as to the similarity of the two instruments. Dr. Miller, when we called his attention to the fact of our prior claim, stated that he was not aware of the existence of our instrument, and we freely acquit Dr. Miller of conscious plagiarism, but we cannot omit to state, at the same time, that at the date at which Dr. Miller's paper was read, any scientific instrument maker worthy of the name was fully acquainted with our arrangement.

6. In order to prove what we thought of our instruments and as to their fitness for the purpose they were intended, when we were written to by the Meteorological Committee, three or four years ago, to produce a thermometer to be submitted to them for approval, we replied that we had already produced the only thermometer which in our opinion would answer the purpose, and that the thermometer was well known to them; we also said we were ready to make that instrument smaller, or larger, but that we could not possibly produce a better one.

Holborn Viaduct, E.C. HY. NEGRETTI & ZAMBRA
October 14

Settle Caves Report

IN your abstract of the "Report of the Committee for exploring the Victoria Cave at Settle, by W. Boyd Dwakins, F.R.S." vol. viii. p. 476, are the following sentences. "The exact age of theCave-earth is a matter of dispute. Mr. Tiddeman from the *physical evidence alone* regards it as preglacial, or rather as older than the great ice-sheet of that district."

Now it is true that in the spring of 1871, at a meeting of the Settle Caves Committee, I suggested the probability of the beds of lower Cave-earth in the Victoria Cave being of preglacial age from the physical evidence in the cave alone; but at a committee meeting at Settle soon after I laid much stress upon the impossibility of any animals, existing before the time of the Ice-sheet, having their remains preserved in the open country, although it was very likely that they might be found sealed up in sheltered caves. Acting on this idea the committee, notwithstanding some opposition, fortunately determined upon continuing their researches, and the result was the interesting discovery of the older mammals.

May I be permitted to cite the following paragraph from the *Geological Magazine* of Jan. 1873, to show that I do not rely upon the physical evidence in the cave alone as determining the age of the lower cave-earth, although I confess that evidence, to my mind, is almost conclusive. "Perhaps one of the strongest pieces of evidence that the older cave mammals mentioned lived in this district only at a time previous to the great ice-sheet is, that so far as we know the remains of none of them (except of *Cervus elaphus*, which ranges from the Forest-bed to the present day) have been found in any of the Post-glacial deposits in this district. Though so common in the river-gravels in the Midland and Southern counties, they are never found except in caves until we get much farther south or east. Leeds, I believe, is the nearest locality where they occur. This would seem to imply that their remains were wiped off the area by the great ice-sheet which occupied what is now the Irish Sea and its tributary river-systems, and only left in the shelter of caves to which it could have no direct access. Brown bear, horse, red deer, reindeer, megaceros, the more modern Bovidæ, and other more recent forms are not uncommon in the Post-glacial beds; but the older cave mammals seem conspicuous only by their absence."

Clapham, Lancaster, Oct. 6 R. H. TIDDEMAN

Carbon Battery Plates

MR. T. W. FLETCHER will obtain what he requires from the India Rubber, Gutta Percha, and Telegraph Works Co., No. 100, Cannon Street, E.C.

I have 12,000 Carbons, or as we call them Graphite Plates, at work at this moment, and for some years past have obtained them solely from the above Company.

Tunbridge, Oct. 14 CHARLES V. WALKER

ASTRONOMICAL ALMANACS *

III.—*Foundation of the Nautical Almanac*

DURING his voyage of 1761 to the island of Saint Helena, for the purpose of observing the transit of Venus, Maskelyne, like La Caille, investigated the methods for determining longitudes at sea, and on his return, in "The British Mariner's Guide" (1763), proposed to adopt the plan of an almanac sketched by the French astronomer. There existed at this time in England a commission instituted by George III. for the discovery of longitudes at sea; † it was a body almost analogous to the present French "Bureau des Longitudes." Maskelyne took many steps to induce this Commission to approve of his proposal; and, at the same time, he commissioned several ship-captains to put it to the test. Their reports confirmed his assertions, and on February 9, 1765, Maskelyne presented to the Commissioner of Longitude a detailed report,‡ in which, besides a complete exposition of the method and plan of a nautical almanac, he gave from the entries in the log-books the result of this new method. The proposition of the wise abbé was adopted, and Maskelyne was entrusted with the calculation and publication of the "Nautical Almanac

* Continued from p. 352.

† "The Commissioners appointed by Act of Parliament or the discovery of longitude at Sea, and for examining, trying, and judging of all Proposals, Experiments, and Imperiments (*sic*) relative to the same, and encouraging attempts to find a Northern Passage between the Atlantic and Pacific Oceans, and to approach the Northern Pole."

‡ It is found *in extenso* in the "New and Correct Tables of the Motions of the Sun and Moon," by Tobias Mayer: London, 1770. Published by order of the Commissioner of Longitude.

and Astronomical Ephemeris." The Commissioners did more; they ordered the printing of the Tables of the Moon, left by Tobias Mayer, according to which the lunar distances were to be calculated. At the same time parliament voted a sum of 3,000*l.* to the widow of the astronomer of Göttingen, and a sum of 300*l.* to Euler, for having furnished to Mayer the theorems which he used to construct his theory.*

The first volume of the "Nautical Almanac" is concerned with the year 1767, and appeared in 1766. Although infinitely superior to the "Connaissance des Temps" for 1767, this publication is far from the perfection which it has since attained. Its object is two-fold, but not well-defined; it contains much information useless to the astronomer, and many things besides which the mariner could dispense with. There is first a calendar with the aspects of the planets; then a solar table giving for each day the longitude of the sun at noon, calculated to $\frac{1}{100}$ of a second; the right ascension of the sun in time to $\frac{1}{10}$ of a second, his declination to a second, and the equation of the time; next follow the eclipses of the four first satellites of Jupiter; then tables of the planets, giving the longitude (to a second) and the latitude (to a minute), heliocentric and geocentric, the declination (to a second), the hour of the passage of the meridian (to a minute), every third day for Mercury, and every sixth day for the other planets. The table following gives, for every day from noon to midnight, the longitude (to the $\frac{1}{100}$ of a second) and the latitude (to a second) of the moon, her right ascension and declination from noon to midnight, as well as her apparent semi-diameter and horizontal parallax. Then follow the distances calculated for every three hours, of the moon from the sun and from a certain number of stars of the first magnitude, and lastly the configuration of the satellites of Jupiter for every day in the year, at 5.30 P.M. The work is completed by detailed and well-written instructions, telling the signification and use of the various tables contained in the volume.

The calculations are, moreover, made with an amount of care far greater, according to Lalande, than was ever bestowed on the "Ephémérides." Each article was calculated separately by two persons and verified by a third calculator. In the case of the longitudes, latitudes, right ascension, declination, semi-diameter, and parallax of the moon, these were calculated by one person for noon and another for midnight, and afterwards verified by the mean of the differences which were carried as far as the fourth order.

Some years later, in 1772, three English astronomers, Lyons, Parkinson, and Williams, published some exceedingly convenient tables, entitled, "Tables for correcting the apparent Distance of the Moon and a Star from the Effects of Refraction and Parallax" (Cambridge, 1772), by the aid of which ten minutes sufficed to calculate an observation of distance between the moon and a star, and therefrom to deduce the longitude. The use of the lunar distances became from that time a great convenience. It was in the same year, 1772, that Lalande transferred into the "Connaissance des Temps" for 1774 the calculations of the lunar distances copied in the "Nautical Almanac," "not having," said he, "either the leisure to do it myself, nor the means which the Commission of Longitude of London furnished to the Astronomer-Royal Maskelyne, for maintaining calculators, whose work he had only to superintend and verify." The introduction of these lunar distances doubled the value of the "Connaissance des Temps," which became a work useful at once to astronomers and mariners.

IV. *Foundation of the Berlin "Astronomisches Jahrbuch"*

This same year, 1774, witnessed the appearance of a great number of publications analogous to the *Connaissance des Temps* and the *Nautical Almanac*, all intended to regulate the publication of the Ephemerides, which in nearly all countries astronomers published at different times. Of these we shall mention the "Jahrbuch" of Berlin, the "Ephemerides" of Vienna, and those of Milan.

The idea of the "Berliner Astronomisches Jahrbuch" originated with Lambert. Born August 29, 1728, at Mulhouse, then a free town of Alsace, of parents who kept a small tailor's shop, Lambert received a very incomplete elementary education, which he afterwards supplemented by assiduous labour and persevering determination. In 1748 Count Pierre de Solis entrusted Lambert with the education of his children; this was an opportunity of which he knew how to take advantage. He found in the Chateau of Coire, the abode of this nobleman, an exceedingly rich library, by means of which he not only completed his imperfect education, but from which he drew the elements of one of his finest works, the "Dissertation on the remarkable Properties of Light." Shortly after, in 1763, the restraints to which Protestants were subjected in France, and in particular the law which prohibited them from exercising any public functions, induced him to yield to the invitations of Frederick the Great; Lambert went to live at Berlin, and became, in 1764, a *pensionnaire* of the Royal Academy of Prussia. France thus lost one of her scientific glories; for, not only was Lambert a distinguished astronomer, but pre-eminently remarkable for the universality and extent of his attainments.*

Long before the time to which we refer there had appeared at Berlin Astronomical Ephemerides; the first, due to the astronomer Grischow, date from 1749; it is the "Calendarium ad annum 1749 pro meridianum Berolinense cum approbatione Academicæ regiæ Scientiarum et elegantiarum litterarum Borussiæ." They were carried on by Grischow until 1754, and suffered afterwards many interruptions. It was these Ephemerides which Lambert undertook to revive. According to the plan which he proposed to the Academy of Berlin, each volume of the "Jahrbuch" would appear two years in advance and consist of two parts. One part was devoted to the astronomical ephemerides (Prussia not then having any marine, Lambert had not to trouble himself with nautical ephemerides) and so disposed that it could easily serve for a place of different latitude; the other forming a collection of all the news concerning the astronomical sciences (observations, remarks, and problems). Lambert also proposed to collect, in another work, all the tables serving either for the calculation of the ephemerides or for other astronomical calculations.

The proposal of Lambert having been adopted, an astronomer who was afterwards director of the Berlin observatory, and whose reputation became universal, J. El. Bode, was entrusted, under the direction of Lambert and the nominal superintendence of the Academy, with the numerous calculations which the publication of these Ephemerides necessitated. The first volume appeared in 1774, under the title of "Berliner astonomisches Jahrbuch für 1776, unter aufsicht und mit Genehmhaltung der königlichen Academie der Wischenschaften verfertigt und zum Drucke befördert."

Lambert had the direction of the "Jahrbuch" for only a very short time; death came soon after to deprive Science of one of her most ardent worshippers. Nevertheless his initiative, though of short duration, was successful, and from its first appearance, the work which he founded progressed more notably than those which preceded it.

At the same time also appeared the Ephemerides of Milan,—"Effemeridi artronomiche per l'anno 1775, calculate pol meridiano di Milano, del abbe Angelo de

* Fifty years later, another parliament authorised the printing of the new lunar tables of Hansen, his compatriot, and awarded to that illustrious astronomer a sum of 1,000*l.* by way of national recompense.

* His most important astronomical work is entitled "Insigniores Orbitæ Cometarum Proprietates."

Cesaris." It was also the first volume of a series of ephemerides which have been since continued without interruption.

