THURSDAY, APRIL 30, 1874

THE FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Association Française pour l'Avancement des Sciences. Comptes Rendus de la 1[re] Session, 1872. Bordeaux. (Paris, 1873.)

THIS, the first volume of the yet young French Society's Proceedings, does it infinite credit. It is a handsome, beautifully printed volume of 1,330 pages, containing upwards of 200 papers, addresses, and lectures on a wide variety of subjects connected with Science, pure or applied. The volume is also well illustrated, some of the plates appended being coloured, a feature which we think the British Association would do well to imitate in its "Proceedings."

The French Association, as our readers no doubt know, made a very auspicious start, the number of members amounting to somewhere about 800. There are two classes of members—1st, *membres fondateurs*, who subscribe one or more shares of the capital of the Association, a share amounting to 500 francs; there are about 250 members of this class, some of whom have subscribed several shares, among the latter being a considerable number of railway and other public companies: 2nd, ordinary members, paying an annual subscription of 20 francs, or a life-subscription of 200 francs; the names of about 50 life-members are in this volume. After an existence of scarcely three months, the Association possessed a capital of nearly 140,000 francs, and an annual revenue of more than 16,000 francs.

The French Association is modelled pretty closely after the older British one, its aim being, according to the rules, "to promote by every means in its power the progress and diffusion of the sciences from the double point of view of the perfection of pure theory and of the development of their practical applications." These ends it proposes to accomplish by means of meetings, lectures, publications, and donations of instruments or money to persons engaged in scientific researches. It appeals for help to all those "who believe that the cultivation of Science is necessary to the greatness and the prosperity of the country."

The Association is divided into four Groups, and each group into several sections; the Groups are—1. The Mathematical Sciences; 2. Physical and Chemical Sciences; 3. Natural Sciences; 4. Economic Sciences. The French Association devotes more attention to the practical application of scientific principles than does the British one; the 1st Group, for example, including Sections of Navigation and of Civil and Military Engineering; the 3rd Group including the Medical Sciences, and the 4th Group Agriculture. This arrangement may at present have some advantages in France, where there are probably fewer special Associations than there are in this country, and because, until the Association gets itself firmly established, it may be advisable to appeal to as many classes of supporters as possible: but we are inclined to believe that it will by and by find that it will serve the cause of Science more effectually by confining its attention to the pure sciences.

In points of administrative detail, the French follows very closely the British Association. One of its rules ordains that each year the capital fund be increased by 20 per cent. of its revenue. If it prospers in the future as it has done hitherto, we have no doubt that it will soon have a very large sum at its disposal.

As we noticed pretty fully the proceedings of the Association at the time of its meeting at Bordeaux in September 1872, it is unnecessary to notice in detail the papers contained in the volume before us. There will be found in its pages the names of many of the most prominent men of Science in France, and a few belonging to foreign countries, among the latter being Sir Benjamin Brodie and Dr. Gladstone. Two of the published lectures have been published in NATURE *in extenso*—that of M. Janssen on the Eclipse of December 12, 1871, and that of M. P. Broca on the Troglodytes of the Vézère.

M. de Quatrefages, the first President, in his eloquent and powerful opening address, speaks very highly, and we would fain hope with justice, of the work which has been done by the British Association. "Thanks to it," he says, "a part of the population has been reformed. The sons of those fox-hunters, who, as a relief from their rude pastimes, only knew of joys equally violent and material, are now botanists, geologists, physicists, and archæologists."

The President's impressive words as to the sphere of Science at the present day are well worth quoting:—"Science is at present everywhere; she is becoming more and more the sovereign of the world. What industry can dispense with the aid of mechanics, and is there any industry which would wish to be bound to the progress already realised by that Science? Is there one which would despise the help of Chemistry? What physician, worthy of the name, would consent to dispense with physiology, that complex science, daughter of chemistry? with physics and with mechanics, any more than with anatomy? What enlightened agriculturist does not understand that the problems of culture and of production are essentially questions of zoology, botany, geology, and chemistry? And in this great city (Bordeaux), one of the queens of universal commerce, what merchant will deny the importance of geography? Science is as indispensable to the military man as to the manufacturer, the physician, the agriculturist. Certainly I am far from denying the part which in war will always fall to courage, to inspiration. But inspiration must be enlightened by study; bravery must be furnished with arms equal to those of the enemy. Revive in imagination Renaud de Montauban or the Roland of legend; place them upon Bayard or Frontin; cover them with their enchanted armour, and dart them against a simple mechanic mounted upon his locomotive. You all know what will be the result of the shock: coursers and paladins will be brayed."

It will be remembered that the first meeting of the French Association took place while the country was yet sore with the humiliation inflicted upon it by Germany; and very naturally the address of the President, as well as the addresses of many others who spoke, took their tone, to some extent, from this condition of affairs. Still the character of these addresses, though intensely patriotic, is perfectly healthy, the various speakers showing that they possessed a clear perception of the most effectual means of raising and advancing their fallen country; they read aright the lessons of the recent war, and declared that Science alone, in its widest acceptance, could be the saviour and elevator of France. And, indeed, there is the greatest hope of a country that has produced men, and that in so great numbers, capable of doing the work the results of which are chronicled in the handsome volume before us; for we are persuaded that this first volume of the French Association's Proceedings will compare favourably with any single volume of the Proceedings of the British Association. The meeting last year at Lyons fully bore out the promise of the first meeting, and we have no doubt that this year's meeting at Lille will be at least equally successful. Let the members of the Association only do all in their power to keep up its high character and carry out faithfully its declared objects, and the beneficial results of its establishment both to Science and to France will, ere long, be evident. As it is, partly no doubt owing to the work of the Association, Science since the conclusion of the Franco-Prussian war has taken immense strides in France; everything taken into consideration, the amount of scientific activity which has recently been developed in that country is very wonderful, and calculated to call forth the gratitude of the friends of science and humanity.

NORTH AMERICAN BIRDS

A History of North American Birds. By S. F. Baird, T. M. Brewer, and R. Ridgway. Vols. i. ii. and iii. Land Birds. (Little, Brown and Co., 1874.)

THE ornithologists of the United States appear to be not less active than those of this country at the present moment. Whilst here we have Gould's "Birds of Great Britain," Dresser's "Birds of Europe," and Newton's new edition of "Yarrell," all appearing at the same time, so in America Coues's "Key" and Cooper's "Birds of California" are quickly followed by the present important work on the whole of the North American Ornis. For this undertaking Prof. Baird, the well-known Assistant-Secretary of the Smithsonian Institution, has obtained the assistance of two very efficient coadjutors, Dr. T. M. Brewer, of Boston, and Mr. Ridgway, already well known for his accurate work in ornithology.

The object of the present work, which aims at a wider grasp than any of its predecessors, is to give an account of what is known of the birds, not of the United States only, but of the whole of the Continent of North America north of the Mexican boundary. Greenland is included on the one side, and the newly acquired United States territory of Alaska on the other, so that many European and Asiatic forms, which have been lately discovered in these two countries, are now for the first time added to the American list.

The materials upon which this undertaking is principally based consist of the very extensive collections of birds from every part of the New World, in the Smithsonian Museum at Washington. The numerous expeditions for exploration and survey sent out of recent years by the Government of the United States into nearly every portion of their enormous western domain have been invariably accompanied by one or more collectors whose contributions have all been deposited in the stores of the Smithsonian Institution. But besides their collections these investigating naturalists have reaped a rich harvest of facts concerning the life-history of the creatures they have collected, and have deposited their records and journals also in the Smithsonian Archives. From these manuscripts, particularly from the notes of the late Mr. Robert Kennicott, who made most extensive explorations in Western America and in the most northern portion of the Hudsons Bay Territory, many of the most novel facts recorded in the present work have been drawn.

The special value of the researches of Mr. Kennicott and his fellow-workers in the north-west lies in the fact that a large number of the rapacious birds and water-fowl of North America resort in summer to these thinly-populated districts for the purpose of breeding. Their haunts, not having been previously invaded, much novel information on the nesting habits of the members of these two groups is for the first time published in this work.

Besides Messrs. Baird, Ridgway, and Brewer, whose names appear on the title-page, we are informed in the preface that two other well-known American naturalists have contributed to the present work—Prof. Gill having furnished a portion of the introduction, and Dr. Coues the tables of the orders and families.

The work is profusely illustrated by woodcuts, besides containing a series of illustrations of the heads of all the species, drawn upon separate plates. The woodcuts contain the outlines of the principal characters of every genus, embracing the shape of the bill as seen from above and from the side, the comparative lengths of the wing and tail feathers, and the outline of the tarsus and toes; besides reduced but well-executed and highly-characteristic whole figures of many of the species.

The tendency of the American ornithologists of late years has been rather to unduly augment the number of species by raising slight local variations in form and structure to specific rank. In the present work rather the opposite tendency is manifested, and we are not sure that it is not in some instances carried too far. For instance, the whole of the Purple Martins, of the genus *Progne*, recently divided by Prof. Baird into seven or eight species, are now treated of as one; and the different species of Redpole Linnets of Dr. Coues are again reduced to their primitive number. As, however, the distinctive characters, such as they are, are invariably stated with accuracy and precision, it does not really make much difference whether the forms are actually classed as species or varieties.

The three volumes of this elaborate work now before us contain the whole of the Land Birds. A fourth volume, shortly to be issued and to be devoted to the Water Birds, will complete the undertaking. There can be no doubt, as will be at once apparent to anyone who consults the work, that it is of a most complete and exhaustive character, and that it will fully sustain the well-known reputation of Prof. Baird and his fellow-labourers.

OUR BOOK SHELF

Our Common Insects. By A. S. Packard, jun. (Naturalist's Agency, Salem, Mass.)

IN this fully illustrated little work Mr. Packard, the author of the excellent and much larger "Guide to the

Study of Insects," gives a short and popular account of entomology generally, by taking a series of types from amongst the best-known North American insects, and describing them in detail. We should have liked to find some of the descriptions rather more explicit, as they might have been, without any alteration in the size of the volume, if some of the illustrations had not been so frequently repeated. In a work like Euclid there is no doubt considerable advantage in having the figures so placed that it is not necessary to turn over the pages in referring to them, especially when it has to be read by boys; but when space is short and the subject of such general interest, we cannot help feeling that their repetition, three times in more than a single instance, is quite uncalled for. The author's own work at the development of Insecta, which he has published in the "Memoirs of the Peabody Academy of Science," enables him to take a larger view of his subject than that held by most. This is particularly indicated in the very suggestive chapter entitled "Hints on the Ancestry of Insects," in which the researches of Ganin, Lubbock, Brauer, Haeckel, and Müller are all brought to bear on such questions as the relation of the *Zoea* form of the embryonic Crustacean to the similarly undeveloped and generalised, here termed *Leptus*, form of Insecta, in which the configuration is ovate, the head is large, bearing from two to four pairs of mouth-organs resembling legs, and the thorax is merged with the abdomen; this general embryonic form characterising the larvæ of the Arachnida, the Myriapods, and the true Insects. The elaborate observations of the first-named of these authors on the development of *Platygaster error*, an ichneumon parasite, in the author's mind tend to confirm the theory held by him that the ancestry of all the Insects, including the Arachnids and Myriapods, should be traced directly to the worms. We recommend this small book to all interested in the progress of this branch of invertebrate zoology.

The Transactions of the Academy of Science of St. Louis, vol. iii. No. 1. (St. Louis, U.S., 1873.)

THIS volume contains a journal of the proceedings of the Society from March 1868 to January 1873, and a few papers *in extenso*. The latter are:—Notes on the Genus *Yucca*, by G. Englemann; On the new Genus in the Lepidopterous Family Tineidæ, with Remarks on the Fertilisation of the *Yucca*; and Supplementary Notes on *Pronuba yuccasella*, by C. V. Riley; Descriptions of North American *Hymenoptera*, by B. D. Walsh; Atmospheric Electricity, by Dr. A. Wislizenus, being the yearly report of atmospheric electricity, temperature, and humidity, from observations made at St. Louis; Catalogues of Earthquakes for 1871, by R. Hayes; and On the Occurrence of Iron Ores in Missouri, by J. R. Gage. Mr. Hayes, on the basis of the recorded earthquakes from 1739 to 1842 has found that the "largest maxima occurred in the years of the heliocentric conjunction and opposition of Jupiter and Saturn, with but three exceptions, and in these cases the increase began in those years, but the maximum was not reached till the following year." He suggests that "these planets induce electric currents which *call into action* those forces to which the causes of seismic phenomena are usually ascribed."

LETTERS TO THE EDITOR

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

Herbert Spencer and *à priori* Axioms

MR. HERBERT SPENCER (vol. ix. p. 461) has "ended what he has to say on the vexed question of the origin of physical axioms" by laying down—

(1) That "the perceptions and inferences of the physicist cannot stand without *preconceptions which are the products of simpler experiences than those yielded by consciously-made experiments.*"

(2) That "the preconception which immediately concerns us is the exact quantitative relation between cause and effect."

(3) That "if definite quantitative relations between causes and effects be assumed *à priori*, the Second Law of Motion is an immediate corollary."

By speaking of it as an "*immediate corollary*," I presume that Mr. Spencer means that Newton's Second Law of Motion is the proposition obtained by substituting for the general term, *cause*, the particular term, *force*, and for the general term, *effect*, the particular term, *motion generated*; so that, according to Mr. Spencer, this law simply asserts "a definite quantitative relation between a force and the motion generated by that force." But surely the quantitative relation asserted by Newton is not only *definite*, but is further the *special* relation of *proportionality*; so that, if the law is an immediate corollary of an *à priori* assumption, the assumption must be that "the exact quantitative relation between cause and effect is that of direct proportionality," or in more familiar words, that "effects are proportional to their causes." Perhaps this is what Mr. Spencer meant to assert. At any rate let us admit it as a definite basis for reasoning, and endeavour to deduce some consequences from it.

"The cause of a stone falling when left to itself is its weight; but 'the greater the cause, the greater the effect,' therefore the greater the weight of the stone the more quickly will it fall, and thus of two stones let fall from the same height, the heavier will reach the ground sooner than the other." Something of this kind, it may be presumed, was the argument of Aristotle and his followers before the age of Galileo: and how on *à priori* principles is it to be refuted? Of course it is disposed of at once by the simple observation that the same force does not produce the same motion in different masses: but independently of some such observation or experiment, it seems to me impossible to deny that it *may be* true, though even an *à priori* philosopher might show that, as other alternatives are conceivable, it is not *necessarily* true. As a matter of historical fact, Galileo refuted it once for all by the "consciously-made experiment" of letting two different weights fall simultaneously from the leaning tower of Pisa.

But it may be said that the above argument is hardly "*definitely* quantitative." Let us then examine Newton's Second Law of Motion as an "immediate corollary" of our *à priori* assumption. Here the cause is "the motive force impressed," and the effect "the alteration of motion." But then the question arises—how are the quantities of this cause and effect to be measured? Newton carefully defines quantity of motion as proportional to *mass* and *velocity* jointly; that is, he measures it by *momentum*. From another point of view it would have been correct to measure quantity of motion by *kinetic energy* or *vis viva*, that is, as proportional to mass and the *square* of the velocity jointly. Further the "alteration of motion" might be measured either with respect to a given time or to a given space. Newton implies the former, and consequently the explicit statement of his second law is that "the *momentum* generated *in a given time* by an impressed force is proportional to that force." Substitute for this "the momentum generated in moving through a *given space*," or "the *kinetic energy* generated in a given time," and the law becomes untrue. Substitute "the *kinetic energy* generated in moving through a *given space*," and we have a law which is true, but not that which Newton asserted as his second law. Now among these four alternatives how is our *à priori* philosopher to decide? He might perhaps analyse them further and show that some of them are inconsistent with the others, and I believe he might reduce the questions to be decided to still simpler ones; but I fail to see (in common, I believe, with everyone who has thoroughly grasped the fundamental principles of rational mechanics) how, without recourse to consciously-made observations or experiments, he could arrive at a certain conclusion.

May we not say then that these great *à priori* principles, whatever value they may have in a "System of Philosophy," are of little avail in any special science, and that the "axioms" of such science, however much they may involve these principles, are not mere "immediate corollaries" therefrom?

If not intruding too much on your space, I am tempted to apply to Mr. Spencer's great principle of the "Persistence of Force" the same mode of treatment as I have applied above to the principle that "effects are proportional to their causes."

Mr. Spencer distinctly refuses to identify this principle with the great physical principle of the Conservation or the Persistence of Energy, the firm establishment of which undoubtedly marks one of the most important epochs in the history of Science. Force, in Mr. Spencer's use of the term, includes numerous species of which energy is but one. I feel sure that every mathematician and physicist would protest against the inclusion under one term of magnitudes of such different kinds as statical force and energy, or the work done by such a force; but not to dwell on this, I believe that Mr. Spencer would certainly acknowledge as one of his species, that which (in my view) is alone properly termed Force, namely, such as can be measured in terms of the weight of a pound or a gramme. What then does Persistence of Force of this kind mean? Does it mean that the numerical sum of the intensities of all the Actions and Reactions throughout the universe is constant? If so, it is untrue: for, to take a simple illustration, if a weight be supported, first by a single string, and then by two strings not vertical, the tensions are quite different in the two cases, and there is no equivalence between those which disappear, and those which are introduced in passing from one to the other. If not, we must take account of the *directions* of our forces, and then, if it mean anything, it appears to be but the expression of Newton's Third Law that "action and reaction are equal and contrary" in this form:—"The algebraical sum of all the forces throughout the universe is persistently zero." To every mathematician, at any rate, this assertion and the assertion that "the sum of the energies of all kinds throughout the universe remains persistently of the same definite numerical amount" are assertions of facts of such different orders, that to class them together is rather to introduce confusion of thought than to establish a grand general principle.

I have offered the above remarks because it appears to me only fair to the author of the article on Herbert Spencer in the *British Quarterly Review* to show that it is felt by others, who have made a study of the fundamental principles of rational mechanics, that his strictures on Mr. Spencer's treatment of those principles are in all essential points fully justified, however much they may wish that the expression of those strictures had been in some instances modified in its tone.

The Park, Harrow, April 20 ROBERT B. HAYWARD

I THINK it is positively due, not only to the writer of the now famous article in the *British Quarterly Review*, but to Newton's memory and to Science itself, that the correspondence which has been going on should not seem to terminate as a drawn game, at any rate in the opinion of some bystanders, who may from their antecedents be presumed competent to judge.

That Mr. Spencer will ever be convinced is, I suppose, hopeless; I at any rate am not going to try to convince him. But I can assure the *British Quarterly Reviewer* that he has my very deepest sympathy in his argument with an antagonist who is at once so able a master of fence as Mr. Spencer, and yet is so intensely unmathematical, it would seem, as to pass from "exact quantitative relation" to "proportionality;" or as to talk of the effect of a force, without defining how the effect is to be measured, without feeling the slightest difficulty.

Nor does it seem that Mr. Frankland, in NATURE, vol. ix., p. 484, is quite justified in his conclusion that the truth lies *between* the two opposite views. And his own view is in fact entirely coincident with the Reviewer's, except, perhaps, on a point which is not relevant to the controversy, viz. how far the experimental proof of the so-called physical axioms is *complete*.

Will it comfort the Reviewer if I tell him some of my own experience? I, too, read Spencer after my degree; and on the first reading of the "First Principles" came to the sad conclusion that I had not understood any mathematics properly; so much fresh light seemed to be thrown on them. I read it again, and more critically, and doubted whether Spencer was quite correct. I read it again, and concluded that he was wrong in his physics and mathematics. I ought to add that I too was, like the Reviewer, A SENIOR WRANGLER

I AGREE so fully with the chief contents of Mr. Frankland's letter (vol. ix. p. 484), that I wish to call his attention to one point in which his letter seems to me calculated to mislead.

He says, "the pure empiricists argue that because certain observed results coincide with the results of calculation, therefore the assumptions on which the calculation was based must be true. Now without doubt the *demonstrative* character of this inference vanishes entirely under Mr. Spencer's searching criticism. But it seems to me that a *high probability* remains."

Now, in the name of pure empiricists, I must protest against our being supposed to think that anything "must be true" in any other sense than that there is a "high probability" of its truth. I cannot refer to a better exponent of our views on this point than Prof. Clifford, to whom Mr. Frankland himself refers. And the idea of our having to thank Mr. Spencer for showing that the inductive proofs of the laws of motion (or of any other physical truths) are not *demonstrative* in any other sense than the above is quite new to us. What Mr. Spencer has done is to bring up instances of this so-called imperfectness in the demonstration as evidences that no *à posteriori* proof of the proposition can exist, when in point of fact they are specially characteristic of such a proof.

Those of your readers who have examined Mr. Spencer's ingenious proof of the second law of motion, contained in his last letter to NATURE (vol. ix. p. 461), will not ascribe my not immediately answering his letter to any difficulty in so doing.

THE AUTHOR OF THE ARTICLE IN THE BRITISH QUARTERLY REVIEW

Lakes with two Outfalls

IN NATURE, vol. ix., p. 485, Mr. Craig Christie begins a letter "to correct a mistake as to a matter of fact:" "Loch-na-Davie, Arran, has *two* outlets, as is correctly represented in the Ordnance map;" and he ends his letter: "I think Colonel Greenwood ought at least to have made himself acquainted with the Ordnance map."

I take the liberty to enclose to you the new Inch Ordnance map of Arran, to which my letter in vol. ix. p. 441 referred. You will see that as "a matter of fact" the map does *not* give two outlets, but only one.

I need not ask for your valuable space in reference to Mr. Christie's own "matters of fact," since my views with reference to them are printed in the *Athenæum* of July 22, 1865. He will see there that I have not only "walked up the north stream from Loch Ranza," but also by Glen Catacol and Glen Dzeven, and a third time from Corrie by Glen Sannox over the water-parting. Also that I have sounded the whole of this little pool of bog-water by walking it, bare-legged, without being over my knees in the deepest part, which was at the south end, where the only outlet is to Glen Iorsa.

I shall have the pleasure to communicate with Mr. Thelwall in reference to his obliging letter.

GEORGE GREENWOOD

[The Ordnance map forwarded to us by Colonel Greenwood gives only one outlet to Loch-na-Davie.—ED.]

AS this subject appears to me to possess an interest apart from the issues hitherto in question, I trust you will allow me a little of your space.

From the fact that lakes do not ordinarily occupy the crest of a watershed, it would *à priori* appear more likely that a double outfall, if it exist, should lie in or towards adjacent districts than connected with opposed valley systems. The following instance, which I observed in Norway last summer, is, in view of Colonel Greenwood's letter (NATURE, vol. ix. p. 441), worth mentioning. The lake exhibiting it lies about two miles inland (N.W.) from the elevated coast which faces Trondhjem, and is named Stor Lake; its length—nearly parallel to the Trondhjem fjord—is about seven miles, its greatest breadth about two. Like many Norwegian lakes, it presents a *facies* different to what we are most familiar with in Britain. Instead of occupying a single valley-basin, it consists of a chain of minor basins strung along an axis of depression (probably a pre-existing valley), and each separated from its neighbours by the subsided walls of the valley of which it is the cup-like enlargement. The form of Stor Lake is irregular, with long arms or creeks extended (obliquely to its longer axis) into the mouths of the valleys. In such lakes it might be expected now and then that the effluent waters should pass out at more than one of these channels, and in Stor Lake such is the case. One stream is discharged from one of the component basins, nearly at right angles to the lake's greatest length, the other issues along the depression on which I have said the basins are "strung"—bead-like. The former opening is of post-glacial date, and is superseding the original one for several reasons:—(1) it flows along the strike of a homogeneous bed of schist, whereas the other cuts across beds of various textures, and (2) its volume is greater. Its rival bears evident traces of progressive attenuation, and is not marked on any published map.

In this case the streams are nearly at right angles to each other when discharged; another instance, however, seems to be furnished in a neighbouring loch, Grön Lake, in which they are collateral. Krefting's map (1868) represents the loch as bifurcating at its north-east end, each of the inlets giving rise to a stream; they seem about two miles apart, are marked by lines of about equal thickness, and flow nearly parallel to the Trondjhem fjord near Mosvigen.

I believe that instances of a like nature with these are by no means rare in Norway. I know at least one lake near Trondjhem, which at a former period seems to have had a double outfall, and many others in which, were the existing outlet dammed by a moraine twenty to fifty feet high, the water would find one or several openings elsewhere.

I have indeed noted several instances of lakes with two outfalls upon Prof. Munch's large map of Norway (1845), but failing to discover any confirmation in other maps, and finding it in other respects unreliable upon matters of such detail, I can assign no value to them.

It would be a fact of curious significance, as bearing upon Prof. Ramsay's theory of the glacial origin of lakes, if most authenticated instances of lakes with several outfalls could be referred to districts which have been traversed by a continuous sheet of glacier ice. When glaciers were confined within valley boundaries, as in Britain, their force was of necessity concentrated along lines, but upon level tracts or plateaux they were free to scoop wherever circumstances favoured erosion. Should it prove that Norway, North America, and Lapland give us the majority of lakes with several outfalls, no other theory can explain the fact.