In 1799 the publication of the Portuguese ephemerides commenced — "Ephemerides astronomicas calculadas para o meridiano Observatorio nacional de universidade de Coimbra, para uso do mesmo Observatorio, e para o da navegaçao Portugueza."

Lastly, in 1756, appeared the ephemerides of Vienna :— "Ephemerides astronomicæ anni 1757, ad meridianum Vindobonensem jussu Augustorum calculis a Maximiliano Hell. Cæsario regio astronomo et Mechanicus experimentalis professore publico et ordinis," which were continued by Triesmecker. The Ephemerides of Vienna were constructed upon the model of the Abbé de la Caille, much more than upon that of the *Connaissance des Temps*. Moreover, at this period, the Ephemerides of La Caille were almost exclusively employed by French astronomers.

(*To be continued.*)

THE BRIGHTON AQUARIUM

IN accordance with an intention entertained previous to resigning the tenure of my office as Curator to the Brighton Aquarium, I propose to give a brief outline of the plan of construction and general system of arrangements obtaining in that institution.

The Brighton Aquarium, while emulated by several buildings of a similar nature, in different parts of the kingdom and on the Continent, still holds its own in being on a scale of magnitude hitherto unsurpassed, more than one of its tanks, in illustration of this, being of sufficient size to accommodate the evolutions of porpoises and other small Cetaceæ. The architect and originator of the undertaking, Mr. Edward Birch, well known as the engineer of the new pier at Hastings, entertained the idea of constructing this Aquarium as long ago as the year 1866 when visiting the one on a small scale then existing at Boulogne; Brighton was selected as a site on account of its proximity to the sea-coast and its great popularity as a place of resort. The works were commenced in the autumn of the year 1869, but owing to various interruptions the building was not formally thrown open to the public until August 1872, the ceremony taking place during the week in which the members of the British Association honoured Brighton as their place of meeting.

The area occupied by the Brighton Aquarium averages 715 feet in length by 100 feet in width, running east and west along the shore line between the sea and the Marine Parade; the principal entrance is at the west end facing the eastern angle of the Royal Albion Hotel. The building internally is divided into two corridors separated from one another by a fernery and considerable interspace. The approach to the first or Western corridor is gained through a spacious entrance-hall supplied with reading-tables, and containing between the pillars which support the roof portable receptacles of sea-water for the display of small marine specimens that would be lost to sight in the larger tanks.

The tanks for ordinary exhibition commence with No. 1 on the left side of the western corridor, and, as shown in the ground-plan, follow in consecutive order round the two corridors, the last, No. 41, immediately facing No. 1. The smallest of these tanks measures 11 feet long by 10 feet broad, and is capable of holding some 4,000 gallons of water, while the largest, No. 6, in the western corridor, and the subject of the accompanying engraving, presents a total frontage, including the two angles of 130 feet, with a greatest width of 30 feet, and contains no less than 110,000 gallons. Every gradation of size occurs between these two extremes, the depth of the water in all ranging from 5 to 6 feet. Supplementary to the foregoing, a series of half-a-dozen shallow octagonal table-tanks occupies a portion of the interspace between the two corridors, these being especially adapted for the exhibition of animals such as starfish, anemones, and others seen to best advantage when viewed perpendicularly through the water. Flanking one side of this same interspace are several ponds fenced off for the reception of seals and other amphibious mammalia and larger Reptilia, while at its further or eastern extremity artistic rock-work runs to a height of 40 feet, thickly planted with choice ferns and suitable exotic plants, and broken in its course by a picturesque waterfall and stream. Tanks 12 to 17 in the eastern corridor, in addition to the stream and basin beneath the waterfall, are set apart for the exclusive exhibition of fresh-water fish, the remaining tanks being devoted to marine species. The bulk of water thus utilised in the fresh and sea-water tanks collectively amounts to 500,000 gallons, and in addition to this several smaller store tanks in the Naturalists' Room, adjoining the eastern corridor, afford accommodation for reserve stock, or for new arrivals before their display to public view.

The style of architecture dominant throughout the building is Italian and highly ornate, the arched roof of the corridors being groined and constructed of variegated bricks, supported on columns of Bath stone, polished serpentine marble, and Aberdeen granite; the capital of each column is elaborately carved in some appropriate marine device, while the floor in correspondence is laid out in acrostic tiles. The divisions constituting the fronts of the tanks are composed each of three sheets of plate glass, each plate having a thickness of one inch, and measuring six feet high by three feet wide, separated from one another and supported centrally by upright massive iron mullions; in the smallest tanks the front is represented by but one of these divisions, while that of the largest, No. 6, consists of as many as eleven. Among other conspicuous structural features of the aquarium demanding notice are the huge masses of rock entering into the composition of the tanks and fernery. Part of these are composed of porous tufa brought from Derbyshire, while the remaining and greater portion presents the appearance at first sight of old Red Sandstone of the Devonian epoch. This latter, however, is entirely artificial, being built up of smaller nondescript fragments, faced with cement and coloured sand, though so true to Nature have the boulders been fashioned and stratigraphically arranged, that more than one eminent geologist has been deceived by their aspect, and it is difficult in looking into the larger tanks to get rid of the impression that some of the miniature picturesque coves characteristic of the Devonshire coast have been transported bodily to Brighton.

The system adopted at the Brighton Aquarium for continually renewing the supply of oxygen necessary for the well-being of the animals agrees with that followed at Berlin, streams of compressed air being constantly forced into the tanks through vulcanite tubes carried to the bottom of the water, and each tank being fitted with a greater or less number of these tubes according to its size. Following the same principle there is no true circulation, each tank being distinctly independent and the same water remaining in it perpetually unless required to be changed on account of turbidity, an accident such as the cracking of a front glass, or for altering the arrangement of the inhabitants. In such cases the tanks are refilled from four large reservoirs situated beneath the corridors, holding in aggregate a quantity approximating but not exceeding that contained in the tanks above, and into which the water is first pumped by a six-horse power centrifugal engine direct from the sea, and thence conveyed by the same force to the tanks, through a main extending round the building.

The system above described, while practical in aquaria at the seaside, where the supply of water is unlimited, does not answer inland, as exemplified in the decadence, from a scientific point, of the one from which that at Brighton is copied, and even in the former case is associated with serious drawbacks and disadvantages, which forbid it from yielding in compensation for the outlay and labour expended the results realised by those constructed on later and more approved principles. It is impossible, for instance, to keep in health at the Brighton Aquarium the number of fish in comparison to the size of any given tank as will be found in the aquarium at the Crystal Palace or that of Hamburgh, or Copenhagen, or any other constructed on the same principle, though at the same time it is essential to remark, that lately the capabilities of the Brighton tanks have not been turned to their greatest advantage, as instanced in No. 6, holding 110,000 gallons of water, which for many weeks past has been occupied by but three dogfish, a ray, and a few turtle; No. 11, with 9,000 gallons, by two mackerel, and so on. A remaining still greater source of dissatisfaction associated with the non-circulatory system, and yet one capable, perhaps, of full appreciation by those only who have held practical aquarium responsibility, arises from the difficulty, verging upon the impossibility, of maintaining the tanks uniformly bright and clear throughout the building. Some fish foul the water to a much greater extent than others, notably the Flat-fish or Pleuronectidæ, who in a few weeks will render a clear isolated tank too opaque for the opposite side some twenty feet distant to be discerned. The only existing remedy for such a case is to run off the water and supply fresh from the reservoirs beneath; but this water being drawn from the shore-line, the feeding pipe remaining exposed at half tide, is necessarily loaded with impurities, which re-agitated by the action of pumping involves the lapse of several more days before the tank is in a fit state for exhibition. At the suggestion of my predecessor, the late Mr. J. K. Lord, oysters and other bivalve mollusca were introduced into the tanks for the purpose of removing the organic particles which rendered the water turbid, but though these have proved of great service, the root of the evil remains undisturbed, and it is only by the application of the circulatory system, securing with it the more thorough oxygenisation of the water, that the problem is to be effectually solved.

This system, initiated by Mr. W. A. Lloyd at the Hamburgh Aquarium, and now maintained under his personal superintendence at the Crystal Palace, consists in having, in the first place, a bulk of water in the reservoirs beneath exceeding by four or five times the total amount contained in the tanks above, and which, being pumped up by steam power and circulated through the building, takes up in its course by exposure to the atmosphere an amount of oxygen, permitting the preservation in health not only of a much larger number of inhabitants to each tank, but at the same time communicates to the water a degree of clearness and brilliancy unattainable by other means, and which brilliancy is increased or diminished in exact proportion to the uniformity and force of the current so maintained. One theoretical objection urged by the architect of the Brighton Aquarium against the circulatory system, is that in the event of paint or other deleterious substance falling into any one tank the water of the neighbouring tanks would suffer equally. Practically, such mishaps have no business to occur, and though in such a case, on the "siphon" mode of circulation first attempted but abandoned as impractical at Brighton, some mischief might be done, it would be impossible under that to be presently suggested as still feasible at the institution here under consideration, and until the adoption of which the Brighton Aquarium cannot be expected to fully realise the highest anticipations of its promoters, while the greater or less turbidity of its tanks must continue as hitherto a constant source of dissatisfaction to the directors, and of anxiety and mortification to the officers held responsible.

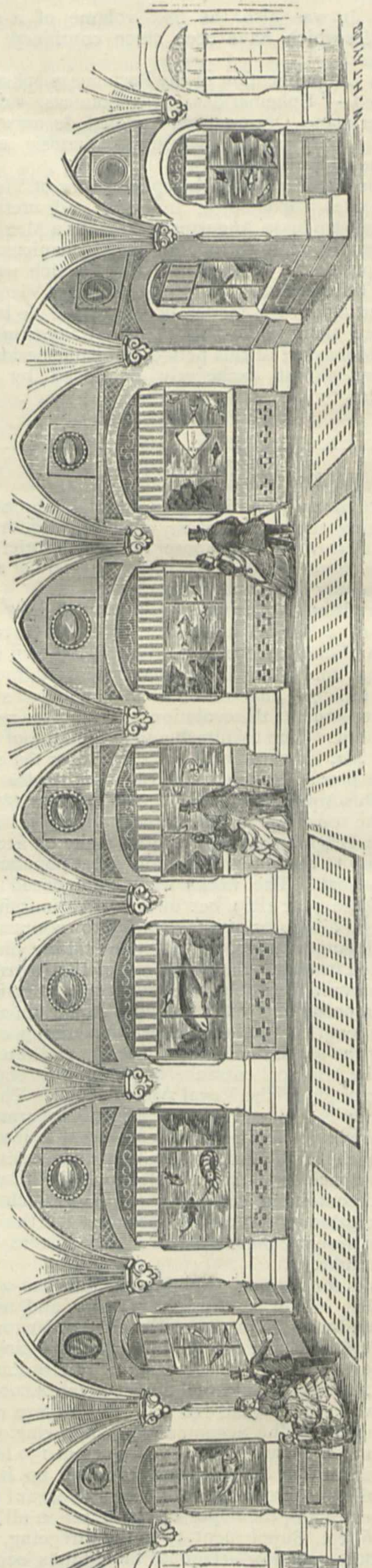
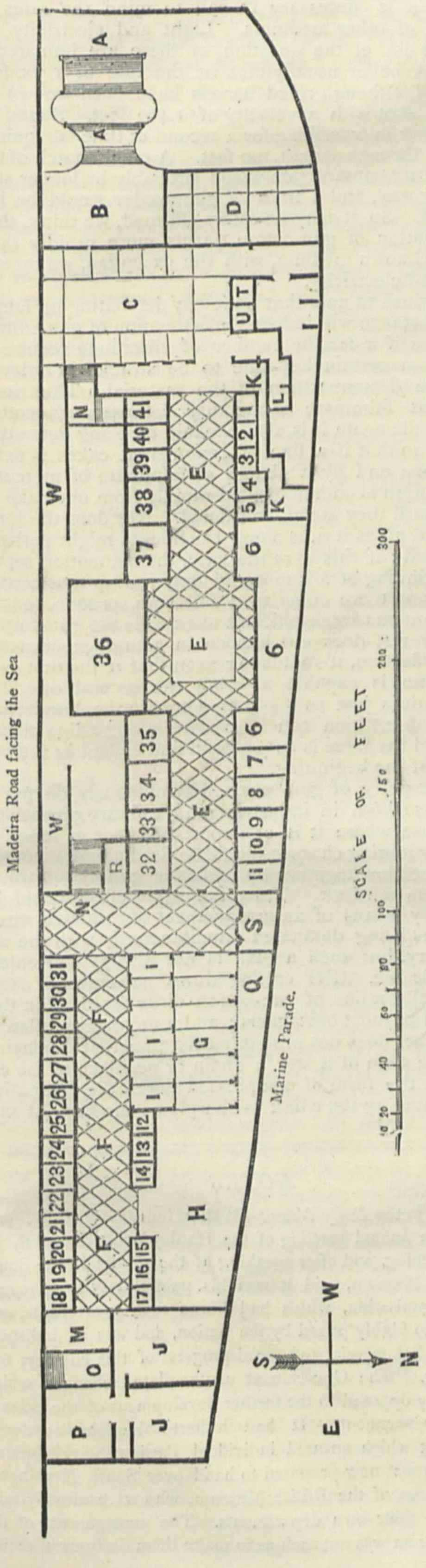


Fig. 1.—Front View of Tank No. 6 (110 ft. long), Western Corridor, Brighton Aquarium.



A Steps descending from West End. B Entrance Court. C Entrance Hall and Reading Room. D Restaurant and Dining Hall. EEE Western Corridor with Tanks on each side. FFF Eastern Corridor. G Interspace. H Rockwork, Fernery, and Cascade. III Table Tanks. JJ Engine Room, Stores, &c. KK Ladies' Cloak Room. LL Gentlemen's do. M Naturalist's Rooms. N Steps to Corridors with Promenade over O Business and Private Entrance. P Curator's Office. Q Rockwork, with Seal-Ponds, &c. R Grotto. S Heating Apparatus. T Clerk's Office. U Board Room. W Inclines for Hand Chairs.

At the eastern extremity of the building there is still a considerable plot of ground unutilised belonging to the company; admirably adapted for the construction of a supplementary reservoir, holding, say, one million and a half gallons, and whose contents, added to those of the existing ones, would yield a body of water sufficient for the purpose. This ground, in fact, being considerably above the level of the tanks, would permit of simplifying matters by pumping the water up from the existing reservoirs to the proposed new one, whence it would circulate through the tanks and return to its original source by the mere force of gravitation. As now the individuality of each tank might be maintained, the water flowing from the main through the existing cocks, and escaping to the reservoirs beneath, through the same overflows, two or more of which are supplied to each tank, which might be enlarged or further multiplied, if requisite to carry off the accelerated stream. Should any tank now become unduly turbid through unforseen circumstances, the accident could be immediately remedied by emptying it into the large reservoirs beneath where so small a quantity in proportion would effect no appreciable alteration, the tank being refilled through the main; while in the event of paint or other poisonous ingredient being upset the water would be run off to waste as under existing circumstances. An important and essential preliminary step to these proposed alterations will, however, be to render the existing reservoirs watertight, their present defective condition in this respect being one of the chief obstacles to the storage of clear water, which in an inland aquarium would have simply proved the ruin of the undertaking. These difficulties surmounted, and the reservoirs filled with water drawn from some little distance off shore, say|at the head of the pier close by, and so free from the chalky wash and innumerable organic impurities inseparable from the present supply, the aquarium will be entirely independent of the sea, and much waste of labour now occupied in pumping from it saved. The still more important results accruing to the institution through the uniform clearness of the water, and the capability of each tank to support a number of inhabitants compatible to its size, cannot be overrated. *

Under any circumstances, if the remedy here proposed is not adopted, it is to be trusted that the weak points of the Brighton Aquarium here noticed will prove sufficient to prevent the repetition of the same errors of construction in any of the Aquaria now in contemplation or being built in this country. On the Continent, the type initiated by our own countryman at Hamburgh, and at the Crystal Palace, with such improvements as practical experience dictates, is almost invariably adopted, and it is incumbent that England, as the initiator of the movement, should maintain her lead. So far, from its size and its proximity to the sea, the Brighton Aquarium has been able to achieve results unrealised by any other institution of its description, as instanced in the recent preservation in its tanks of creatures so large as porpoises, and fish so delicately constituted as herrings and mackerel; but these results are by no means commensurate with the expenditure involved in its establishment, and we hope steps will be forthwith taken to remedy the defects indicated.

The Isle of Wight and the Devonshire coast, especially Torquay, are localities offering far greater advantages than Brighton, as zoological stations for the acquisition of specimens, and now that the financial success of large Aquaria under judicious management in centres of sufficient population is well established, the temptation these places offer to an enterprising company cannot be long resisted.

W. SAVILLE KENT

* Defects of construction in the Brighton Aquarium likely to interfere with the future efficiency of the establishment were alluded to without specification, while the building was in the hands of the contractor.—See NATURE, vol. iv. p. 394.

THE RAPIDITY OF DETONATION

A CIRCUMSTANCE of singular interest has recently been revealed in connection with the investigations still being carried on with gun-cotton at Woolwich Arsenal. The experiments made with this powerful explosive have now extended over a period of ten years, and although many discoveries of vital interest have been made by Professor Abel and by Mr. E. O. Brown, who is aiding in the research, the results teach us, before everything, how much more we have yet to learn of the properties of pyroxilin. First of all, the violence of its explosion had to be tamed, then a compressed form of the material was devised, and after that it was shown that, like its sister-explosive, nitro-glycerine, gun-cotton could be violently detonated, if ignited by a charge of fulminate. Gun-cotton, in fact, turns out to be sympathetic, for, according to the energy with which it is inflamed, so it responds in its behaviour: thus, if gently ignited by a spark, the cotton, in the form of yarn, smouldered slowly away; when set fire to by a flame, it burnt up rapidly; if in the form of a charge it was exploded in a mine or a fire-arm, it at once resented the shock and replied with corresponding energy, behaving like gunpowder under similar circumstances; while, lastly, if fired with great violence with a few grains of fulminate, it is detonated with as much force and with the same terrible effect as its instigator.

More recently, as many may have heard, our investigators have succeeded in detonating, or, in other words, exploding to the best advantage, gun-cotton when in a damp condition; and in this state the explosion is every bit as violent as when the material is dry. This grand discovery is naturally of the utmost importance, because, although many objections may be advanced as to the danger of storing and using gun-cotton when dry, the most nervous of us would scarcely hesitate to employ it sopping wet. In this latter condition the material is, strange to say, not only non-explosive, but positively non-inflammable; so much so, indeed, that it would be probably as serviceable in putting out a fire as a wet blanket or a damp towel would be. It can neither be inflamed nor exploded when wet; and further, unless one has the key to its detonation—a little fulminate of mercury—it is of no more value as an explosive than so much wet paper pulp. When placed in contact, however, with a fuse of the proper construction and a cake of dry gun-cotton, to start the action, the wet pyroxiline, as we have said before, detonates as readily as when the moisture amounts to but a fraction of a per cent. Moreover, the quantity of water in the material is really of no importance, for it has been found that for submarine mines, compressed cakes enclosed in a fishing-net and thrown overboard with a dry primer and a fulminate fuse, will explode with just as much energy as when confined in a water-tight steel case.

It is in respect to this detonation, and more particularly to the rapidity of its action, that we desire to speak at the present moment. Recent experiment has shown that the rapidity with which gun-cotton detonates is altogether unprecedented, the swiftness of the action being truly marvellous. Indeed, with the exception of light and electricity, the detonation of gun-cotton travels faster than anything else we are cognizant of. Thus, detonation will run along a line of gun-cotton cakes, placed so as to touch one another, with a rapidity only inferior to that of electricity, setting fire to a charge or conveying a signal, if desired, almost instantaneously. Twenty thousand feet, or nearly three miles per second, is calculated to be its rate of travelling according to Noble's electric chronoscope. In one experiment forty-two feet of the material was fired, and records secured at every six feet; and in this case the results given were most uniform, for the velocity only varied from nineteen to twenty thousand feet per second, the ratio of transit being in no instance less than this.

To form an approximate idea of this extraordinary rapidity, it is necessary to call to mind the rates of travelling of other mediums. Light and electricity we may leave out of the question, as these are immaterial bodies. A bullet usually flies at the rate of 1,300 feet per second, although rifled barrels have been known to project a shot with a velocity of 1,400 feet. Sound is much slower in travelling, for a second of time is required in getting through some 1,100 feet. A quick match of the most delicate construction would probably be longer still in making way, and a train of gunpowder would be left far behind. So it may be safely affirmed, we think, that the detonation of gun-cotton travels more rapidly than any other known medium, with the exception, we repeat, of light and electricity.

It is curious to note that not every detonating or fulminating substance will induce the detonation of gun-cotton. It seems as if a certain number of vibrations require to be set up—a certain key-note to be struck—in order to secure the decomposition of the material. Thus it is found that fulminate of mercury detonates guncotton readily, while again it is also capable of being detonated by itself; so that if a line of compressed cakes is detonated at one end by a charge of fulminate of mercury, the detonation is communicated rapidly from one cake to another, until they are all consumed. Nor does the force diminish at all as it runs along the line, as might perhaps be imagined; if this were the case, the detonation set up at the beginning of a line would only run up to a certain distance, and there come to a full stop, as soon, that is, as the vibrations are insufficient to explode the gun-cotton. This, however, does not happen in actual experiment; and, on reflection, it stands to reason that if the first cake of pyroxilin is capable of firing the second one, the ninety-ninth is just as ready to detonate the hundredth. Thus the detonation can be carried along a line of any length, and the force is as powerful and violent at the end as it was at the beginning.

This property of gun-cotton may obviously be put to valuable use both in industrial and military operations. In any case where it is of importance that a series of blasting or mining charges should be fired simultaneously, their connection together by means of gun-cotton would ensure such a result. True, the same effect could be obtained by means of an arrangement of insulated wires, the charges being detonated simultaneously with the aid of a battery, but such a plan is not always convenient nor practicable. For cutting down palisades, or stout wooden walls, a line of gun-cotton discs exploded in this way would be most efficacious; and a more ready plan of felling timber does not probably exist than that of placing around the stem of a tree a chain or necklace of the explosive in the form of compressed cakes, the detonation of these dividing the trunk as sharply as the keenest axe.