St. James's Park, S.W. HUGH MILLER

Trees "Pierced" by other Trees

COLONEL GREENWOOD'S answer (NATURE, vol. ix. p. 463) to Mr. J. J. Murphy encourages me to mention a botanical phenomenon which I witnessed in 1865, but have scarcely ever mentioned before for fear of being disbelieved. I was standing on the bank of the little river Evenlode, in Oxfordshire, looking at an old pollard willow trunk about six feet high, when I observed in the decayed wood of the tree an upright sort of staff resembling a dark-coloured old school ruler, and of about that size. I knocked away some of the touchwood above and below, and found my ruler lengthened each way. At the point where it would naturally issue at the top, I found a small twig of undoubted ash, of which the leaves were fully expanded, sprouting up among the branches of willow. Upon clearing away a little more rotten wood I laid bare another ruler, which, like the first, appeared to lengthen upward to the top of the trunk and downward to the ground, but there was no second twig of ash above. The "rulers" were rough where they were totally enclosed by the willow, and had put forth little threadlike rootlets. But the part which I found exposed to the air was smoother and looked like a true branch, but was darker than the usual colour of ash. I afterwards drew the proprietor's attention to the tree, but he could not suggest any explanation. I daresay it is there and in the same condition to this day; if anyone wished it, I could easily describe where it might be found. One explanation I have had offered is, that an ash-seed had fallen down a deep crack in the willow. But there was no sign of such a crack—no crack-like cavity—one of the "rulers" being totally and closely enveloped with the rotten wood, and the other very nearly so. Whether it would have been possible for an ash-seed to germinate in a crack which must have been at least four feet deep and probably much deeper, and was open at the top only and was certainly no larger than the shoot which it formed, is a question I must leave to botanists. Another explanation was, that as ash-roots travel for a considerable distance underground, it was possible that two such roots, finding suitable pabulum in the rotten trunk of the willow, had turned upwards. But this also I must leave to men of science, and notably to Col. Greenwood. T. S.

PROF. TAIT ON "CRAM"

ON Wednesday, the 22nd inst., at the ceremony of capping the Graduates in Arts of Edinburgh University, Prof. Tait gave an address in which he touched on various subjects of Academical interest. On the subject of "Cram" he spoke as follows:—

"It is a mere common-place to say that examination, or, as I have elsewhere called it, artificial selection is, as too often conducted, about the most imperfect of human institutions; and that in too many cases it is not only misleading, but directly destructive, especially when proper precautions are not taken to annihilate absolutely the chances of a candidate who is merely crammed, not in any sense educated. Not long ago I saw an advertisement to the effect:—'History in an hour, by a Cambridge *Coach*.' How much must this author have thought of the ability of the examiners before whom his readers were to appear? There is one, but so far as I can see, only one, way of entirely extirpating cram as a system, it may be costly—well, let the candidates bear the expense, if the country (which will be ultimately the gainer) should refuse. Take your candidates, when fully primed for examination, and send them off to sea—without books, without even pen and ink; attend assiduously to their physical health, but let their minds lie fallow. Continue this treatment for a few months, and then turn them suddenly into the Examination Hall. Even six months would not be wasted in such a process if it really enabled us to cure the grand inherent defect of all modern examinations. It is amusing to think what an outcry would be everywhere raised if there were a possibility of such a scheme being actually tried—say in Civil Service Examinations. But the certainty of such an outcry, under the conditions supposed, is of itself a complete proof of the utter abomination of the cramming system. I shall probably be told, by upholders of the present methods, that I know nothing about them, that I am prejudiced, bigoted, and what not. That, of course, is the natural cry of those whose 'craft is in danger'—and it is preserved for all time in the historic words, 'Thou wert altogether born in sin, and dost thou teach us?' I venture now to state, without the least fear of contradiction, a proposition which (whether new or not) I consider to be of inestimable value to the country at large:—Wherever the examiners are not in great part the teachers also, there will cram to a great extent supersede education. I need make no comment on this, beyond calling your particular attention to the definite article which twice occurs in the sentence, and which gives it its peculiar value.

"I said, in my former address [eight years ago], that 'coaching' seems quite natural to all who are engaged in it, and, in particular, that it did so to myself more than twenty years ago. This shows that it is possible that something akin to the results of the profound speculations of Riemann, Helmholtz, and others, may hold in the moral if not in the physical universe. It is probably new to most of my audience to hear that very great authorities are as yet in doubt whether the properties of space itself are the same in different localities; whether, in short, in our rapid flight through space, we may not be insensibly getting into a region, our existence in which will involve a gradual change of form, in order that our physical substance may continue to fit the varying circumstances of our position. Assume that something like this holds in the world of mind, and you see at once how the same man may, while residing in Edinburgh, honestly denounce certain methods as wholly pernicious which a few years' residence in Cambridge may invest in his eyes with a perfection more than human. I do not say that this is an explanation; but the analogy is at least worthy of remark; and I leave further discussion of it to my old friend Mr. Todhunter, who, living in the middle of that singular region, tells me he thoroughly agrees with me in my main arguments against examinations, and then soundly rates me for my mode of propounding them."

After advocating the restoration of the B.A. degree to Edinburgh University, Prof. Tait spoke in forcible terms against the centralisation of our various Universities, Licensing Boards, &c, "with its inevitable acolyte cram." He illustrated in an original and striking way what he thinks would be the inevitable result of centralisation, by referring to the dead and motionless uniformity which must be the result of the degradation of energy. Prof. Tait drew a ludicrous yet melancholy picture of what would be the results of universal uniformity in the social world.

"The application of these ideas," he said, "to political and social questions, among which of course comes University centralisation, is not far to seek. What would the world of men be without what we may call 'social entropy'? Everyone would then be his own farmer, baker, butcher, brewer, banker, boot-black, &c.—all would be at the same dead level—no possible help from one to his neighbour, even if it could be required; no distribution of tasks, and therefore (in every department) that endless waste which is inevitable in operations conducted on a petty scale. No possibility of that mutual reliance and assistance which forms the friendships we delight in, none of that variety which is the real charm of life—no idea which would not simultaneously strike every unit of the race—no news, no books—nothing but sameness! None of the pleasure of being able to assist struggling worth, none of gratitude for generous aid. Nay, we might pursue it further. No difference of temper, character, tendencies, age, sex—a state lower than the lowest known in vegetation; but here the end must come. Or, to take a somewhat different point of view (though the basis is absolutely the same, for oscillation implies entropy), what if everything were always at its average value? Never absolutely either fair or rainy weather, clear or cloudy, calm or stormy, hot or cold; but a dead average. Never either absolutely day or night; no tides, no seasons; men never either absolutely awake nor absolutely asleep—continually in a semi-lethargic state—half happy, half discontented; half playful, half serious—neither running, walking, standing, sitting, nor lying, but a perpetual average. No catastrophes such as a birth, a marriage, or a death—no distinction between man and man—nothing of that variety which is the law of nature. Eternal, hideous, intolerable sameness, by necessity devoid of all capacity for action: the human race turned into a set of Nürnberg toy-solders, all cast in the same mould, of the same base material, and all similarly bedaubed from the same glaring paint-pots, and moving on the same lazy-tongs with the same relative velocities. No one to advise you in a difficulty, no one in whose superior strength of mind or body you could confide; nothing around you except what you feel must be but the image of yourself (as you will early have learned introspectively to look at it)—mean, sordid, and grovelling! No one whom you can respect, none to trust—all, like yourself, vile and despicable! Here I would gladly say—'Enough of such horrors,' and quit the disgusting theme. But, unfortunately, the application has still to come. It will be found very pertinent to many things which have been of late evolved from the innermost consciousness of statecraft, and hailed, with altogether inexplicable delight, by what seemed (till lately) to be at least a numerical majority of the representatives of our countrymen."

Prof. Tait then referred to the late Prof. Forbes and the recent discussion concerning his character and work. For what Prof. Tait has to say on this subject we must refer our readers to his address, which is printed in full in the *Scotsman* of the 23rd inst. He then spoke of the scheme for extending Edinburgh University, and the facilities which would thereby be acquired for teaching Science practically, as it ought to be taught, and thus tend to extinguish "paper-science," a term which "conveys to all who are really scientific men an impression of the most unutterable contempt." In conclusion, Prof. Tait referred to the difficulties attending the work of his own class, that of "Natural Philosophy," arising from the want of adequate means. He hopes to be able, at least, to put the Natural Philosophy Department in Edinburgh University on a proper footing for his successor.

THE SOIRÉE OF THE ROYAL SOCIETY

ON Wednesday, April 22, the first soirée of the Royal Society since their removal into their new apartments was given by the President, Dr. Hooker, and came off with the greatest *éclat*. There was a remarkably good display of scientific apparatus, and we think that the interdependence of theman of Science and of the manufacturer of instruments is at no time better exemplified than on occasions like the present. The apartments devoted to the purposes of exhibition were thronged by the most eminent in the various branches of Science—it might have been said with reason that a considerable fraction of the nation's mind had centred for the time being in the rooms at Burlington House. Not as an unhealthy sign either did we regard the presence of Archbishop Manning and the attention shown towards that divine by scientific men of the very opposite poles of thought.

Of the objects of interest displayed in the six rooms devoted to this purpose we can here only give details of the more prominent. In the first room several maps and photographs were exhibited by the Royal Geographical Society: also some splendid pieces of glass-work by Messrs. Chance, consisting of a dioptric fixed light (4th order) with nine prisms and six rings of lenses in four panels, a segment of a dioptric totally reflecting mirror first proposed by Mr. Thomas Stevenson, C.E., a dioptric holophote designed by the same engineer, and a lamp-burner designed by Mr. J. N. Douglass, C.E., with six concentric wicks. This burner can be used either for colza oil or for petroleum. The President exhibited also in this room some interesting objects from the Kew Museum. Amongst these we noticed some fossil copal gums from Zanzibar, carved cocoa-nut shells from the Fiji Islands, a vase made from the ash of *Moguilea utilis*, mixed with clay, from Parà, and different chemical and medical products from species of *Eucalyptus*.

In the second room Mr. Crookes exhibited his experiments showing the attraction and repulsion accompanying radiation. The pendulum described by Mr. Crookes in his communication to the Society was exhibited under various forms, and the experiments excited the liveliest interest. Here also Dr. C. J. B. Williams exhibited some new ear-trumpets, and Messrs. Whitehouse and Latimer Clark an electrical recorder for registering time, speed, distance, and number of passengers inside and out in tram-cars and omnibuses. This information is registered in four parallel columns in red ink on long strips of paper, by automatic pens.—Mr. Vernon Heath exhibited some autotype landscapes, and the president some Tappa dresses from Fiji, which reminded us strongly of the ornaments placed in our fire-stoves during the summer. Here also we were shown a microscope by Messrs. Powell and Lealand, with a $\frac{1}{50}$ immersion objective and the eternal Podura scale.

In the third room, the Entrance Saloon, were some exquisitely coloured drawings of the flora of Brazil, and landscapes by Miss North; likewise some coloured drawings of New Zealand birds, exhibited by Dr. W. Lawry Buller. The pair of new Paradise Birds collected by Signor D'Abertis* in New Guinea, promised by Dr. Sclater, was not exhibited.

In the fourth room, the Reading Room, Dr. Tyndall exhibited the apparatus (already described in our columns) for showing the stoppage of sound by a non-homogeneous mixture of air and vapours, and also experiments illus-

* See NATURE, vol. viii. p. 305.

trating Savart's observations on the action of sound on a jet of water. Dr. J. H. Gladstone exhibited some photographs of fluorescent substances. Bottles containing fluorescent liquids, such as æsculin or quinine di-sulphate, appear in the photographs nearly as black as a bottle filled with ink; similarly, labels written with such liquids, although the characters are ordinarily invisible to the eye, show up their designs when photographed. In this room were to be seen also photographs of the Naples Aquarium, exhibited by Mr. W. A. Lloyd, and one of Dr. Dohrn's Zoological Station at Naples, lent by Mr. Darwin; likewise some lithographed plates of recent Foraminifera from the Abrolhos Bank, exhibited by Profs. W. K. Parker and Rupert Jones. Mr. J. Norman Lockyer exhibited a series of photographs of metallic and solar spectra enlarged by Messrs. Negretti and Zambra from photographs taken by his new method of comparing spectra by means of a perforated shutter sliding in front of the slit of the spectroscope. In this room the new sextant devised by Capt. J. E. Davis was exhibited. This instrument, which will be found particularly useful in night observations, permits the taking of a series of observations without reading off each observation; this being accomplished by the adaptation of a micrometer movement to the tangent-screw, and the application of indicators to the arc of the instrument. Mr. Alfred Tribe here exhibited some specimens of metals (palladium, copper, &c.) which had become agglomerated in a most remarkable manner by hydrogenisation; under ordinary circumstances the metals shown existed in the form of fine powders, but, as soon as charged with hydrogen, become agglomerated.