NOTES

We read in the *Daily News*:—"Mr. Henry Cole, C.B., presided at the annual meeting of the Hanley School of Art, on Monday evening, and after speaking of the results of the South Kensington Museum, said it was his painful duty to announce that this organisation, which had borne such great fruits, and which was so highly prized by the nation, and was so indispensable to the commercial and social progress of this country, was in jeopardy. The Government contemplated changes which were directly opposed to the further development of the Science and Art Department. It had hitherto flourished under a management which ensured individual Parliamentary responsibility, but it was now proposed to hand over South Kensington to the Trustees of the British Museum, who were already fully occupied in their own departments. The management of the British Museum was not such as to make them desirous of seeing it extended to South Kensington, nor were fifty trustees the proper administrators of public money to the amount of hundreds of thousands a year granted to science and art. He appealed to art students throughout the country not to allow the work of the Prince Consort to be destroyed, and the means of their own instruction to be taken away or muddled with old decaying notions. He urged them to call upon their representatives in Parliament—and an election was not far off—to protect their interests and rights from unprincipled invasion; and he offered his humble services, if he could assist them, to preserve the institution which the Prince Consort founded from the hands of the ignorant spoiler. Mr. Melly, M.P., in proposing a vote of thanks to Mr. Cole, spoke in terms of praise of his efforts to spread art and science, and said it would be far more sensible to transfer the British Museum to South Kensington than to place the latter under the management of the British Museum. It was not by following antiquated notions that the work of education was to be carried on, but by adopting the free-trade principle which Mr. Cole had carried out at South Kensington. He was the Cobden and Bright in the education of art and science. He had been in this matter a true free-trader, and in following the public he had served it. Mr. Cole, in responding, offered 50*l.* towards the establishment of a local museum." Surely it is monstrous that while a Royal Commission is sitting to inquire into these matters the Government should thus attempt to make the Commissioners look ridiculous by taking such a step without waiting for their report. This is another instance of the ignorant action of Government in all matters appertaining to Science.

THE *Challenger* reached the coast of Brazil on September 15 last, after a successful but rather stormy voyage across the Atlantic. She was to have left Bahia on September 25 for the Cape of Good Hope.

MR. SCLATER has received a letter from Dr. A. B. Meyer, announcing his return to Vienna after a most successful expedition to New Guinea. Dr. Meyer landed in Mac Cleur's inlet on the west coast, and crossed the main land to the Bay of Geelvink. He has obtained fresh specimens of nearly all the known Paradise-birds, and of one which he belives to be new to science.

THE examination for Natural Science Scholarships, held in common at the same time and with the same papers for Magdalen, Merton, and Jesus Colleges, Oxford, has terminated in the following elections:—At Magdalen College, to the Demyship, Mr. W. W. Jones, of Clifton College; to the Exhibition, Mr. F. J. Bell, of Christ's Hospital. At Merton College, to the Postmasterships, Mr. W. Carter, of Blackburn Science School, and Mr. F. J. Bell, of Christ's Hospital. At Jesus College, to the Scholarship, Mr. E. W. Poulter. It will be seen that Mr. Bell was elected by two colleges and has decided to accept the election to Magdalen. There were fourteen candidates. The election to the Biological Fellowship at Magdalen College took place on Saturday last, when Mr. C. J. F. Yule, of St. John's College, Cambridge, was announced as the successful candidate. The election to the Physics Fellowship at Merton College will not take place until Oct. 30.

WE regret to have to announce the death of M. Jules Pierre Verreaux, Aide-Naturaliste au Musée d'Histoire Naturelle du Jardin des Plantes. M. Verreaux was a great traveller in early life, and enriched the French National Museum by large collections from the Cape and Australia. On his return to Europe, he was for many years scientific assistant to his brother, the late Edward Verreaux, at the Maison Verreaux in the Place Royale at Paris, so well known to naturalists of all countries. After his brother's death, M. Verreaux accepted the office in the Jardin des Plantes, which he held until his decease. M. Verreaux had a very complete and extensive knowledge of the class of birds, and was the author of numerous ornithological memoirs and papers. His loss will be severely felt by ornithologists who have occasion to consult the rich collection in the Jardin des Plantes, and by many friends and correspondents in this country and elsewhere.

WE have also to record the death of Dr. Otto Wacherer, a German physician, resident at Bahia, who made large collections in various branches of Natural History, and was the author of an excellent memoir on the Ophidians of that district of South America, published in the Zoological Society's "Proceedings."

DR. BESSELS, of the *Polaris* expedition, has given evidence that the death of Captain Hall was solely due to natural causes.

SIR C. B. ADDERLEY, M.P., speaking at the annual meeting of Saltley Reformatory yesterday, expressed his satisfaction at the undoubted diminution of crime in this country. He did not attribute the decrease to any change in our system of secondary punishments but to the gradual spread of education and enlightenment, more especially among the lower classes.

ON November 18 there will be an election at Balliol College, Oxford, to a scholarship on the foundation of Miss Hannah Brackenbury, "for the encouragement of the Study of Natural Science;" worth 80*l.* a year (and tuition free) for four years: open to all such candidates as shall not have exceeded eight terms from Matriculation. At ten o'clock, A.M., papers will be set in the following subjects:—(1) Mechanical Philosophy and Physics; (2) Chemistry; (3) Physiology; but candidates will not be expected to offer themselves in more than two of these. There will also be a practical examination in one or more of the above subjects, if the examiners think it expedient. Candidates are requested to communicate their intention to the Master of Balliol by letter, on or before Monday, November 10, enclosing testimonials from their colleges or schools, and (if members of the University) certificates of their Matriculation; and stating the subjects in which they offer themselves for examination.

WE have received the List of the Candidates who took Honours at the May Examination of Science Schools and Classes in connection with the Science and Art Department. We are sorry that our space does not permit us to publish the list of names, which we are glad to see is very large; it is, moreover, very gratifying to notice that in nearly every department a considerable proportion of the successful Candidates have been "self-taught."

THE following science-teachers, who attended the special course of instruction in magnetism and electricity to science-teachers, in connection with the Science and Art Department, having passed first class, are registered as qualified to earn payments in magnetism and electricity:—T. N. Andrews, G. Armstrong, T. Bayley, J. Bresland, R. Brown, W. Cook, S. Cooke, J. Hamilton, H. Harris, J. Harte, D. Low, S. G. Maunder, A. J. Rider, A. Robinson. J. Sayle, J. Simpson, C. Symons, P. H. Trachy, J. Webb, J. W. Woods. The following for the same reason are registered as qualified to earn payment in acoustics, light, and heat:—J. Alexander, T. J. Baker, S. Barbour, J. Beavis, G. R. Begley, P. Doyle, J. B. Duckett, T. Elliott, T. Isherwood, G. Jeffrey, L. M. Leader, E. Leech, E. Magennis, J. Marsahll, J. Moylan, W. Patterson, E. Reynolds, L. J. Ryan, J. Schofield, G. Severs, W. J. Snowdon, W. Sturgess, C. Symons.

THE name of Dr. Kaup, whose death we noted last week, was inadvertently misspelled "Kemp." Jean Jacques Kaup was Grand-ducal Inspector of the Natural History Museum of Darmstadt.

SIR SAMUEL AND LADY BAKER, it is said, have accepted an invitation from the Geographical Society of New York to visit that city during the summer months of next year.

THE inaugural lectures in connection with the scheme of education adopted by the University of Cambridge for the town of Nottingham, were delivered on the 9th inst. in the Lecture Hall of the Mechanics' Institution of that town, and were largely attended. Mr. E. B. Birks, M.A., Fellow of Trinity, who has been appointed to conduct classes and to lecture on English Literature, gave his inaugural lecture in the afternoon to a large audience, composed principally of ladies, for whom this subject has been specially selected; and in the evening Mr. V. H. Stanton, M.A., Fellow of Trinity, who had been appointed to teach Political Economy, opened his course. On Friday week Mr. T. O. Harding, B.A., B.Sc., Fellow of Trinity, commenced his instruction in "Force and Motion," the introduction to Physical Science. The Session will continue to next April, and will be divided into two terms. For the second term, which will commence after Christmas, arrangements have been made for the study of Astronomy, Physical Geography, and English Constitutional History. Examinations will be held at the conclusion of each Term in the work done, and University Certificates will be granted to those who succeed in them.

WE learn from the *Bulletin International* of the Paris Observatory, that Lieutenant Parem and Dr. Wykander, while passing the winter of 1872-3 on the coast of Spitzbergen, made a series of spectrum observations on the Aurora, and determined seven different spectral lines, which, according to Wykander, are identical with the spectrum at the bottom of the flame of a candle or petroleum lamp.

MESSRS. ROUTLEDGE & SONS, have in the press, a "New Illustrated Natural History," by the Rev. J. G. Wood, M.A., with 500 Illustrations; and "The Book of African Travel," by W. H. G. Kingston. This work is intended to give records of the journeys of all the celebrated travellers in Africa down to the present time. It will be profusely illustrated.

MESSRS. HODDER and STOUGHTON will shortly publish "Life, Wanderings, and Labours in Eastern Africa," with an account of the first successful ascent of the equatorial snow mountain Kilima Njara, and remarks on the East African slave trade, by the Rev. Chas. New, of the Livingstone Search and Relief Expedition, illustrated.

THE annual migration of the butterfly from east to west across the isthmus of Panama in August and September was, according to the *Star*, proceeding. The butterfly has golden green stripes on a black ground, and is very beautiful. It has been recognised by Mr. O. Salvin, of London and Guatemala, as the *Urania fulgens*.

WE have received the diminutive prospectus of what is likely to be at least an ingenious and curious work; it is entitled "Chemistianity," and will contain "2,000 chemical facts, relating to inorganic chemistry, explained within 5,000 lines of oratorical verse, compiled by permission from the works of leading chemists of the day; together with the views of the author (expressed in verse) as to the advantages of a general knowledge of chemistry." If the book is readable it will certainly be a triumph of ingenuity, if not of genius, on the part of the author, Mr. J. C. Sellars, manufacturing chemist, Birkenhead, who is also publisher.

IN the *Chemical News* for Oct. 17 will be found a long list of subjects for prizes to be awarded in May 1874, by the Société Industrielle de Mulhouse.

THE first three parts are published (price 6*d.* each) of "British Marine Algæ; being a popular account of the Seaweeds of Great Britain, their collection and perservation," by W. H. Grattann. It is intended as a cheap and popular rather than scientific handbook to our marine flora, and will apparently serve a very useful purpose as such. The illustrations, though on a small scale, are sufficient to recognise the more striking forms.

THE last two parts, xi. and xii., of the new edition of Griffith and Henfrey's Micrographic Dictionary, bring down the work as far as Hydra. The botanical articles have been written up to the present state of science by the Rev. M. J. Berkeley.

MR. A. ELLEY FINCH has published the lecture he delivered last March before the Sunday Lecture Society, "On the Pursuit of Truth." We think he has done well in so doing, as he shows clearly and shortly the only principles of evidence upon which permanent and satisfactory belief can be founded, showing the distinction between the evidence which satisfies the theologian, the lawyer, and the man of science. Mr. Finch has added many footnotes and appendices, which, though often irrelevant, are in most cases valuable and interesting, the appendices being mostly abstracts of passages from the works of well-known authors bearing more or less on the subject alluded to in the lecture. We wish the lecture a large circulation among the general public, whom it would tend to enlighten.