The fifth room, or Principal Library, is by far the largest apartment of the suite. Mr. C. V. Walker's electrical apparatus for carrying out the "block system," or "space intervals," between trains on the South-Eastern Railway, was here displayed. Messrs. Tisley and Spiller exhibited their compound pendulum apparatus in action, and distributed cards with the exquisite curves described upon them. This firm exhibited also the beautiful triple combination double-image prism belonging to Mr. Spottiswoode. Mr. E. B. Tylor's ingenious apparatus for illustrating refraction (already described in these columns) was exhibited in this room.* We observed also some splendid gold crystals exhibited by Mr. W. C. Roberts, Chemist to the Mint; Mr. W. H. Barlow's "Logograph," a recording instrument for showing the pneumatic action accompanying the exercise of the human voice; and a pair of gyrostals exhibited by Prof. Sir William Thomson. Messrs. Negretti and Zambra exhibited their ingenious thermometer for recording deep-sea and atmospheric temperatures, already described in NATURE. Mr. John Browning exhibited a good collection of apparatus. Mr. G. P. Bidder's micrometer, a most ingenious device for observing the transit of very faint stars, in which the spider lines, capable of the usual micrometer movements, are illuminated by a side light, and are reflected into the eye-piece by a mirror, thus appearing bright upon a dark ground, and by interposing coloured glasses between the lamp and the spider lines can be coloured at pleasure. Sir Charles Wheatstone's new photometer is well worthy of notice: the screen slides along the divided scale and its motion causes the increased overlapping of two sliding wedges of neutral-tint glass. The light is looked at directly through a hole in the screen, and the latter moved along the scale till the light just ceases to be visible. We noticed also a micro-spectroscope of very good definition, showing the absorption spectrum of cantharides. Mr. Apps exhibited a model and diagram of a fireproof building, and a model of an improved apparatus for indicating the speed of revolving shafts, both being the inventions of Sir David Salomons. The plan for rendering buildings fireproof consists in laying on water-pipes between the walls and floors of the building, these pipes being self-acting by means of fusible-metal plugs or electrical communications. The last-named model is an application of the ordinary governor balls, which are connected with the shaft, and by a system of levers, with an index, which moves up a graduated scale. A double-action spectroscope with a divided object-glass, made by Grubb, of Dublin, was shown and explained by Lord Lindsay; this instrument is intended by its owner to be attached to a large equatorial for the observation of stellar spectra. Among other noticeable things in this room we may mention the Megohm, one million British Association units, by Messrs. Elliott Brothers; Mr. George Barnard's highly artistic water-colour drawings and the copies of sacred Icons of the Greek Church in Russia, and photographs by Mr. John Leighton. Col. Stuart Wortley's photographs from life are high examples of art, and the group of living corals (*Astroides calicula*) from the Bay of Naples, exhibited by the Crystal Palace Aquarium Company, attracted large numbers of admirers by their beauty. At 10 o'clock Dr. R. Norris, of Birmingham, exhibited in the meeting-room experiments to illustrate a form of contractive energy which displays itself in various substances. Among other things the Doctor showed that the statement that india-rubber *contracts* by heat is incorrect; this substance, it is true, contracts in the direction of its length, but it expands in breadth at the same time, thus resembling the so-called contraction of muscular fibre.

In soirées of this kind experiments illustrative of new chemical discoveries are generally "conspicuous by their absence." This surely cannot be due to the fact that the science does not permit of public demonstration; it arises rather from the "messy" nature of the materials employed by chemists, thus precluding the introduction of chemicals into such rooms as are devoted by the Society to their gatherings. We are of opinion that in not fitting up and adding to their now noble apartments a laboratory, an omission has been made which may be regretted in the future.

* We should recommend lecturers using this apparatus to see that the wood is well seasoned; the one exhibited soon ceased to act satisfactorily, owing to the warping of the board.

THE LECTURES AT THE ZOOLOGICAL SOCIETY'S GARDENS

II.

IN the second and third of his lectures On the Geographical Distribution of the Mammalia, delivered on the Tuesday and Friday of last week, Mr. Sclater described in detail the ranges of the different orders of terrestrial mammals; and to avoid unnecessary repetition, employed the well-known system of division of the earth's surface, proposed before the Linnean Society in 1857, from a study of the bird class, according to which there are six regions—(1) The *Palæarctic*, including Europe, Africa north of the Atlas Mountains, and Northern Asia. (2) The *Ethiopian*, including all Africa south of the Atlas Mountains, and the southern part of Arabia. (3) The *Indian*, including Asia south of the Himalayas, Southern China, and the Indian Archipelago. (4) The *Australian*, including Australasia. (5) The *Nearctic*, including North America down to the centre of Mexico; and (6) The *Neotropical*, including South and Central America. The following is a summary of his remarks.

Among the monkeys the anthropoid apes inhabit equatorial Africa, where the gorilla and chimpanzee are found; Sumatra and Borneo are the home of the orang outang; while the eastern portion of India, Burmah, and the Indian Archipelago constitute the habitat of the various species of gibbon. The catarrhine monkeys, including the green monkeys (*Cercopitheci*), and the macaques inhabit Africa and India respectively; the latter, however, extending into Africa north of the Sahara, as far as Apes Hill and the Rock of Gibraltar. The platyrrhine monkeys, among which are the spider monkeys, the howlers, and the marmosets, are found in the Neotropical region, except in its southern and western parts. The lemurs are mostly confined to the island of Madagascar, some few inhabiting Eastern India, and two forms occurring in Western Africa.

Among the large order of the Carnivora the lion is a denizen of the forests of the Ethiopian region, and spreads slightly beyond it into India. The tiger is found in the Indian region, and spreads up into China and Central Asia, where its coat becomes coarser in texture. The leopard is distributed over the districts of the lion and tiger; it is also found in Borneo and Ceylon, whilst the lynx occurs in the Neartic and Palæarctic regions. The dogs are cosmopolitan, though it is doubtful whether the single form of Australia has not been introduced by man in early times. The bears inhabit the Palæarctic, the Nearctic, and the Indian regions, being also found in the Andes of Peru.

Among the odd-toed, or Perissodactylate Ungulates, the horses and asses are strictly Old-World forms, the exact place of origin of the former being uncertain. The asses are spread over the Indian and Ethiopian regions. The tapir is very aberrant in its distribution, one species appearing only in Sumatra and the Malay Peninsula, while in the northern portion of South America and Central America three others occur. The rhinoceroses are from the Indian and Ethiopian regions only, the Asiatic species all being now or having lately been exhibited in the Zoological Gardens. Those from Africa are less perfectly known, only two species having been accurately determined.

Among the even-toed, or Artiodactylate Ungulates, the camels are very peculiar in their habitats, the Llamas of the Andes and the camels of Africa, Arabia, and part of Russian Asia being the only known forms; those from the last-named locality being the only known wild true camels of the present day. The giraffe is purely Ethiopian. The bison in North America represents the oxen of the Indian region, which in Africa and Arabia are in great measure replaced by the antelopes, so varied in form and size. The Cervidæ are not found in the Ethiopian nor Australian regions. The hippopotamus inhabits all the large rivers of Africa, the smaller species being found in and about Liberia. Of the Swine-family the peccaries are the representatives in the Neotropical region, whilst the quaint Wart-Hog and Red River Hog are exclusively African.

The hyrax, or coney of Scripture, whose zoological position is so uncertain, is found in Arabia and parts of Africa only.

There are only two species of elephant known, the Indian being from the Indian region, and the African from the Ethiopian. In very recent times they abounded in Siberia, and earlier still in many other parts of the world.

The Neotropical region abounds in peculiar Edentate animals, as the armadillos, sloths, and ant-eaters. The scaly ant-eaters or Pangolins, and the ant-bears or Orycteropus, are found, the former in India and Africa, the latter in Africa only.

Among the Insectivora, the peculiar Solenodon inhabits St. Domingo; the gilded mole, South Africa; the Tenrec, Madagascar; and the Tupaias, the Malay districts.

Among the Rodentia the porcupines, divided into two well-distinguished sub-families, inhabit, one the Old and the other the New World. The Neotropical region, however, is the head-quarters of the *Hystricidæ*; the capybara, together with the agoutis, and numerous other forms being from that locality. There are also found the chinchilla and viscacha. The beaver abounds in the Nearctic region, and used to do so in Europe, till the increase of population has almost exterminated it. The hare and rabbits have a wider distribution, as have also the squirrels.

It will be noticed that Australia has been scarcely mentioned in the above remarks, and that the dog which is spoken of in connection with it is not known certainly to be indigenous. This is because the mammalian fauna is almost entirely represented by animals of the Marsupial order, the kangaroos, bandicoots, phalangers, wombat, koala, thylacine, and dasyures being peculiar to it and Van Dieman's land. Among Marsupialia the group of opossums is only found in the Neotropical region, extending quite through Mexico into the United States.

The Monotremata, including only the duck-bill or ornithorhynchus and the echidna, are confined to New South Wales and Tasmania.

(*To be continued.*)

THE FLUCTUATIONS OF THE AMERICAN LAKES AND THE DEVELOPMENT OF SUN-SPOTS

IN the course of an investigation, undertaken in my capacity as Geologist to the B.N.A. Boundary Commission, as to late changes of level in the Lake of the Woods, bearing on the accuracy of certain former surveys, I found it desirable to tabulate the better-known fluctuations of the great lakes for a series of years as a term of comparison. The observations of secular change in Lake Erie are the most complete, and these, when plotted out to scale, showed a series of well-marked undulations which suggested the possibility of a connection with the eleven-yearly period of sun-spot maxima. A comparison with Mr. Carrington's diagram of the latter confirmed this idea, and as I do not remember to have seen these phenomena connected previously, I have been induced to draw out the reduction of both curves here presented, and the table of the height of water in the lakes.

The changes of level affecting the great lakes are classed as follows by Colonel Whittlesey, who has given much attention to the subject:—

1. General rise and fall, extending through a period of many years, which may be called the "Secular Variation."

2. Annual rise and fall within certain limits, the period of which is completed in about twelve months.

3. A sudden, frequent, but irregular movement varying from a few inches to several feet. This is of two kinds, one due to obvious causes, such as winds and storms; another, described as a slow pendulum-like oscillation, has been somewhat fully discussed by Whittlesey in a paper read before the American Association at its last meeting, and is due probably to barometric changes in the superincumbent atmosphere.

The first class is the only one directly included in the present inquiry.

I.—*Table of Great Lakes.*—In Mr. Lockyer's new work on Solar Physics, chap. xxvi., entitled "The Meteorology of the Future," exhibits the parallelism of periods of solar energy, as denoted by the outburst of sun-spots, with the maximum periods of rainfall and cyclones, and for the southern hemisphere, by a discussion of his own and Mr. Meldrum's results. In the table (p. 505) I have arranged the more accurate numerical observations of the height of the lakes from registers kept for the last few years, in a method similar to that there adopted.

Prof. Kingston's observations of Lake Ontario were taken at Toronto, and measured upward from an arbitrary mark. They extend from the year 1854 to 1869, and include the minimum periods of 1856 and 1867, and the maximum of 1860. Taking the mean annual level for each minimum and maximum epochal year, and one year on each side of it, as is done by Mr. Meldrum, and deducing a mean from each of three tri-yearly periods,

Table showing the height of water in the American Great Lakes, measured upward from an arbitrary mark, for the years surrounding periods of maxima and minima in the occurrence of Sun-spots.

Sun-spot Periods.	Year.	Lake Ontario, from Prof. Kingston's observations.		Lake Ontario, from U.S. Lake Survey Observations.		Lake Superior, from U.S. Lake Survey Observations.		Lake Michigan, from U.S. Lake Survey Observations.		Lake Erie, from U.S. Lake Survey Observations.	
		Yearly means.	Tri-yearly means.	Yearly means.	Tri-yearly means.	Yearly means.	Tri-yearly means.	Yearly means.	Tri-yearly means.	Yearly means.	Tri-yearly means.
Min.	1855	17·8									
	1856	20·6	21·7								
	1857	27·5									
Max.	1859	28·6		30·48		40·32		29·88		33·60	
	1860	18·3	24·7	22·68	28·80	30·24	33·12	23·76	25·92	28·32	30·60
	1861	27·4		33·12		28·26		23·88		29·76	
Min.	1866	9·3		18·36		18·12		3·72		17·76	
	1867	19·7	11·2	28·86	19·20	20·16	18·84	7·68	5·28	18·00	16·56
	1868	4·6		13·68		18·24		4·32		13·80	

Mean of maximum periods in Lakes Ontario, Superior, Michigan, and Erie, from U.S. Lake Survey Obs. 29·61
Mean of minimum ,, ,, ,, ,, ,, ,, ,, 14·97

Difference 14·64

The measurements are in inches and decimals.

the agreement is close between the solar periods and those of fluctuation in the lakes.

The remaining observations are those of the U.S. Lake Survey, and include only one period each of maximum and minimum in solar spots. The measurements of the U.S. Survey are reckoned *downwards* from a mark representing the high water of 1838 in each of the lakes, but in the table here given they have been reduced so as to read upwards from an arbitrary line chosen 4 feet below that datum. They are thus rendered more intelligible and made to agree in sense with Prof. Kingston's measurements.

The result is the same in each of the lakes, only differing in amount by a few inches. A mean deduced from the U.S. Lake Survey observations in Lakes Superior, Michigan, Erie, and Ontario, gives a difference between the years surrounding the maximum of 1860 and the minimum of 1867 of 14·64 inches in favour of the former.

2. *Diagram of Curves.*—The curve representing the fluctuation of Lake Erie from 1788 to 1857 inclusive is constructed on a careful discussion of the evidence collected by Col. Whittlesey and given by him most fully in the "Smithsonian Contributions to Knowledge" for 1860.

From 1788 to 1814 there are no accurate measurements to any well-recognised datum line, and I therefore give below the measurements and approximations on which the general curve for these years has been constructed. The description of the fluctuation of the lake will be seen in many cases to apply with verbal accuracy to the sun-spot curve.

"1788—1790. By tradition derived from the early settlers very high; according to some as high as 1838, but this is doubtful.

"1796. By the first emigrants and surveyors reported as very low—5 feet below 1838.

"1797. Rising rapidly.

"1798. Water continues to rise, but 3 feet below June 1838.

"1800. Very high; old roads flooded.

"1801. Still high.

"1802. Very low; reported by old settlers as lower than 1797.

"1806. Very low; reported by old settlers as lower than 1801—2, and declining regularly to 1809—10 when it reached a level by many considered as low as that of 1819.

"1811. Rise of 6 inches in the spring over 1810, by measurement, and a fall of 2 inches.

"1812. Rise of 14 inches in spring over 1810, by measurement, and a fall of 3 inches.

"1813. Rise of 2 feet 2 inches in spring over 1810 by measurement.

"1814. Rise of 2 feet 6 inches in spring above general level of 1813."

From 1815 to 1833, both inclusive, occasional measurement to fixed data exist; the supplementary notes are here given.

"1815. Rise of 3 feet above average level of 1814. (This statement is not confirmed by an actual measurement made in August, and is probably exaggerated).

"1816. Water still high, but falling, and continued to fall till 1819.

"1819. Lowest well-ascertained level of the waters in Lake Erie.

"1820. Stated to be in August as low as 1819.

"1821. Rising.

"1822. Rising; in the spring 4 feet below June 1838.

"1823. Rising; in the spring 3 feet 3 inches below 1838.

"1824. Rising gradually.

"1825. Rising; lowest level 3 feet below June 1838.

"1826. Rising; lowest level 2 feet 10 inches below June 1838.

"1827. About the general level of 1815.

"1829. Water still rising.

"1830. General level same as 1828.

"1831. Lower than last year; yearly change at least 3 feet.—Col. Whiting. (Probably an error as this would place the water unprecedentedly low. Col. Whiting probably ascertained that the lake was falling and erred in taking some former high-water mark for that of the preceding year).

"1832. General average 2 feet 10 inches below June 1838.

"1833. General average 3 feet 2 inches below June 1838."

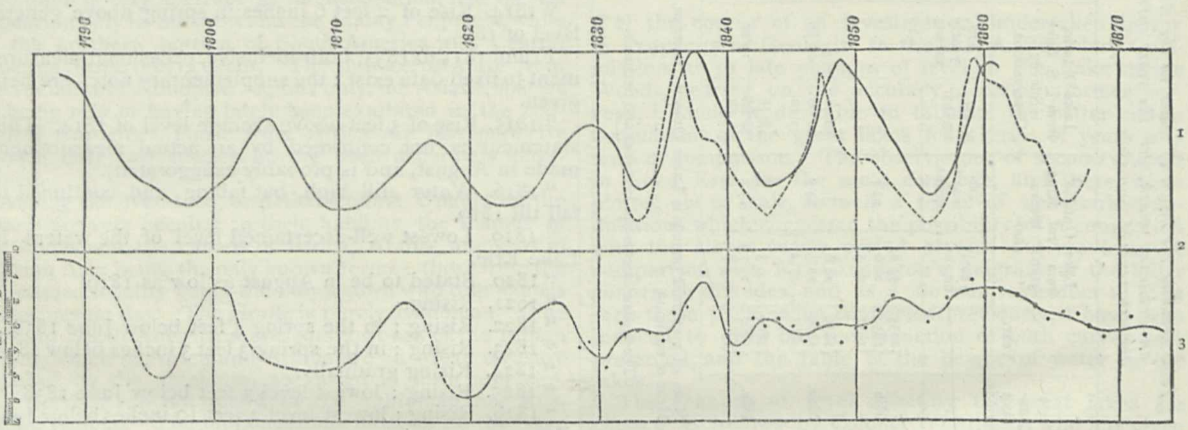
From this date to 1857 many actual measurements are given by Whittlesey, and from these the curve for those years has been constructed. The whole of the observations are reduced as nearly as possible to the average level for each year by comparison with a mean annual curve for about 10 years constructed from monthly averages of bi-five-day means given by the U.S. Lake Survey. 1859 to 1869 both inclusive are from yearly means derived from continuous observations at Cleveland by the U.S. Survey. 1871 to 1873 are from information kindly furnished by Gen. Comstock, Director of the Lake Survey. I have no data for 1870.

The earlier and less systematic observers of the fluctuations of the lakes would scarcely give attention to any but the more important changes of level, and it is possible that these in many cases may have been exaggerated in amount. It would seem improbable, however, from the number of observations which have come down to us, that any variations of importance have escaped notice.

In the upper part of the diagram, the unbroken line represents Carrington's curve founded on the number of sun-spots. The broken line is a reduction of a mean curve based on the area of the spots given by De la Rue, Stewart, and Loewy in the Philosophical Transactions for 1870; and is introduced as showing the solar periods to a later date.

3. *General Remarks.*—The first four maxima of sun-spots represented in the table being separated by long intervals of years with few spots, and not being very intense, would appear to have been closely followed by L. Erie. More especially 1837, the year of greatest known intensity according to both spot curves (333 new groups of spots according to Schwabe), was marked in its effects on the lakes, giving rise in 1838 to the highest recorded level of the waters in Erie and Ontario, and probably also in Superior, though here the data are not so certain. The high-water mark of 1838 has since been employed as the datum to which all the measurements of the Lake Survey are reduced.

The three last periods of maxima of sun-spots are extreme, and the intervals characterised by their deficiency so short that the lakes seem to have been unable to follow them as closely as before. One period of high water being to a great extent merged in the next, and resulting in a general high state of the lakes for the last thirty years, which may be connected with the Wolfian Cycle of fifty-six years in the development of sun-spots. The lakes do not seem to have responded to the maximum of 1848, but by a reference to the curve of area of sun-spots, it will be seen that the intensity of this period was not so great as of those on either side of it, and the period of maximum was maintained for a very short time only. The important sun-spot maximum of 1859-60 was evident in its effect on the lakes even at their present general high level. With regard to the Lake of the Woods the data are slight, but it may be mentioned that this lake is known to have been very low in 1823, and in 1859 to have attained a point which it has never touched since, and which is about 3 feet higher than the present level. The lake is also known to have been for a good many years higher than usual, and at least one well-marked high water took place between 1823 and 1859, which may very probably have been synchronous with that of 1838 on the great lakes.



Comparative Diagram of the Fluctuations of Lake Erie, and Periods of greater or less Solar Activity as indicated by the occurrence of Sun-spots. 1. Solar Spot Curves. 2. High Water, June 1838. 3. Lake Erie.

This lake derives its water from the western slope of the same Laurentian range which feeds Lake Superior.

The correspondence between the periods of maxima and minima in solar-spot cycles and in the fluctuation of the great lakes, though by no means absolute, seems to be sufficiently close to open a very interesting field of inquiry, and to show the extension of the meteorological cycle already deduced by Messrs. Meldrum and Lockyer for oceanic areas in the southern hemisphere, to continental ones in the northern.

The great lakes in their changes of mean yearly level probably show a very correct average of the rainfall over a large area, and thus indicate the relative amount of evaporation taking place in different seasons. It is to be observed, however, that the actual mean annual outflow of the lakes would be a better criterion, and that from the form of the river valleys giving exit to the waters, this must necessarily increase in a much greater ratio than the measured change of level in the lake itself. It is much to be desired that such observations should be systematically made. The occurrence of seasons of great activity of evaporation and precipitation, as indicated by the lakes synchronously with those of maximum in solar-spot production, would tend to confirm the opinions previously formed as to the coincidence of the latter with periods of greater solar activity. Wolf, as quoted by Chambers, states from an examination of the Chronicles of Zurich, "that years rich in solar spots are in general drier and more fruitful than those of an opposite character, while the latter are wetter and stormier than the former." Gautier, from a more extended series of observations, including both Europe and America, has deduced an exactly opposite conclusion, which, from the evidence of the great lakes, would appear to be the correct one.

It is quite possible, however, that both may be true (see "Solar Physics," p. 430). The great lakes lying at the base of the Laurentides, where moisture-bearing winds from the southward and westward are interrupted in their course, and meet with cold currents journeying over these hills from the north, are essentially in an area of precipitation, and greater precipitation would here be the natural result of greater solar energy. In other regions excessive evaporation may result from the same cause, and this may account for the gradual desiccation which on the authority of many observers is going on at present over great areas of the inland plains of the west.

The observations here given cannot be accepted as conclusive, but derive additional importance from the large area which they represent, and may suggest more systematic investigation of the subject, and the accumulation of accurate observations, which in the course of years may lead to results of greater value.

G. M. DAWSON

POLARISATION OF LIGHT *

VIII.

A QUARTZ plate cut parallel to the axis, when examined with convergent light, gives curves in the form of hyperbolas. These curves are wider in proportion to the thinness of the plate, but if the plate be thick enough to render the curves moderately fine, the colour becomes very faint. They may, however, be rendered distinct by using homogeneous light. The dark and light parts exchange positions when the analyser is turned through 90°. Two such plates with their axes at right angles to one another give coloured hyperbolas perfectly visible with the white light. Plates of Iceland spar exhibit similar phenomena, but the lines and curves are far more closely packed.

If the plate be cut in a direction inclined at 45° (or at any angle differing considerably from 0° or 90°) to the axis, the curves are approximately straight lines perpendicular to the principal section of the plate. Two such plates placed with their principal planes at right angles to one another give straight lines bisecting the angle between the principal planes. On this principle Savart constructed the polariscope which bears his name. It consists of two such plates and an analyser, and forms a very delicate test of the presence of polarisation. The lines are, of course, always in the direction described

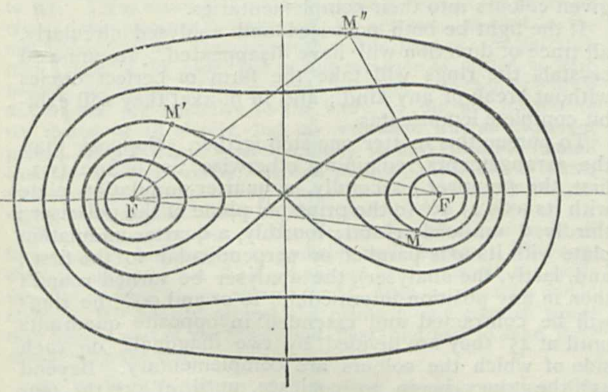


FIG. 26.

above, and the delicacy of the test increases in proportion as their direction becomes more and more nearly perpendicular to the original plane of vibration.

Bi-axal crystals exhibit a more complicated system of rings and crosses, or brushes as they may in this case be better termed. If such a crystal be cut in a direction perpendicular to the line which bisects the angle between the two optic axes (or the middle line, as it is called), the extremity of each of the axes will be surrounded with rings similar to those described in the case of the uni-axal crystals. The larger rings, however, are not strictly circles, but are distorted and drawn out towards one another ; those which are larger still meet at a point midway between the centres, and form a figure of 8, or lemniscata ; beyond this they form curves less and less compressed towards the crossing point, and approximate more and more nearly to an oval (see Fig. 26).

The vibrations of the two rays emerging from any point of a bi-axal crystal are as follows :—Of the two rays produced by the double refraction of a bi-axal crystal neither follows the ordinary law of refraction ; but one does so more nearly than the other, and is on that account called for convenience the ordinary ray. And if through any point of the field of view we draw two lines to the points where the optic axes emerge, the directions of vibration of the two rays will be those of the bisectors of the angles made by the two lines. If, therefore, the crystal be so placed that the line joining the extremities of the two axes coincides with the plane of vibration of either polariser or analyser, it is not difficult to see that there will be a black cross passing through the centre of the field, with one pair of arms in the line joining the extremities of the axes and the other pair at right angles to it. But if the plate be turned in its own plane round the central point, the points, for which the vibrations are parallel or perpendicular to those of the polariser or analyser, will no longer lie in straight lines passing through the centre, but will form two branches of a hyperbolic curve, passing respectively through the extremities of the optic axes.

If the analyser be turned round, the dark hyperbolic brushes, or the black cross, will undergo the changes analogous to those shown in the cross in the case of uni-axal crystals ; but the most interesting effects are those seen when the polariser and analyser are crossed, and the crystal is turned in its own plane.