THE *Gazette de Vos* publishes some statistics with regard to education in Germany, which appear in *La Nature*. According to the latest official information, the German Empire numbers 380 gymnasiums, pro-gymnasiums, and academies (*lycées*); 156 Latin schools (in Bavaria and Wurtemberg); 270 "realschulen," 12 high schools, technical and polytechnic. Prussia possesses besides, 26 provincial schools of arts and industry; Saxony, 5 commercial schools and 4 schools of arts, industry, and architecture; Saxe-Coburg-Gotha, 3 schools of the kind last mentioned; the City of Hamburg possesses a school of art for boys and another for girls. Bavaria has 33 schools of arts, commerce, and agriculture; Prussia, 26 agricultural schools, with 41 winter schools of rural economy. The rest of the German Empire possesses 56 other schools belonging to one or other of these categories. Prussia numbers 260 superior public schools for girls, and the rest of Germany, 54. 143 seminaries for the training of teachers are in full activity in the German Empire during the present year; primary instruction is given in 60,000 schools. All the German States have schools for deaf-mutes and for the blind; Prussia possesses 35 for the former and 14 for the latter. With regard to schools for the artistic professions, Bavaria occupies the first rank, but Wurtemberg and Prussia have latterly made great progress in this direction.

"THE Pearl of the Antilles; or, An Artist in Cuba," by Walter Goodman, is the title of a volume just published by Messrs. King & Co. Since Mr Goodman calls himself an artist, we should have expected a few illustrations of Cuban scenery in his work, but there are none. The work makes no pretensions to be a contribution to the natural history of Cuba, but in a very entertaining manner the author gives a series of sketches of social life on the lovely island.

THE additions to the Zoological Society's collection during the past week include two Weka Rails (*Ocydromus australis*) from New Zealand, presented by the Acclimatisation Society of Otago; an Alligator (*Alligator mississipiensis*) from New Orleans, presented by Capt. M. Cowper; two Patagonian Conures (*Conurus patagonus*) from Chili, two Solitary Tinamous (*Tinamus solitarius*) from Brazil, received in exchange; a Macaque Monkey (*Macacus cynomolgus*) and a Bonnet Monkey (*M. radiatus*) from India, presented by Mr. G. Veitch, and deposited; a Cape Petrel (*Daption capensis*), purchased, from Manilla, which is the first specimen of this bird obtained by the Society.

ON THE FINAL STATE OF A SYSTEM OF MOLECULES IN MOTION SUBJECT TO FORCES OF ANY KIND

LET perfectly elastic molecules of different kinds be in motion within a vessel with perfectly elastic sides, and let each kind of molecules be acted on by forces which have a potential, the form of which may be different for different kinds of molecules.

Let x, y, z, be the the coordinates of a molecule, M, and ξ, η, ζ the components of its velocity, and let it be required to determine the number of molecules of a given kind which, on an average, have their coordinates between x and $x + dx$, y and $y + dy$, z and $z + dz$, and also their component velocities between ξ and $\xi + d\xi$, η and $\eta + d\eta$ and ζ and $\zeta + d\zeta$. This number must depend on the coordinates and the components of velocities and on the limits of these quantities. We may therefore write it

$$dN = f(x, y, z, \xi, \eta, \zeta)\, dx\, dy\, dz\, d\xi\, d\eta\, d\zeta \qquad (1)$$

We shall begin by investigating the manner in which this quantity depends on the components of velocity, before we proceed to determine in what way it depends on the coordinates.

If we distinguish by suffixes the quantities corresponding to different kinds of molecules, the whole number of molecules of the first and second kind within a given space which have velocities within given limits may be written

$$f_1(\xi_1, \eta_1, \zeta_1)\, d\xi_1, d\eta_1, d\zeta_1 = n_1 \qquad (2)$$

and

$$f_2(\xi_2, \eta_2 \zeta_2)\, d\xi_2\, d\eta_2\, d\zeta_2 = n_2 \qquad (3)$$

The number of pairs which can be formed by taking one molecule of each kind is $n_1 n_2$.

Let a pair of molecules encounter each other, and after the encounter let their component velocities be ξ_1', η_1', ζ_1' and ξ_2', η_2', ζ_2'. The nature of the encounter is completely defined when we know $\xi_2 - \xi_1$, $\eta_2 - \eta_1$, $\zeta_2 - \zeta_1$ the velocity of the second molecule relative to the first before the encounter, and $x_2 - x_1$, $y_2 - y_1$, $z_2 - z_1$ the position of the centre of the second molecule relative to the first at the instant of the encounter. When these quantities are given, $\xi_2' - \xi_1'$, $\eta_2' - \eta_1'$ and $\zeta_2' - \zeta_1'$, the components of the relative velocity after the encounter, are determinable.

Hence, putting α, β, γ for these relative velocities, and a, b, c for the relative positions, we find for the number of molecules of the first kind having velocities between the limits ξ_1 and $\xi_1 + d\xi$, &c., which encounter molecules of the second kind having velocities between the limits ξ_2 and $\xi_2 + d\xi$, &c., in such a way that the relative velocities lie between α and $\alpha + d\alpha$, &c., and the relative positions between a and $a + da$, &c.

$$f_1(\xi_1, \eta_1, \zeta_1)\, d\xi\, d\eta\, d\zeta . f_2(\xi_2, \eta_2, \zeta_2)\, d\xi\, d\eta\, d\zeta . \phi(abc\,\alpha\beta\gamma)\, da\, db\, dc\, d\alpha\, d\beta\, d\gamma \quad (4$$

and after the encounter the velocity of M_1 will be between the limits ξ_1' and $\xi_1' + d\xi$, &c., and that of M_2 between the limits ξ_2' and $\xi_2' + d\xi$, &c.

The differences of the limits of velocity are equal for both kinds of molecules, and both before and after the encounter.

When the state of motion of the system is in its permanent condition, as many pairs of molecules change their velocities from V_1, V_2 to V_1', V_2' as from V_1', V_2' to V_1, V_2, and the circumstances of the encounter in the one case are precisely similar to those in the second. Hence, omitting for the sake of brevity the quantities $d\xi$, &c., and ϕ, which are of the same value in the two cases, we find—

$$f_1(\xi_1, \eta_1, \zeta_1) f_2(\xi_2, \eta_2, \zeta_2) = f_1(\xi_1', \eta_1', \zeta_1') f_2(\xi_2', \eta_2', \zeta_2') \qquad (5)$$

writing—

$$\log f(\xi, \eta, \zeta) = F(MV^2, l, m, n) \qquad (6)$$

where l, m, n are the direction cosines of the velocity, V, of the molecule M.

Taking the logarithm of both sides of equation (5)—

$$F^1(M_1 V_1^2 l_1 m_1 n_1) + F_2(M_2 V_2^2 l_2 m_2 n_2) = F_1(M_1 V_1'^2 l_1' m_1' n_1') + F_2(M_2 V_2'^2 l_2' m_2' n_2') \qquad (7)$$

The only necessary relation between the variables before and after the encounter is—

$$M_1 V_1^2 + M_2 V_2^2 = M_1 V_1'^2 + M_2 V_2'^2 \qquad (8)$$

If the righthand side of the equations (7) and (8) are constant, the lefthand sides will also be constant; and since l_1 m_1 n_1 are independent of l_2 m_2 n_2 we must have—

$$F_1 = A M_1 V_1^2 \text{ and } F_2 = A M_2 V_2^2 \qquad (9)$$

where A is a quantity independent of the components of velocity, or—

$$f_1(\xi_1, \eta_1, \zeta_1) = C_1 e^{A M_1 V_1^2} \qquad (10)$$

$$f_2(\xi_2, \eta_2, \zeta_2) = C_2 e^{A M_2 V_2^2} \qquad (11)$$

This result as to the distribution of the velocities of the molecules at a given place is independent of the action of finite forces on the molecules during their encounter, for such forces do not affect the velocities during the infinitely short time of the encounter.

We may therefore write equation (1)

$$dN = C e^{AM(\xi^2 + \eta^2 + \zeta^2)}\, d\xi\, d\eta\, d\zeta\, dx\, dy\, dz \qquad (12)$$

where C is a function of $x\,y\,z$ which may be different for different kinds of molecules, while A is the same for every kind of molecule, though it may, for aught we know as yet, vary from one place to another.

Let us now suppose that the kind of molecules under consideration are acted on by a force whose potential is ψ. The variations of x, y, z arising from the motion of the molecules during a time δt are

$$\delta x = \xi \delta t, \ \delta y = \eta \delta t, \ \delta z = \zeta \delta t \qquad (13)$$

and those of ξ, η, ζ in the same time due to the action of the force, are

$$\delta \xi = -\frac{d\psi}{dx}\delta t, \ \delta \eta = -\frac{d\psi}{dy}\delta t, \ \delta \zeta = -\frac{d\psi}{dz}\delta t \qquad (14)$$

If we make

$$c = \log C \qquad (15$$

$$\log \frac{dN}{d\xi\, d\eta\, d\zeta\, dx\, dy\, dz} = c + AM(\xi^2 + \eta^2 + \zeta^2) \qquad (16)$$

The variation of this quantity due to the variations δx_1 δy_1 δz_1 $\delta \xi_1$ $\delta \eta_1$ $\delta \zeta_1$ is

$$\left.\begin{aligned} &\left(\xi\frac{dc}{dx} + \eta\frac{dc}{dy} + \zeta\frac{dc}{dz}\right)\delta t \\ &- 2AM\left(\xi\frac{d\psi}{dx} + \eta\frac{d\psi}{dy} + \zeta\frac{d\psi}{dz}\right)\delta t \\ &+ M(\xi^2 + \eta^2 + \rho^2)\left(\xi\frac{dA}{dx} + \eta\frac{dA}{dy} + \zeta\frac{dA}{dz}\right)\delta t \end{aligned}\right\} \qquad (17)$$

Since the number of the molecules does not vary during their motion, this quantity is zero, whatever the values of ξ, η, ζ. Hence we have in virtue of the last term—

$$\frac{dA}{d} = 0 \quad \frac{dA}{dy} = 0 \quad \frac{dA}{dz} = 0 \qquad (18)$$

or A is constant throughout the whole region traversed by the molecules.

Next, comparing the first and second terms, we find

$$c = 2AM(\psi + B) \qquad (19)$$

We thus obtain as the complete form of dN

$$dN_1 = e^{(AM_1(\xi_1^2 + \eta_1^2 + \zeta_1^2 + 2\psi_1 + B_1)}\, dx\, dy\, dr\, d\xi\, d\eta\, d\zeta \qquad (20)$$

when A is an absolute constant, the same for every kind of molecule in the vessel, but B_1 belongs to the first kind only. To determine these constants, we must integrate this quantity with respect to the six variables, and equate the result to the number of molecules of the first kind. We must then, by integrating $dN_1 \frac{1}{2} M_1 (\xi_1^2 + \eta_1^2 + \zeta_1^2 + 2\psi_1)$ determine the whole energy of the system, and equate it to the original energy. We shall thus obtain a sufficient number of equations to determine the constant A, common to all the molecules, and B_1, B_2, &c. those belonging to each kind.

The quantity A is essentially negative. Its value determines that of the mean kinetic energy of all the molecules in a given place, which is $-\frac{3}{2}\frac{1}{A}$, and therefore, according to the kinetic theory, it also determines the temperature of the medium at that place. Hence, since A_1, in the permanent state of the system, is the same for every part of the system, it follows that the temperature is everywhere the same, whatever forces act upon the molecules

The number of molecules of the first kind in the element $dz\,dy\,dr$.

$$\left(-\frac{\pi}{A}\right)^{\frac{3}{2}} e^{AM_1(2\psi_1 + B)}\, dx\, dy\, dz \qquad (21)$$

The effect of the force whose potential is ψ_1 is therefore to cause the molecules of the first kind to accumulate in greater numbers in those parts of the vessel towards which the force acts, and the distribution of each different kind of molecules in the vessel is determined by the forces which act on them in the same way as if no other molecules were present. This agrees with Dalton's doctrine of the distribution of mixed gases.