The angle between the optic axes in different kinds of crystals varies very much ; in those where the angle is small it is easy to exhibit both at once in the field of view, but in others where the angle is large it is necessary to tilt the crystal so as to bring the two successively into view. In the latter case the crystal is sometimes cut in a direction perpendicular to one of the axes. The rings are then nearly circular, especially towards the centre, and in that respect they resemble those of a uni-axal crystal ;

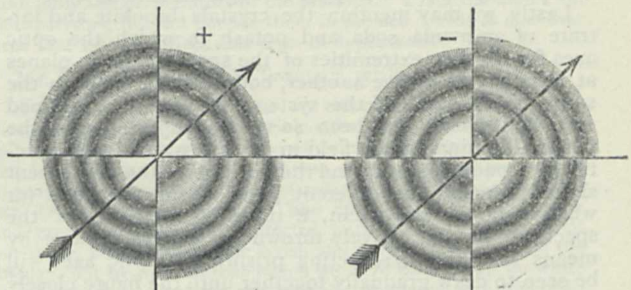


FIG 27.

but the character of the specimen can never be mistaken because the rings are intersected by a black bar, or two arms in the same straight line, instead of by four arms at right angles to one another, as would have been the case if the crystal had been uni-axal. The following are the angles made by the optic waves in a few crystals :—

	°	′
Carbonate of lead	5	15
Saltpetre	5	20
Talc . . . . . , .	7	24
Titanite	30	0
Borax	28	42
Mica	30 to 37	0
Carbonate of Ammonia . . .	43	24
Topaz of Brazil	49 to 50	0
Sugar	50	0
Gypsum	57	30
Felspar	64	0
Topaz of Aberdeen	65	0
Oxyde of Lead	70	25
Cyanite	81	48
Chrysolite	87	56

These angles are determined by placing the crystal for an examination into an apparatus adapted to show the rings, and attaching it to an arm whereby the plate can be turned about an axis in its own plane. The axis is furnished with a circle divided into degrees and seconds, and an index. If this axis be horizontal, the plate is so

* Continued from p. 466.

placed that the line joining the centres of the two systems of rings is vertical, and the crystal is first turned so as to bring one centre into the centre of the field of view (usually marked by cross wires); the index is then read, and the crystal turned so as to bring the centre of the second system of rings to the centre of the field. The index is again read, and the difference of the two readings noted. This, however, gives not the true angle of the optic axes, but the apparent angle in air, that is, the angle between the rays as affected by refraction on emerging from the crystal. (See Fig. 27.)

In some crystals the optic axes have different angles of inclination for the different rays of the spectrum. Of this titanite or sphene is an example. All rays have a common middle line, and lie in the same plane, but the optic axes for the red rays are more widely separated than those for the blue, and consequently the part of the field which would exhibit a dark brush if red light were used is deprived of the red rays but not of the blue. The brushes, therefore, appear broader than with ordinary crystals, and are tinged with blue on the edges farthest from the middle point, and with red on the edges nearest to it. It is said that a similar distribution of the optic axes, or its opposite in which the red rays are least separated and the blue most, is found in all crystals belonging to the rhombic system.

In other crystals, the axes all lie in one plane, but all have not the same middle line, so that the two ring systems are unsymmetrical. This is the case with borax. In others the optic axes for different colours lie in different planes, all of which pass through the middle line.

Lastly, we may mention the crystals brookite and tartrate of ammonia soda and potash, in which the optic axes for the two extremities of the spectrum lie in planes at right angles to one another, both passing through the same middle line. If the systems of rings be examined with light which has been so widely dispersed that the portion illuminating the field in any given position is practically monochromatic, and the position of the instrument shifted through the different parts of the spectrum (or what is more convenient, if the different parts of the spectrum be successively thrown on the polariscope by means of a totally reflecting prism), the optic axes will be seen to draw gradually together until the figure closely resembles that of a uni-axal crystal; after which the axes open out in a direction at right angles to the former, until they have attained their greatest expansion. This experiment requires a strong light, but it is instructive, as showing the exact distribution of the optic axes for different rays.

In some bi-axal crystals, notably in gypsum, the distribution of the optic axes varies with the temperature. When the crystal is heated the angle between the optic axes diminishes until the crystal appears uni-axal; with a further increase of temperature the axes again open out, but in a direction at right angles to the former. When the crystal is cooled the axes generally resume their original directions. Sometimes, however, when the heating has been carried to a great degree, or has been continued for a long time, the axes never completely return to their normal condition; and in such a case the crystal may appear permanently uni-axal. Such an appearance, when permanent, has been considered a test of former heating; and this phenomenon, when presented by crystals found in a state of nature, may be taken as evidence that the rocks in which they have been formed have been subject to high temperatures.

In the production and examination of the rings hitherto described, we have used light which has been plane-polarised and plane-analysed; but there is nothing to prevent our polarising the light or analysing it circularly, or indeed doing both.

If a quarter-undulation plate be placed between the polariser and the crystal to be examined, with its axis inclined at 45° to the plane of original vibration, the light will fall upon the plate in a state of circular polarisation; and as the polarisation will then have no reference to any particular plane of vibration, the black cross will disappear. A system of rings will be produced, but they will be discontinuous. At each quadrant, depending upon the position of the analyser, the rings will be broken, the portions in opposite quadrants being contracted or expanded, so that in passing from one quadrant to the next the colours pass into their complementaries. If either the direction of the axis of the quarter-undulation plate be changed from 45° on one side to 45° on the other side of the plane of vibration of the polariser; or if the crystal be changed for another of an opposite character (*i.e.* negative for positive, or *vice versâ*), the quadrants which were first contracted will be expanded, and those which were first expanded will be contracted. Hence for a given position of the quarter-undulation plate the appearance of the rings will furnish a means of determining the character of the crystal under examination.

Similar effects are produced if the quarter-undulation plate be placed between the crystal and the analyser; that is, if the light be analysed circularly.

In the case of bi-axal crystals under the action of light polarised or analysed circularly, the black brushes are wanting, but they are replaced by lines of the same form marking where the segments of the lemniscatas pass from given colours into their complementaries.

If the light be both polarised and analysed circularly, all trace of direction will have disappeared. In uni-axal crystals the rings will take the form of perfect circles without break of any kind; and in bi-axal they will exhibit complete lemniscatas.

To pursue this matter one step farther. Suppose that, the arrangements remaining otherwise as before (viz., first, the polariser; secondly, a quarter-undulation plate with its axis at 45° to the principal plane of the polariser; thirdly, a uni-axal crystal; fourthly, a quarter-undulation plate with its axis parallel or perpendicular to the first; and, lastly, the analyser), the analyser be turned round; then in any position intermediate to 0° and 90° the rings will be contracted and extended in opposite quadrants until at 45° they are divided by two diagonals, on each side of which the colours are complementary. Beyond 45° the rings begin to coalesce, until at 90° the four quadrants coincide again. During this movement the centre has changed from bright to dark. If the motion of the analyser be reversed the quadrants which before contracted now expand, and *vice versâ*. Again, if the crystal be replaced by another of an opposite character, say positive for negative, the effect on the quadrants of the rings will be reversed. This method of examination, therefore, affords a test of the character of a crystal.

A similar process applies to bi-axal crystals; but in this case the diagonals interrupting the rings are replaced by a pair of rectangular hyperbolas, on either side of which the rings expand or contract, and the effect is reversed by reversing the motion of the analyser, or by replacing a positive by a negative crystal. The test experiment may then be made by turning the analyser slightly to the right or left, and observing whether the rings appear to advance to, or recede from, one another in the centre of the field. In particular if, the polariser and analyser being parallel, the first plate have its axis in a N.E. direction to a person looking through the analyser, the second plate with its axis at right angles to the former, and the crystal be so placed that the line joining the optic axes by N.S., then on turning the analyser to the right, the rings will advance towards one another if the crystal be negative, and recede if it be positive.

W. SPOTTISWOODE

(*To be continued.*)

FLOWERS OF THE PRIMROSE DESTROYED BY BIRDS

WE have received a number of answers to Mr. Darwin's letter on this subject in NATURE, vol. ix., p. 482; these we have thought it advisable to bring together here. On the general question of the destruction of flowers by birds, Prof. Thiselton Dyer writes as follows:—

MR. DARWIN remarks that he has never heard of any bird in Europe feeding on nectar. There is perhaps one well-authenticated instance in Gilbert White's "Selborne" (illustrated edition, p. 186): "The petticaps . . . . runs up the stems of the crown imperials, and putting its head into the bells of those flowers, sips the liquor which stands in the nectarine of each petal." This is the more curious, because, according to Kirby and Spence ("Entomology," 7th edition, p. 384), this plant "tempts in vain the passing bee probably aware of some noxious quality that it possesses." I do not know how far this is true, but it has a peculiar odour which makes it rather unpopular as a garden plant.

I have, in my note-book, another instance, also from the *Liliaceæ*, of a plant visited for nectar in an extra-tropical country. Mrs. Barber relates that in South Africa "the long tubular flowers of the aloe are well supplied with nectar, and this provision affords during the winter season a continued store of food for our beautiful sun-birds," the numerous species of the genus *Nectarinia* (Journ. R. Hort. Soc., n.s., ii. 80).

Two other cases of the destruction of flowers by birds occur to me. I was assured this year that the flowers of the common crocus are persistently destroyed by sparrows, at least in the neighbourhood of Hammersmith. The base of the perianth tube, which is the usual seat of any secretion of nectar, is here beneath the surface of the ground; perhaps, however, the style and stigma are attractive to the birds. I did not investigate the matter at all closely, but my informant was an observant person, who I think would be likely to have satisfied himself that the sparrows really did the mischief, the effects of which were obvious enough. If so, we have a clear instance in crocus-eating of an acquired habit on their part.

The other case, that of the destruction of flower-buds of fruit-trees by bullfinches, is probably well known. The mischief is said to be out of all proportion to any benefit the birds can derive from it, as regards food. Such a visitation would obviously tell heavily against the plants in any country where they formed part of the indigenous flora, and had to take their chance with the rest.

Dr. J. H. Gladstone writes, that in his garden the flowers of the primroses have been similarly bitten off, and the crocuses also. He says—

ONE morning some weeks ago I especially remember seeing the beds and the gravel walks strewn with the yellow petals of the latter flower, which were severed from their stalks, and bore abundant marks of the sharp beaks which had torn them asunder. I cannot learn that anyone saw these London birds at their destructive work, which was probably done before any of us were stirring.

Mr. T. R. Archer Briggs, of Plymouth, writes—

I HAVE been familiar with the fact to which Mr. Darwin directs attention for as long a period as that during which he says it has engaged his own, without, however, my being able to point out the author of the mischief. In the neighbourhood of Plymouth it is no uncommon thing to find the flowers both of the primrose and polyanthus bitten off and lying around the plants exactly as Mr. Darwin has described; indeed, so often does this occur here, that I have known it a source of annoyance to cultivators of the latter plant. When residing some years ago at a house in the parish of Egg Buckland, about four miles from Plymouth, I remember to have repeatedly seen the polyanthus flowers in the grounds so destroyed, and to have heard it asserted that the redbreast was the culprit; but of this no proof was brought forward. The locality is a land of springs and streams, and it could not have been a want of water that led the destroyer to do the work there.

The tubular portion of the primrose is much infested by small insects (*thrips?*), and I have sometimes thought that a bird, for the sake of feeding on these, might be led to bite the flowers; but, on the other hand, they are so minute that one can scarcely think they would attract its notice.

I would say, in reply to Mr Darwin's queries, that primroses are in profusion about Plymouth (at least beyond the immediate neighbourhood of the town, whence they have been rooted out by wretched fern- and wild flower-grubbers), but I have never seen the flowers bitten off to such an extent as in the small Kentish wood he refers to, or in a sufficiently large quantity to materially affect the numbers of the species here.

The Rev. H. C. Key, of Stretton Rectory, Hertford, says that primroses being in great abundance in his neighbourhood, he was led by Mr. Darwin's letter to make a careful search for flowers bittten off in the way he describes, but he failed to find even one.

IT is obvious that the abundance of other food for which birds have a preference—such as apple, pear, plum, and cherry blossoms afford—may possibly have saved our primrose flowers from destruction; but, taking into consideration the fact that animal food must necessarily be supplied to the young birds at this season, I should be disposed to suggest that the primroses Mr. Darwin speaks of have been mutilated by birds rather for the sake of procuring thrips and other beetles, which are attracted by the nectar, than for the nectar itself.

I find the untouched primrose flowers here swarm with beetles and acari; but the great profusion of apple, and pear-blossom, &c., close at hand, may prove more attractive to the birds from the flowers being more open, and therefore more easily accessible.

Mr. G. M. Seabroke writes—

I HAVE observed the same thing as he relates in my small garden in this town. Nearly all the early buds from some twenty primrose plants were bitten off, and birds of some sort were undoubtedly the perpetrators of the mischief. I laid the blame on the sparrows, but did not see them in the act. This is the first year that I have noticed this form of depredation.

Mr. T. R. Stebbing, of Torquay, writes as follows:—

A FORTNIGHT ago the bank on either side of the road from Kingsbridge Road Station to Salcombe were covered, for many miles, with a brilliant profusion of primroses in bloom. In all this long range of country, eighteen miles in all, there was no appearance anywhere of that destruction of blossoms as to which Mr. Darwin makes inquiry. The attention of my companion and myself was especially directed to the primroses throughout our route, not merely by the lavish and unexpected beauty of the display, but by the look-out which we were keeping up for white or red varieties. Among the myriads of plants with the ordinary yellow blossom we noted five with white and two with pinkish flowers. On returning over a portion of the same road ten days later, we detected as many as seven plants with the pale-red or pink flowers, but none of these were blooming freely like the white and the yellow flowering-plants in the same district.

It may be worth noticing that this great stream of primroses flowed down from the rather bleak upland near the railway right into the fertile and sheltered valley of Salcombe, so that in one district or the other the birds might have been expected to seek the nectar, had they been to the manner born, in this part of the country.

A correspondent, E. T. S., says that—

IN the north-west corner of Hampshire the birds have the same taste as in Kent for the nectar of primroses and polyanthuses. A few weeks ago a correspondent wrote thence that this spring the blackbirds "were as bad as peacocks," whose well-known habit of cutting off the blossoms of polyanthuses, carnations, lilies, and any particularly choice tropical plant that they can get hold of, makes them a gardener's despair. A peacock who resided for a short time in the neighbourhood referred to, might possibly have taught the native birds the trick, but this is hardly probable, as he died three winters ago, and the present year, when all spring flowers have bloomed earlier and more abundantly than usual, is the first in which his example has been extensively followed. I should doubt the practice being limited to a single species. Sparrows certainly gather flowers very carefully; I have seen them almost strip a bed of the variegated arabis, though in this case the flower-stalks were carried away and used, not for food, but in nest-building. Does any other bird use fresh flowers for that purpose?

JOHN PHILLIPS

BORN DECEMBER 25, 1800: DIED APRIL 24, 1874

THE daily press has already spread the sad tidings from Oxford that Prof. Phillip met with an accident which suddenly cut short his life while in good health and such full vigour that we still expected work from him. A few days ago he was here amongst us in London, bearing himself with form as erect and step as elastic as if the last ten years had but further mellowed though in no way lessened his energy. Now we learn that a stumble over a door-mat, on leaving a friend's rooms in All Souls, followed by a heavy fall, has deprived Oxford of one of her brightest ornaments, and men of science of a genial friend.

Another bond is broken which linked together by a living presence the geologists of to-day with those who watched the infancy of the science which, in place of wild phantasies of the imagination as to the origin of our planet, substituted a patient and careful investigation of its structure, as far as observation was possible. From the time when William Smith in 1792-3 surveyed the ground between High Littleton and Bath for the Somersetshire Coal Canal, and proved an unvarying sequence in the strata of England, and their identification by their fossil contents, every "cosmogomy" and "theory of the earth" was doomed. Fact henceforth took the place of fancy.

Among the earliest of those trained in the new school was young John Phillips. Born at Marden, in Wiltshire, on Christmas-day (N.S.) 1800, he lost his father when he was but seven years old, and his mother dying soon after, his training fell into the hands of his mother's brother, the renowned William Smith, "Father of English Geology."

We have never heard that there was anything to be recorded of his father beyond that he was the youngest son in a Welsh family, settled for many generations on their own property at Blaen-y-ddol, in Caermarthenshire, who was destined for the Church, but became an officer of the Excise, and that he married the sister of William Smith. Mr. F. Galton, a few weeks ago, read a paper at the Royal Institution, in which he gave statistics about eminent scientific men, showing the number of cases in which the greatness was due to the father, and the number of cases in which it was due to the mother. Whether Prof. Phillips was included we do not know, but he most certainly was an instance in which the influence of the mother preponderated. The mould of the features were distinctly those of the Smith family, and the likeness between Prof. Phillips and the busts and picturesof William Smith has often been remarked. His habit of thought was so much due to the direct training of his uncle that we cannot trace how much of it was hereditary. No particular school could have much influenced him, for he passed through four schools before he was ten, and then for a short time went to the excelent old school at Holt Spa, in Wiltshire. It is said that Latin, French, and Mathematics were his favourite studies, and the enjoyment of Latin authors seems to have grown on him, for in the writings of no other geologist will be found so many quotations from the Latin classics. The Rev. Benjamin Richardson, Rector of Farley Hungerford, near Bath, was one of his earliest instructors in natural history. Very little, indeed, is known of Mr. Richardson; he had the reputation of being in his time the best naturalist in the west of England, and the obituary notices at the time of his death mention that he was a member of Christ Church, Oxford. One fact about him which has an historical interest is certain, and that is that it was his hand which, from the dictation of William Smith, "first reduced to writing at the house of the Rev. Joseph Townsend, Pultenay Street, Bath, 1799" the table of "the order of the strata and their imbedded organic remains in the vicinity of Bath." The original document is in the keeping of the Geological Society, and is regarded as a memorial of the first step towards the examination of strata on a definite plan, the first step in the science of geology as contrasted with cosmogony. During the year that young Phillips spent at the pleasant rectory of Farley, he heard continually of the importance attached to the discoveries of his uncle and of the results which, in the estimation of Richardson and Townsend, were to flow from it. Under Mr. Richardson's direction he spent a large portion of his time in searching for fossils through the valleys around Farley, and in making drawings of the fossils he found and of the recent forms that were most nearly allied to them in Mr. Richardson's extensive collections. Prof. Phillips always spoke with pleasure of his recollections of Mr. Richardson, and attributed to him both his early taste for natural history and the ready use of his pencil, which so often not only reproduced faithfully a geological section but artistically included the foliage and background recording the pleasant accompaniments of the work which principally engaged his attention. Mr. Richardson though a kind was not a flattering guide to the young man, for a frequent remark on being shown the drawing of a fossil was, "Very good John, now put that in the fire and try and do even better."

At the end of the happy year at Farley, young Phillips went to live with his uncle in London, to share with him his labour, his hopes, and his disappointments. William Smith had then just removed to Buckingham Street, after the fire in Craven Street, which had so disarranged his work. Here, however, he rearranged his collection of fossils, the first collection in which fossils were placed in their stratigraphical sequence. Made first at Cottage Crescent, Bath, removed to Trim Street, then to Craven Street, and Buckingham Street, this historical collection finally found a resting-place in the British Museum. Each separate stratum recognised by Smith had one or more shelves sloping to represent the dip as he knew them in the typical ground of the Dunkerton Valley, near Bath, where he first studied them. This was the collection from which young Phillips first derived his ideas of a geological museum for teaching purposes, and which he saw so often referred to by his uncle in explaining to his many visitors his new ideas, when urging upon them the national importance of his iscovery as regarded agriculture and mining. William Smith was then working at his map of England, and to this his best energies were given and all his money devoted. In the "Memoirs" of his uncle, published in 1844, Prof. Phillips has described all the delays and trials that attended the production of this, the first geological map of England ever produced. The indomitable courage shown by Mr. Smith in the face of every discouragement could not fail to impress young Phillips with the importance of his uncle's work, and to win respect for him. How he was attached to him, and how he valued his teaching, is apparent in many places in his writings. In the preface to the "Memoirs" he speaks of himself as "an orphan who benefited by his goodness, a pupil who was trained up under his care." The map was issued in 1815, and Mr. Smith's professional engagements rapidly increased, requiring him to visit all parts of the county. He conceived the plan of producing county geological maps on a scale considerably larger than that of the map of England, and on almost every journey his nephew was his glad companion, "haud passibus æquis;" and according to an established custom on all such tours, was employed in sketching parts of the road and recording on maps the geological features of the country. In 1821, the map of Yorkshire, in four sheets, was published, which were prepared and coloured by his own hands. Throughout the "Memoirs" we have indications of the way in which he worked under his uncle's direction. Here is one which gives an insight into the way in which he gained his intimate knowledge of the strata of the country. "The whole of the remainder of 1821 was devoted to long and laborious wanderings. Two lines of operation were drawn through the country which required to be surveyed. On one of these Mr. Smith moved with the due deliberation of a commander-in-chief; the other was traversed by his more active subaltern, who afterwards found the means to cross from his own parallel to report progress at head-quarters." In this way 2,000 miles were traversed in six months, and he thus learned to rely on his own judgment. His work delighted him. "Innumerable rambles," he says, "led up every glen and across every hill, now sketching waterfalls, anon tracing the boundaries of rocks or marking the direction of diluvial detritus." As greater accuracy in tracing the boundary of different strata was thus acquired, the successive issues of the map of England were modified. The lines of these alterations were mostly traced by Mr. Phillips himself, and thus it was that differences appeared in maps which apparently belonged to the same "edition."

At length, in 1824, Mr. Smith was asked to deliver a course of lectures on his geological work at the newly-formed Yorkshire Philosophical Society. For this "new maps were coloured, new sections drawn, and even the distant cabinet of Mr. Richardson at Farley was laid under contribution, to supply illustrations for these discourses." Lectures at Hull, Scarborough, and Sheffield soon followed. The share that Mr. Phillips took in the preparation of these lectures brought him under the notice of the executive of the Yorkshire Philosophical Society; he was offered the curatorship of the new museum, and accepted it. This was one of the important events of his life. His work no longer came before the public in his uncle's name, he had an individuality of his own, "and commenced to make his own reputation." I was delighted to find in the prosecution of this duty innumerable proofs of the truth of Mr. Smith's views respecting the distribution of organic fossils, and saw very clearly that many of the strata in the north-eastern part of Yorkshire might be confidently identified with well-known formations in the south of England. Soon after (in 1826) he read before the Society the first paper he wrote. His subject was: The Direction of the Diluvial Currents of Yorkshire, and it was thought worthy of being reprinted in the "Philosophical Magazine." From this time his pen was ever active. His early geological papers were on Yorkshire, and with that county his name is indissolubly connected. In addition to the curatorship of the museum he was appointed one of the secretaries of the Society, and delivered courses of lectures, and in 1829 he published his illustrations of the Geology of Yorkshire.

It was not till 1834 that Mr. Phillips communicated a paper to the Geological Society, and in the same year he published his "Guide to Geology," was appointed Professor of Geology in King's College, London, and was elected a Fellow of the Royal Society. His recommendature to election into the Society is of sufficient interest to be printed; and is as follows:—

"John Phillips, Esq., of York, Fellow of the Geological Society of London and Secretary of the Yorkshire Philosophical Society, a gentleman well versed in geology, meteorology, and various branches of natural science, and author of "Illustrations of the Geology of Yorkshire," being desirous of becoming a Fellow of the Royal Society, we whose names are hereunto subscribed do, from our personal knowledge, recommend him, as highly deserving of the honour he solicits, and likely to prove a valuable and useful member.

"Rod. I. Murchison, Wm. Buckland, G. B. Gresnough, William Clift, Edw. Turner, Adam Sedgwick, John Taylor, H. T. De la Beche, C. Daubeny, John Edw. Gray, Geo. Peacock, John Lindley, B. Powell.

"Elected April 10, 1834."

Not only was he associated in work with the "father" of Geological Science, from which such valuable practical results have flowed, but he was one of the band who, in his own words, "stood anxious but hopeful by the cradle of the British Association." It is well known how through his activity the first meeting at York was a success in September 1831, and how till 1863 he was the courteous assistant-secretary of the Society.

Among other posts Prof. Phillips has filled are the Chair of Geology at Dublin, to which he was appointed in 1844; the Presidency of the Geological Society in 1859-60; Rede Lecturer in Cambridge in 1860; and the Presidency of the British Association in 1866. The Chair at Oxford he has held since 1853.

He not only helped to lay the foundations of English Geology, he has been to the last an active worker and an industrious writer. Besides more than sixty papers communicated to Societies' proceedings and to magazines, he was largely a contributor to the "Penny Encyclopædia," the "Encyclopædia Britannica," and the "Encyclopædia Metropolitana."

In 1841 was published his "Palæozoic Fossils of Cornwall, Devon, and West Somerset, after he had examined the country in company with Mr. William Sandars.

In 1842 he began an examination of the Malvern district, and having settled his data at Malvern, Abberley, and Woolhope, he extended his observations to May Hill, Fortworth, and Usk. The work was given to the world in 1848 as one of the Memoirs of the Geological Survey. "The Rivers, Mountains, and Sea-coast of Yorkshire" appeared in 1853, and his Essay in the "Oxford Essays," in 1855.

His contribution to the Palæontographical Society on the Belemnitidæ, and his "Geology of the Thames Valley," are well known; and he has also written many smaller works which we have not space to notice.