J. CLERK-MAXWELL

ORIGINAL RESEARCH AS A MEANS OF EDUCATION*

THE subject of the value of original scientific investigation may be considered from many points of view. Of these, that of the national importance of original research is the one which naturally first engages attention; and it does not take long to convince us that almost every great material advance in modern civilisation is due, not to the occurrence of haphazard or fortuitous circumstances, but to the long-continued and disinterested efforts of some man of science. Nor do I need to quote many examples to show us the immediate dependence of the national well-being and progress upon scientific discoveries thus patiently and quietly made. If it had not been for Black's researches on the latent heat of steam, James Watt's great discovery, which has revolutionised the world, would not have been made. Practical applications cannot be made until the scientific facts or principles upon which those applications rest have been discovered. In our own science I might instance hundreds of cases in which discoveries made in the pure spirit of scientific inquiry have (generally in the hands of others than the original investigators) led to results of the first importance to civilisation. Chloroform was first prepared by Liebig in 1834; but it was Simpson who long afterwards applied it to the relief of suffering humanity. Faraday in 1825 discovered benzole, and from it Zinin prepared a substance called aniline, which for many years remained a chemical curiosity only interesting to the scientific man. In due course, however, a practical sphere of usefulness was to be opened out for this little known substance. Perkin discovered that this rare body was capable of yielding splendid colours. Commercial skill then at once seized upon aniline, and, instead of its being made by the ounce, it is now manufactured by thousands of tons, and the bright and beautiful colours which it yields are known all the world over, and are alike pleasing to the eye of the connoisseur of fashion and of the dusky denizen of the forest primæval. Thus, too, the purely scientific researches of our distinguished fellow-citizen Dr. Schunck, respecting the dyeing principle contained in the well-known madder root, laid the foundations for the subsequent discovery, by Graebe and Lieberman, of the artificial production of this naturally occurring principle, termed alizarine, the manufacture of which is now assuming such gigantic proportions. Again, the discovery of chlorine by Scheele, in 1774, lies at the foundation of the whole of our Lancashire trade, for without bleaching powder the cotton and paper manufactures could not exist on their present extended scale. I might almost indefinitely extend this list of discoveries, which, when first made, were apparently far removed from any useful application, but which all at once become the starting-point of a new branch of industry, and a source of benefit or gratification to mankind.

This subject of the national importance of original research is one which is gradually but surely forcing itself on public attention. A few years ago national elementary education was looked upon as a chimera; now it has become the question of the day. As soon as English people see as clearly as we do the imperious necessity for encouraging, stimulating, and upholding original research as containing the seeds of our future position as a nation, they will not be behindhand in securing the free growth of those seeds. It is therefore the bounden duty of all those whose employment or disposition has led them to feel the truth of this great principle, to leave no stone unturned to make widely known and keenly felt the importance of the national encouragement of original investigation.

It might have been a useful task for me to contrast what is done in other countries for the encouragement of free inquiry and research, and what is done, or rather left undone, in England. We should have seen that on the Continent of Europe, to a great extent, and in the United States, in some measure, those who have to wield the sceptre of government are not only aware of the national importance of original research, but, what is more, that they act up to their convictions, whilst we feel that the same cannot be said in our country. We should have seen that in Germany the facilities given in the universities, which are Government institutions, and in the other numerous and well-organised scientific educational establishments, to original research are very great; that an original investigation in some branch of human knowledge is considered the usual termination of the student's university career; and that degrees are generally given only when some new observations or experiments have been added to the mass of human knowledge. We should find that the position of professor is mainly influenced by the amount and quality of his original researches, and that this power, and not any secondary or subsidiary ones, as is sometimes the case with us, is taken as the proof of a man's fitness to fill the professorial chair.

It is my wish, however engrossing this view of the subject may be, to ask you to consider to-day another aspect of the question—viz. the educational value of original research; the value of personal communication with nature for its own sake, the influence which such employment exerts on the mind, the effect which such studies produce as fitting men for the active duties of life, and the question, therefore, as to how far original investigation should be encouraged as an instrument of intellectual progress. It may be well, however, before we commence this special question, to place clearly before our minds what is meant by scientific inquiry in general, and to see how it is related to the studies and habits of mind with which men up to the dawn of the present, or scientific age, have been familiar.

In the first place, then, the essence of the scientific spirit is that it is free and disinterested. If, therefore, any of the habits of mind, studies, or beliefs in which men have hitherto indulged have not been free nor disinterested, in so far they have not been scientific. In the second place, the spirit of true scientific inquiry knows nothing of tradition or authority. It lays down laws for itself, and refuses to be bound by any others. Scientific education begins with no preconceived idea in accordance with which everything else must be moulded. It starts in simple communion with Nature, and is content to pick up little by little the truth which she is always ready to communicate to patient listeners. Thus step by step and generation by generation, slowly but surely, the perfect edifice of science is being built up, and all those who contribute, however insignificantly, to this great work have the safe assurance that their labour has not been in vain. This process is, it is clear, at once opposed to, and, if successfully carried out, subversive of the old order of things. Between a system based on authority and one founded on freedom of thought and opinion there can never be any united action; and whilst fully acknowledging that intellectual eminence, and, of course, moral excellence, are common to all classes of men, and are not confined to those holding particular opinions, if only they be honest, it is as well that we should admit with equal candour that the followers of the old system have no claim to be called scientific, and that there is, from the nature of things, a great and impassable gulf between us and them.

It does not concern us at present to inquire which of these two systems, the free or the authoritative, is for the future to rule the world. It must now suffice for us to see clearly that the habits of mind necessary for the establishment of the one are absolutely opposed to those needed for the success of the other.

I must, however, here not be misunderstood. It would ill become me, connected as I am with a college to which it has been our constant aim to impart a university character, to undervalue or depreciate the study of subjects other than those included under the head of the physical sciences. Literary studies, whether of modern or ancient authors, giving an acquaintance with the noblest thoughts and opinions of the great men of past ages; historical studies, giving us a knowledge of the acts of men in times gone by; the study of language and philology, as giving a knowledge of how men of all times and countries express their ideas and language; of logic, as pointing out the laws of thought; and above all, that of mathematics, are all matters of the highest importance, the neglect of which would render our education poor and incomplete indeed. The same rules, however, which all acknowledge to be necessary for the teaching of physical science must be applied to the study of all these subjects. In short, the *scientific method* must be employed in all cases and carried out to its fullest extent. Whilst attempts to shackle the mind, or to stifle free inquiry, which have too frequently succeeded in past times, and which may, if we are not on our guard, succeed again, must be repulsed with all our vigour.

* Address by Prof. Roscoe at the opening of the new buildings of the Owens College Manchester.

I would, however, here wish to protest against the supposed materialistic tendency of scientific studies. It is true that certain opinions and professions of belief have been and will be shaken by studying the book of nature; it is also equally true that the study of nature does not and cannot interfere with the highest and noblest aspirations of the mind of man. In the investigations of every branch of science we come at last to a point at which further inquiry becomes impossible, and we are obliged to acknowledge our powerlessness and insignificance. We can see and learn concerning only the minutest fraction of the great whole of nature, and it is with this minute fraction alone that we as men of science are concerned.

In inaugurating, as we are now doing, a scientific department of an institution devoted to the higher education, it may be well to glance for a moment at the preliminary stages through which, in the subject of chemical science, with which alone I am competent to deal, a student must pass to reach the portal of original inquiry. And first let me gratefully acknowledge the help which we have received in endeavouring to find a habitation for a school of chemistry aspiring to be worthy of the intellectual vigour and manufacturing power of the great district of which this city is the centre—help not only of the necessary, and therefore valuable kind of pecuniary assistance generously and willingly given, but help of a personal, and therefore still more valuable kind, without which the funds would have been useless, and our scheme for the foundation of a really great scientific institution would have fallen to the ground. The results of this help you now see in this large theatre, and in the splendidly fitted laboratories behind it. They are, I say it with confidence, the most spacious and best arranged laboratories in Great Britain, and will be found, I believe, second to none in the world for convenience and suitability to their proposed uses. It now remains for my colleagues and myself to discharge our debt; to show that the confidence which has been placed in us has not been misplaced, and to prove year by year that the goods we furnish in the shape of soundly and scientifically educated chemists bring a return worthy of the capital, both in specie and intellect, which has been expended upon their production.

Our mode of instruction in the principles of chemistry is of two distinct kinds: (1), by lectures, accompanied by experimental illustration by the lecturers, as well as by recapitulatory and tutorial classes; and (2), by experimental work practically carried out by the student himself in the laboratory. Both of these means of obtaining command over the facts and principles of our science should be carried on simultaneously; the lectures serve as giving a general view of the main features of the subject; the laboratory work brings the student into direct contact with Nature, and gives him an insight into her processes, which can only thus be obtained. In the lecture room the student forms an idea, as in a panorama, of the general appearance of the country; but it is in the laboratory, as in a walk through a given district, that he first learns what the land he is travelling through is really like. And although we know that we must spend much time and labour if we go on foot, we know that we shall be rewarded by a vivid and lasting impression, and one which may perhaps give a new colour to our lives. It is thus with the study of chemistry; the laboratory is the place where the details of the science are really mastered; and a young man must not expect to become a competent chemist without having passed several years of hard and unremitting toil in solving the sometimes tedious and difficult problems which are presented to him.

It is not necessary for me here to detail to you the particulars of the course of instruction which all students of chemistry, as a rule, go through. Suffice it to say that this course begins at the very A B C of our subject; and, if I am freely to speak my mind, I would say that in general I do not object to take students who know nothing of the science. We first seek to give him some notion of the kind of phenomena with which the science is concerned; we then begin to train him in manipulative dexterity, and, by a graduated series of examples and exercises, make him acquainted with the fixed and exact quantitative laws upon which our science is founded. From the beginning we introduce a strict system of note-taking and of carrying out simple chemical calculations, so as to insure a firm foundation for the subsequent building. The student then begins to learn the properties of the more commonly occurring amongst the sixty-three elementary bodies of which (as far as we are yet aware) the material world is built up, and properties of their compounds. He commences the study of qualitative analysis, and at last he is able to tell you the nature of the exact constituents of any substance, whether of earth, of air, or of sea, of mineral, vegetable, or animal nature, which you may ask him to examine. He has accomplished a great work, and if he has carried his examinations as far as the reactions of the rare elements (as is usually the case with all our students), he is master of the first or qualitative stage of the science. Next the question arises as to the quantity of each constituent present in the given substance, and the second or quantitative stage is reached. This is necessarily a longer and more difficult matter than his preceding task. Not only must the choice of methods of separation and estimation be successful, so as to employ good ones and eschew the bad or inaccurate ones, but skill in manipulation must be forthcoming. All depends on accuracy and care in performing delicate operations, such as weighing, collecting and washing precipitates, and a hundred other manipulations, and the results of many days' work may be in a moment lost by one false step or one careless action.

In all this preliminary work the hand is gradually trained to perform the various mechanical operations, the eye is at the same time taught to observe with care, and the mind to draw the logical inferences from the observed phenomena. Habits of independent thought and ideas of free inquiry are thus at once inculcated; no authority besides that of the senses is appealed to, and no preconceived notions have to be obeyed; the student creates for himself his own material for observation, and draws his own conclusion therefrom. If he is inaccurate either in his manipulation, his observations, or in his conclusion, nature soon finds him out. Something or other is out of order, and he is sent back with the task of finding out his mistake for himself. Not until all this has been accomplished (and very often not then) is the student fit to think about original research. Before he can successfully grapple with new difficulties he must have learned to overcome the old ones. His hand must be dexterous and accustomed to meet all the mechanical difficulties which invariably accompany such investigations; his eye must not only be open to what he expects to see, but, what is far more difficult, it must quickly seize upon the occurrence of phenomena which he does *not* expect to see; his mind, working, perhaps, with a leading thought—for without this, original work is almost impossible—must be free in its power to grasp any new combination of ideas to which the phenomena may suddenly and unexpectually give rise, and be willing at once to relinquish a favourite and cherished hypothesis if the results of experiment prove that hypothesis to be erroneous. This dexterity of hand, quickness and keenness of sight, and pliability of mind must in greater or lesser degree be possessed by all who would undertake original scientific work. I do not mention as a preliminary necessity a competent theoretical knowledge of the phenomena and laws of our science, because, though this is a matter of course, many having this knowledge will altogether fail, owing to their not possessing the other requisites.

In carrying out, then, even the simplest original investigation, some or all of these requirements are needed. In addition, other faculties are called into play by the very fact of the phenomena being in part at least new. Not only do we ourselves not know what to expect, but nobody can tell us what will happen. We are exploring new country, and our outlook must therefore be doubly sharp; we must be prepared for every possible event, and ready to meet every change of fortune. We must, like a traveller, not be discouraged by reverses, but patiently persevere in our course, feeling convinced that the path, which for a long time may be a thorny one, must in due course lead us to a point from which we shall enjoy an extended view of the surrounding country, and be able to trace the tortuous paths by which the elevation was reached. The faculties which are called into active operation in the prosecution of experimental scientific research are, in fact, exactly those which are valuable in the every-day occurrences of life, the proper employment of which leads to success in whatever channel they may happen to be directed. A man who has learnt how successfully to meet the difficulties and overcome the obstacles which occur in every experimental investigation, is able to grapple with difficulties and obstacles of a similar character with which he comes in contact in after-life.

(*To be continued.*)

CONDUCTING POWER FOR HEAT OF CERTAIN ROCKS*

A collection of more than twenty specimens of rocks of the best marked descriptions were chosen for the purpose, and were cut to a uniform shape and size by Messrs. Walker, Emley, and Beall, of Newcastle-on-Tyne, and a part of them were subjected to experiment. The plates are circular, 5 in. in diameter, and half-an-inch thick, and they are as smoothly and accurately ground to this uniform size as was possible in the case of some of the refractory substances as granite, whinstone, &c., that were employed. On the other hand, many more friable and softer rocks, as chalk, coal, marl, &c., are not included in the list of sample sections now collected.

The purpose of the present paper is simply to establish from the experiments the general *bad* conducting powers of the harder rocks, and to corroborate in the case of a few examples that were numerically reduced the conclusions of a similar kind that were obtained by Peclet.

The rock-plate to be tested is placed on a flat-topped tin boiler of its own diameter to raise its temperature on the underside to the boiling-point of water, while on its upper side a conical flat-bottomed tin flask of spring-cold water is placed, and absorbs the heat transmitted through the rock section from its heated side. A thermometer inserted through a cork in this flask marks the rise of temperature and the quantity of heat transmitted through the rock.

A small quantity of heat is also intercepted and absorbed by it which requires a part of the higher temperature on the heated side to introduce it into the rock, but this quantity is so small compared to the quantity which passes through it and enters the water, that it may easily be allowed for by a suitable correction.

The flask above the rock contained about ½ lb. of water, and under the action of the steam heat below, it rose in temperature about 1° in 35 seconds for *slate*, and 1° F. in 38 or 40 seconds for different kinds of hard and close-grained rocks, as granite, serpentine, marble, and sandstone; while the time occupied for a similar rise in temperature was greatest in the case of a specimen of black shale from the coal-measures round Newcastle, when the thermometer rose 1° in 48 or 50 seconds, or *slower than* in the case of slate in the proportion of about 5 : 8.

In this series of trials it was easily supposed that the real temperature of the surfaces of the rock-plates was considerably different from those of the metallic surfaces in contact with them; and a thermo-electric pair of wires attached to cork-faces was now applied to test the real difference of temperatures of the two faces of the rocks. Two platinum wires were twisted on to the two ends of a piece of iron wire and were connected with the poles of a Thomson's reflective galvanometer. The iron wire itself was bent so as to bring its two twisted ends into contact with the opposite faces of the rock. On testing the thermo-electric arrangement by means of a double tin lid placed between its cork-faces, filled with water of different degrees of temperature on its two sides (which were measured by thermometers inserted in the lids), it was found that a difference of between 3° and 4° F. produced a deflection of 1 division of the galvanometer.

On now taking a plate of marble out of the heating vessel and placing it between the thermopyles, it was found that no sensible heat difference was recorded by it; the rock was reversed, top for bottom between its poles, and the effect was still insensible, although the heat of the finger pressing alone on one of the wire junctions moved the galvanometer 3° or 4°. In order to increase the temperature difference the rock-plate was then brought into contact with the metal surfaces by means of mercury; and the thermometric flask itself being filled with about 10 lbs. of mercury instead of ½ lb. of water, it was found that the thermometer rose 1° in 10 seconds, corresponding to a transmission of 330 heat units per hour through a standard plate 1 in. thick, and 1 square foot in surface. When taken out of its cell and transferred to the galvanometer, the temperature difference was now found to be about 7°; giving the rate of conduction about 47 heat units per hour, instead of between 22 and 28 heat units as assigned by Peclet.

The process of lifting the rock out of its cell having undoubtedly produced a loss of the heat difference before the measurement was made; a new mode was' now employed, and the wire junctions were pressed against the rock faces *in situ*, being at the same time protected from the heat of the boiler and thermometer plates facing opposite to them by thick felt wads upon which they were fastened to those plates. In this case a very different variation between the two rock-faces was now found the difference in the case of marble being 50° or thereabouts, while the passage of heat into the water thermometer flask was now about 264 heat units per hour, corresponding to a conducting power of about 5¼ heat units per hour. The same process was applied to two kinds of the black shale already described, and their conducting power was found to be much less than that of the fine-grained marble specimen, being at the rate of only 2 or 2½ heat units per hour. These quantities are not more than ⅛th or ⅒th part of the values obtained by Peclet for the same kinds of rocks. Although time did not permit these experiments to be repeated with a different arrangement of the apparatus, when the sources of error peculiar to each of them would have been easily removed, as their origin in each case is easily explained, yet they confirm provisionally the values of the thermal conductivities found by Peclet; since in two experiments which certainly gave the values alternately in excess and defect, the quantities obtained varied from 5 or 7 to 42 or 47 heat units per hour for a kind of marble to which Peclet assigns 22 or 28 heat units per hour as its conducting power; and in the case of some other rocks of which Peclet describes the conductivity as about half that of the close-grained marble just mentioned, the values found by experiment also indicate a smaller thermal conductivity of these rocks in almost exactly the proportion which Peclet has assigned.

The form in which it will be desirable to repeat these experiments is one which will show the amount and kind of influence exercised by junctions between the surfaces of solid, liquid, and gaseous bodies in retarding the transmission of heat across them; as well as to conclude the actual thermal conductivities of the materials employed, and for this purpose a suitable modification of the apparatus and of the mode of conducting the experiments has been contrived, which it may be expected will fully effect the objects which it is thus intended to obtain.

* Paper read by A. S. Herschel, F.R.A.S., before the British Association, Bradford.

THE DIVERTICULUM OF THE SMALL INTESTINE CONSIDERED AS A RUDIMENTARY STRUCTURE*

THE author took this structure as an illustration in reply to those who are not yet satisfied that structures exist which are useless to the animal body containing them. Referring first to the case of the appendix vermiformis of the great intestine, a survey of the anatomy of the cæcum in various animals, and of the stages of its development in man, leads to the inference that this worm-like appendage is a rudimentary and virtually a useless structure. It has, however, been generally supposed that, being present, it must have some function; and as it was manifest that a thing of this kind at the otherwise closed end of the great intestine is a source of danger by admitting foreign bodies which it could not expel, it has been argued that contrivances designed to avert this danger might be recognised. That it opens at the back instead of at the bottom of the cæcum; that its opening is oblique; that it has a kind of valve; that it is directed more or less upwards; and so on. On the contrary, the worm-like appendix is a vestige, the rudimentary representative of the true cæcum, and all these supposed contrivances by which the danger is lessened are simply the result of the forward and downward development of the great intestine away from the resisting wall of the abdominal cavity against which the appendix and back of the intestine lie. Although from this cause the appendix vermiformis is not nearly so dangerous a structure as it might have been, it is, notwithstanding, occasionally the cause of death. The author knew of several cases of this, and every experienced pathologist must have met with it. Foreign matters get impacted, causing ulceration, and perforation takes place, followed after a few hours by death.

The conclusion, however, that there are parts within the animal body which are useless, and worse than useless because dangerous, is so distasteful to the adherents of the extreme theological school that they will rather fall back on the bare possibility of some unknown function even for such a rudiment. The diverticulum of the small intestine may be employed here to complete the argument. Although in a classification of rudimentary

* Abstract of a paper read by Prof. Struthers, F.R.S.E., of Aberdeen, before the British Association, Bradford.

structures they would be placed in different groups, the one being normal though often varying, the other only occasional, they are on the same footing for the purposes of this argument. It is known to be a vestige of the structure joining the intestine by which, at an early stage of the evolution of the animal frame, nourishment is introduced. All trace of it usually disappears, but occasionally part of it remains as a pouch opening from the small intestine. It has the usual coats of intestine, the inner coat presenting the same food-absorbing villi. It is therefore acting, but no one will argue that it is designed for use in those comparatively few persons who possess it. Unfortunately it is sometimes the cause of death. The author had met with cases of this, and it is well known to surgeons. It may be unable to expel its contents; or by adhering to a neighbouring part a noose is formed, a most dangerous condition, a sort of bowel-trap, through which a knuckle of intestine slips, and strangulation, followed by death, is the result. Here then we have an elaborate structure which is useless, or worse because dangerous. Were a railway contractor to leave open a siding which he had used in the construction of the line, the train might dash into it and a fatal accident result. This is exactly what is done when this diverticulum of the small intestine is left unclosed, and the fatal accident occasionally occurs. Were further illustration necessary we might refer to the fact of disease sometimes attacking that functionless structure the rudimentary breast in the male.

The consideration of such structures as the diverticulum may be said not to take us farther than to clear the ground, showing us that we have been on the wrong path. But a survey of rudimentary structures generally carries us farther. On the hypothesis of the independent origin of species they are unintelligible, while the hypothesis of evolution furnishes a clue to the whole. The facts of embryology, of palæontology, of rudimentary as well as developed structures are harmonised, and the whole present themselves as the result of the operation of a great law, the equivalent in the organic world of the law of gravitation in the inorganic. Although we do not as yet see so well how this biological law operates, the anatomist sees enough to make him feel that he is shut up to some form or other of the theory of evolution, and that the notion which we imbibed in our early years, and have long cherished, that so-called species arose independently of each other, must be a mistake.

The slow progress which this view has made in this country compared with Germany, the author attributed partly to the teleological bias which anatomy early received among us, but mainly to the fact that anatomy has been taught in the medical schools of this country for the most part as a mass of detail in its professional application, without reference to the ideas which it suggests when more widely and profoundly studied as a science.

SCIENTIFIC SERIALS

Ocean Highways, October.—The principal article in this month's number is one by Lieut. Salaverry, of the Peruvian Navy, on the "Navigation of the Upper Amazon and its Peruvian Tributaries," in which he gives some very interesting particulars of the measures that have been adopted by the Peruvian Government to open up and encourage the flow of commerce along the great fluvial highways which connect the rich provinces of the Andes with the Atlantic. The amount of work done by the Peruvian Government during the last few years in the exploration of the region with which the article is concerned is wonderful, and we are sure quite unknown even to many of those who take an interest in geographical discovery. Captain Davis contributes a second article on the *Challenger*, which is followed by one on the Pacific Railways of the South, *i.e.* the Southern United States. Two very interesting narratives are "A Visit to the Kuh-I-Khwajah in Sistan," the place mentioned being a remarkable hill to the west of Naseribad, the chief city of Sistan; and "A Visit to Kuloja," by Mr. Ashton Wentworth Dilke, the plain of Kuloja being "a continuation of the Seven Rivers country running up between the Ala Tau and Thian-Shan Mountains."—Mr. E. G. Ravenstein contributes a paper on "Elmina, and the Dutch Gold Coast;" which is followed by an article on the *Polaris*, the usual reviews, proceedings of societies, &c. There are Maps of the former Dutch Possessions on the Gold Coast, of the Amazonas in Peru, of the Pacific Railways of the South, and a Chart of the *Challenger's* course to the Cape de Verde Islands.

Bulletin de la Société Impériale des Naturalistes de Moscou, No. 3, 1872.—In a paper on tantalum, in this number, M. Herman describes five different combinations of the metal with oxygen, two only having been hitherto known.—There are several zoological and botanical lists,—M. Becker gives an account of beetles and flies met with on a journey to the Astrachan region; Mr. M'Lachlan gives drawings of some new species of Phryganides, and a Chrysopa, found in Finland and the Caucasus; M. Hochhuth enumerates the beetles of Kien and Volhynien, &c., while M. Lindemann furnishes a report on the formation of his herbarium.—M. Lubimoff's paper on a new theory of the field of vision and magnification of optical instruments, has been elsewhere noticed in our columns.

No. 4 (1872) commences with an interesting article, with illustrations, by M. Mayewski, on evolution of the barbules of *Begonia manicata*, showing the various stages from that of simple hairs consisting only of epidermic cells.—Some strictures on M. Lubimoff's views as to the field of vision are offered by M. Bredichin, who thinks the theory neither new nor exact.—M. Hochhuth continues his list of beetles (as also in the following number), and M. Kryloff describes some geological formations in the Government of Kostroma.—Dr. Dreschler communicates an account of a collection of mathematical and physical apparatus in Dresden: and the number concludes with a table of meteorological observation in Moscow, in 1872.

SOCIETIES AND ACADEMIES

LONDON

Royal Horticultural Society, Sept. 17.—General Meeting.—Mr. Henry Little in the chair.—The Rev. M. J. Berkeley called attention to some pears, part of which were cracked and small, while the rest were perfect. They had been taken from opposite sides of the same tree, and the difference was probably caused by injury from wind when in a young state.—Mr. Bull exhibited for the first time *Odontoglossum Roezlii*, a near ally of *O. vexillarium*, and which Prof. Reichenbach suggests may be a hybrid between that species and *O. Phalænopsis*.

Oct. 1.—General Meeting.—Mr. Henry Little in the chair.—The Rev. M J. Berkeley alluded to the numerous interesting and rare species of fungi which were exhibited. *Paxillus atrotomentosus*, sent by the Rev. W. W. Newbould from Woburn; *Russula aurata*, by Miss Hubbard, from Horsham; *Hydnum squamosum*, new to Britain, from Somerset, by Mr. Aubrey Clark; *Cortinarius orellanus*, also new to Britain, from Epping Forest, by W. G. Smith, &c. Mr. Berkeley also referred to Schwendener's theory as to the nature of lichens. Bornet had recently published an admirable paper in support of the same views. He himself, however, was not convinced of their correctness. On the contrary he believed he had seen the gonidia of *Parmelia* originating from hyphæ within the cells of some drift wood from the Arctic regions. He also read a letter from Dr. Thwaites, of Ceylon, who thought that the symmetrical growth of the lichens was an argument against one portion being parasitic on the other.

PHILADELPHIA

Academy of Natural Sciences, June 10.—Dr. Ruschenberger, president, in the chair.—Mr. Gentry made the following remarks:—At the last meeting of the Academy, Mr. Meehan made some observations upon the peculiar structure of the flowers of *Pedicularis canadensis*, observing that he had vainly watched them during two seasons with the view of determining the manner in which they were fertilised. He further said that he had noticed that they received the attention of a species of humble-bee, for the sake of their honey, which, in order to accomplish its purpose, always bored a hole into the side of the tube. On Wednesday morning last, I visited a spot where the plants were growing luxuriantly, affording an interesting field for observation. It was not long before I observed a *Bombus terrestris* to alight upon the outer side of the tube of a flower, at a distance of three feet from me. At this distance it did seem as if the bee in order to obtain the honey which it secretes, produced a slit into the tube, as Mr. Meehan observed. But the movements of the bee being so quick, and the distance too great to judge accurately, I approached the insect by degrees, until I was within three inches of it, when the whole process became apparent. The bee, however, was so intent upon its labours, as not to take any notice of me. The flower is composed of an erect tube, with a natural cleft running along its lateral walls from above, through one-third its entire length, presenting outwardly apparently a mere crease, from the manner in which the compressed margins of the upper lip fit into the rolled-in edges of the lateral lobes of the under lip. The upper lip is compressed, arched, and beaked, presenting an aperture at the apex, through which passes a curved pistil, the lower lip is reflexed, consisting of three lobes, one median and two lateral, assuming a platform arrangement. Enclosed within the upper lip are four stamens, didynamous, with their anthers turning backwards, facing each other vertically. When ripe these anthers split upon the inner side, thus giving a fancied resemblance to an oval snuff-box thrown backwards upon its hinges. Each cell is filled with white pollen grains. Now when the bee alights upon the tube, by means of its trunk, it opens the natural cleft above alluded to, and having thus gained partial entrance, it would defeat its intention did not the length of the flower's tube when contrasted with that of the bee's trunk, necessitate the admission of the entire head also. In this operation the lips of the flower are pressed apart, the margins of the upper lip are separated to receive the head, and the pollen grains, already ripe, by the considerable motion to which they are subjected, become dislodged from their cells, and fall down in a dense shower upon the bee's back and head. Having obtained the coveted sweet, it flies to another flower upon a different stalk, as I observed in a score of cases during two days; but before renewing the preceding operations, stations itself awhile upon the lower lip, its head coming in contact with the stigma of the pistil. Then, by means of the hairs that line the inner side of the tarsus of each interior leg, and the constant rubbing together of the parts comprising its trophi or its instrumenta cibaria the attached pollen grains are sent flying in every direction, sure to adhere to the stigma. Whilst observing the above process, I also noticed that after the lips had been pressed apart, and were permitted to regain their position, the upper lip, being somewhat elastic, sprang back to its place with considerable force, sending through the aperture, through which passes the pistil, a complete cloud of pollen, enveloping the stigma upon every side. This operation can be performed artificially, by taking hold of the under lip with the left thumb and fore-finger, and pulling the upper lip backward, by the right, and then releasing the hold of the latter: the upper lip springs to its place, spirting the pollen through the aperture upon the left hand. From the above it is to be seen, that the plant has two chances of being fertilised—one by its own pollen, and the other by that of another. Although the flower seeds abundantly, yet I am disposed to think that it is mainly through the pollen of another that the seeds become perfect. I incline to this opinion because, in an examination of many pods, I noticed that a few seeds were found in a rudimentary condition, apparently manifesting a tendency to abort, while the majority were in a vigorous condition; the former, doubtless, being the effects of self-fertilisation in part, which, as is well-known, is a degenerating process. I desire also to call attention to an interesting discovery which I was enabled to make recently, whilst engaged in an examination of a double flower of *Ranunculus fascicularis*. In the genus Ranunculus, the corolla of a normal flower is made up of five petals, each of which on the inner side of its basal part is usually provided with a scale. This scale from its position is denominated the *nectariferous scale*. In the specimen under consideration three of these scales had assumed the character of petals, agreeing with the flower's true petals in every particular except size, being but three-fourths the dimension of the latter. It very frequently happens that we find, in examining flowers, parts which we can refer to no organ with which we have become acquainted. They appear to be distinct from any of the whorls which make up a perfect flower, although located among them and attached perhaps to them. All such parts are designated as appendages. Under this category are placed the scales that are characteristic of some species of Crowfoot. Prof. Lindley thinks that these small appendages are barren stamens united to the bases of the petals. This opinion I think is a just one. From the facts here indicated it is reasonable to conclude, that the double flowers of the Ranunculus do not always originate by true staminal metamorphosis, but sometimes by scale transformation; also that nectariferous scales when they exist are barren stamens, which favourable conditions may develop into true petals. Whilst examining several specimens of *Potentilla canadensis* lately, I was struck with the variableness displayed in the number of segments which constituted their outer or calycine whorls. This series in *Potentilla*, as is well known, consists of five sepals, with as many intermediate bractlets. In the specimens to which I refer, I counted from seven to ten bractlets. This numerical variation I am confident results from the splitting, so to speak, of some or all of the primary bractlets, as specimens were observed which exhibited all the transitional forms, from a slight indentation at the apex to partial and complete division.

PARIS

Academy of Sciences, Oct. 13.—M. de Quatrefages, president, in the chair.—The president announced the death of M. Antoine Passy.—The following papers were read:—On crystalline dissociation, by MM. Favre and Valson. This portion of the author's researches deals with the estimation of the work done in saline solutions. Tables of the value of this work were given.—Researches on the ancient fauna of the Island of Rodriguez, by M. Alph. Milne-Edwards.—Verification of Huyghens's law by means of the prismatic method, by M. Abria.—Monograph on the fishes of the family of the *Symbranchidæ*, by M. C. Dareste.—On a mechanical purifier for illuminating gas which will also serve to mix vapour with the gas, by M. D. Colladon.—Researches on the action of the so-called antiseptics on carbuncular virus, by M. C. Davaine. The author found the bodies in question were, as a rule, effective in destroying the virus.—Studies on the *Phylloxera*, continuation by M. Max Cornu.—On the oak *Phylloxera*, by M. Balbani.—Note on a new method of tempering steel, by M. H. Caron. The method consists in quenching the heated steel in heated water, the temperature varying with the size of the article. The author stated that this method augmented the elasticity considerably without altering the softness of the metal.—On the use of potassic disulphate as a means of detecting galena, by M. Jannettaz.—Meteorological observations made in a balloon, by M. G. Tissandier.—New remarks on the epidemic goitre of the St. Etienne barracks, by M. Bergeret.

CONTENTS

Erratum.—Vol. viii. p. 519, 2nd col. last line, for "tonic" read "toxic."