For many years he has been Keeper of the Museum at Oxford, and his lectures have had such a reputation for being popular that they have been largely attended by ladies. The Professor had also given much time to meteorology and astronomy, and had made many observations in his own observatory. He was an honorary M.A. and D.C.L. of Oxford, and LL.D. of Cambridge and Dublin.

NOTES

Dr. Lyon Playfair, C.B., has given notice that, on the House of Commons going into committee on the Education Estimates, he will call attention to the deficient ministerial responsibility under which the Votes for Education, Science, and Art are administered, and will move for a Select Committee to consider how such ministerial responsibility may be better secured. We believe that Dr. Lyon Playfair's views are strictly in accordance with those of the best scientific men of the country, namely, that the only satisfactory way of dealing with the subject will be by the appointment of a Minister for Education, Science, and Art.

The 15th or 16th of June has been fixed for the inauguration of the physical laboratory, the gift of the Duke of Devonshire to the University of Cambridge.

The following is a list of candidates selected and recommended by the Council of the Royal Society for election as Fellows:—Isaac Lowthian Bell, F.C.S.; W. T. Blanford, F.G.S.; Henry Bowman Brady, F.L.S.; Dr. Thomas Lauder Brunton, Sc.D.; Prof. W. Kingdon Clifford, M.A.; Augustus Wollaston Franks, MA.; Prof. Olaus Henrici, Ph.D.; Prescott G. Hewett, F.R.C.S.; John Eliot Howard, F.L.S.; Sir Henry Sumner Maine, LL.D.; Edmund James Mills, D.Sc.; Rev. Stephen Joseph Perry, F.R.A.S.; Dr. Henry Wyldbore Rumsey; Alfred R. C. Selwyn, F.G.S.; Major Charles William Wilson, R.E.

IT is stated that Dr. J. H. Gladstone, F.R.S., has been nominated to succeed Dr. Odling at the Royal Institution.

THE funeral of the late Professor Phillips will be solemnised at York to-day at 11 A.M. It is understood that this locality was fixed on by himself, other members of his family being buried there.

A DEPUTATION, consisting of Sir Bartle Frere, president of the Royal Geographical Society, Sir James Watson, Lord Provost of Glasgow, Sir William Stirling Maxwell, M.P., and several other members of Parliament, waited on Lord Derby last Friday, to lay before him the claims which exist for an official recognition of the late Dr. Livingstone's arduous services in the cause of humanity and of Science during his long tenure of office as one of Her Majesty's Consuls. The memorial, which was handed to Lord Derby, was signed by many eminent and well-known names, and his lordship said he agreed with the deputation that something ought to be done for the members of Livingstone's family. There seems no doubt that Government will meet the wishes of the country in this matter.

ON Monday night, at the usual meeting of the Royal Geographical Society, the principal business of the evening consisted of reading extracts from the letters of Dr. Livingstone to Sir H. Rawlinson, to Sir R. I. Murchison, to Sir Bartle Frere, and to some private friends. This correspondence extended over six or seven years. Very voluminous materials have been preserved, but the work of editing them has yet to be performed. Sir Bartle Frere was happy to say that the son of the illustrious traveller accepted the duty of editing the materials left by his father, and had resigned a promising career in Egypt for that purpose.

THE *Spectator* proposes that as an appropriate memorial to the late Dr. Livingstone, some Exploration Scholarships should be founded, to be called by the explorer's name.

MR. F. J. SCHUSTER has made a donation of 225*l.* to the Physical Laboratory of Owens College, Manchester, for the purpose of buying apparatus.

THE Royal Irish Academy has sanctioned the following grants from the fund at its disposal for aiding scientific researches by providing suitable instruments and materials :—30*l.* to Messrs. Studdert and Caldwell for the chemical analysis of the mineral waters at Lisdoonvarna, in the county of Clare; 30*l.* to Prof. Macalister, to be expended in the purchase of rare insectivora and other mammals for dissection, in order to enable him to report on the myology of mammals; 40*l.* to Mr. W. H. Bailey, to investigate the fossils of the coal districts in Ireland, with a view to their comparison with those of British and other coal-fields; 50*l.* to Prof. Haughton, to complete an investigation into the chemical and mineral composition of the successive lava-flows of Vesuvius; 39*l.* 17*s.* 11*d.* (being the remainder of the fund) to Dr. David Moore, for the investigation and cataloguing of the Irish Hepaticæ. Gentlemen purposing to undertake scientific researches during the coming year, and desirous to obtain grants from this fund, are invited to send in their applications to the secretary of the Academy without delay.

THE Ogham inscribed stones, ten in number, purchased by the Royal Irish Academy from the representatives of the late Mr. Windele, have been arranged in the crypt of their Museum with the other Ogham stones belonging to the Academy, one being set vertically in the floor, and the others placed either on iron stands in the bays at the south side, or on the dwarf walls forming the bays. These stones are now all easy of access, and, in the daytime, have the advantage of a light well adapted to the examination of their respective inscriptions. The Academy is in possession of 134 photographic negatives of Ogham inscriptions, representing about eighty different texts. It is intended to print these in autotype, and thus to afford to inquirers in this curious branch of study authentic copies of considerably more than half the whole number of such inscriptions known to exist. They will be accompanied by short notices, strictly limited to a statement respecting the localities where the inscriptions were found, and other matters of fact respecting them; the philological discussion and interpretation of them being left to the free competition of scholars.

REAR-ADMIRAL CHARLES H. DAVIS was ordered, on Feb. 23, to the duty of superintendent of the Naval Observatory at Washington, U.S., in place of Rear-Admiral Sands, who has been detached and placed on the retired list, in accordance with the rules of the service. Admiral Sands, during his tenure of office, has merited the respect and goodwill of British Astronomers, who will view with regret the necessary termination of his functions.

AMONGST the estimates passed by the House of Commons on Friday last was 80,000*l.* to continue the works on the New Natural History Museum at South Kensington, with which rapid progress is now being made.

IN answer to a question in the House of Commons on Tuesday Viscount Sandon stated that arrangements consequent on the retirement of Mr. Cole were now the subject of consideration by the Science and Art Department, but had not yet been completed.

THE Council of the Paris Observatory is said to have protested against a ministerial decision which allowed the Bureau des Longitudes to take the half of the astronomical library, which has been forming during centuries, and which is one of the richest in the world. It is almost certain that the decision will be cancelled, M. Leverrier having given the alternative of leaving the whole of the books in the hands of the Bureau, and refusing to be a party to such a mutilation. When the library shall be saved, it will be open to the public under certain regulations.

WE recently announced the oppressive treatment to which M. Alglave, editor of *La Revue Scientifique* and Professor of Law at Douai, had been subjected; there is no doubt now that his suspension by the Minister of Public Instruction has been caused by his refusal to resign the editorship of the journal just mentioned and of the *Revue politique et littéraire*, of which he is also editor. On Monday week, on his going to open his class for the term, he received a letter from the Under-Secretary of the Education Department informing him that his course would be suspended until further notice. Science has many difficulties to contend with in this country, but happily vexatious interference on the part of the State is not one of them.

A PAPER on the grasses and fodder plants which may be beneficial to the squatter and agriculturist in South Australia, by Dr. Richard Schomburgk, director of the Adelaide Botanic Gardens, has been officially published by order of the Governor.

IT is stated in the *Scientific American* that the well-known and much admired Japan lacquer-work, the secrets of which were supposed to be known only to the Easterns, has been successfully reproduced, or rather imitated, in Holland. The lacquer is prepared from Zanzibar copal, coloured black with Indian ink. The articles are painted with several coats of this lacquer, in which the pieces of mother-o'-pearl or other substances used for ornamentation are placed before it becomes hard. The lacquer is then dried by placing the articles in a heated oven or furnace, after which another coat of lacquer is applied, and when dry smoothed with pumice, which is repeated until all cracks are filled up and the surface has become perfectly smooth, when the whole is polished, or rather burnished, with tripoli.

THE Russian Scientific Expedition to the Amu Daria was to set out on Monday last. The expedition will be commanded by the Grand Duke Nicholas Constantinovitch, assisted by Colonel Stoletoff and Dr. Moreff, secretary. It will include 25 persons, whose work will be divided into four sections:—(1) The Trigonometrical and Topographical. (2) The Meteorological Section, which will construct two stations on the Amu Daria, at one of which hourly observations will be made of all the meteorological phenomena. (3) The Ethnographical Statistical Section. (4) The Natural History Section.

THE meeting of French Astronomers took place last week at the Ministry of Public Instruction, under the presidency of M. Leverrier. It was composed of M. Dumeril, director of the *Enseignement*, the astronomers from Paris, Toulouse, and Marseilles Observatories, and Officers from the General Staff of the Trigonometrical Survey. Four sittings were held, and an account of them will be issued shortly. Steps have been taken for the determination of the latitude of Algiers, by telegraph. M. du Barail, Minister of War, and M. Saget, his Staff-Officer, visited the Observatory last Saturday, in order to see for themselves how the work may be begun without further delay.

THE additions to the Zoological Society's Gardens during the last week include four Bladder-nosed Seals (*Cystophora cristata*) from Greenland, presented by Capt. Alex. Gray; a White-winged Whydah Bird (*Urobrachya albonotus*) from West Africa, presented by Mr. J. Fairchild; a Rose-crested Cockatoo (*Cacatua moluccensis*) from the Moluccas, presented by Mr. H. Baldwin; an Azara's Fox (*Canis azaræ*) from South America; a Snowy Owl (*Nyctea nivea*) from South America; a Green-cheeked Amazon (*Chrysotis viridigenalis*) from Columbia, purchased.

ON THE REFRACTION OF SOUND*

THE principal object of this paper is to show that sound, instead of proceeding along the ground, is lifted or refracted upwards by the atmosphere in direct proportion to the upward diminution of the temperature; and hence to explain several phenomena of sound, and particularly the results of Prof. Tyndall's recent observations off the South Foreland.

The paper commences with the explanation of the effect of wind upon sound, viz., that this effect is due to the lifting of the sound from the ground, and not to its destruction, as is generally supposed. The lifting of the sound is shown to be due to the different velocities with which the air moves at the ground and at an elevation above it. Owing to friction and obstructions the air moves slower below than above, therefore sound moving against the wind moves faster below than above, and the bottom of the sound waves will thus get in advance of the upper part, and the effect of this will be to refract or turn the sound upwards; so that the rays of sound which would otherwise move horizontally along the ground actually move upwards in circular or more hyperbolic paths, and may thus, if there is sufficient distance, pass over the observer's head. This explanation was propounded by Prof. Stokes in 1857, but it was discovered independently by the author.

The paper then contains descriptions of experiments made with a view to establish this explanation.

These experiments were made with an electric ball, over a nearly flat meadow, and again over the same when it was nearly covered with snow, and it was found (as indeed it was expected) that the condition of the surface very materially modified the results in two ways. In the first place, a smooth surface like snow obstructs the wind less than grass, hence over snow the wind has less effect in lifting the sound moving against it than over grass; and it is inferred that a still greater difference would be found to exist in the case of smooth water. In the second place, the ends of the waves of sound travelling along in contact with the rough ground are continually destroyed by the roughness, and the sound from above slowly diverges down to replace that which is destroyed, and this divergence gradually weakens the intensity of the lower parts of the waves, so that, under ordinary circumstances, the sounds which pass above us are more intense than those we hear. The general conclusions drawn from these experiments are:—

1. The velocity of wind over grass differs by ½ at elevations of 1 and 8 feet, and by somewhat less over snow.

2. That when there is no wind, sound proceeding over a rough surface is destroyed at that surface, and is thus less intense below than above; owing to this cause the same sound would be heard at more than double the distance over snow at which it could be heard over grass.

3. That sounds proceeding *with* the wind are brought down to the ground in such a manner as to counterbalance the effect of the rough surface (2), and hence, contrary to the experiments of Delaroche, the range of sound over rough ground is greater with the wind than at right angles to its direction or than when there is no wind. When the wind is very strong it would bring the sound down too fast in its own direction, and then the sound would be heard farthest in some direction inclined to that of the wind though not at right angles.

4. That sounds proceeding against the wind are lifted off the ground, and hence the range is diminished at low elevations. But that the sound is not destroyed and may be heard from positions sufficiently high (or if the source of sound be raised) with even greater distinctness than at the same distances with the wind.

5. In all cases where the sound was lifted there was evidence of diverging rays. Thus although on one occasion the full intensity was lost when standing up at 40 yards the sound could be faintly and discontinuously heard up to 70 yards. And on raising the head the sound did not at once strike the ear with its full intensity nor yet increase quite gradually; but by a series of steps and fluctuations in which the different notes of sound were variously represented, showing that the diverging sound proceeds in rays separated by rays of interference.

On one occasion it was found that with the wind sound could be heard at 360 yards from the bell at all elevations, whereas at right angles it could be only heard for 200 yards standing up, and not so far at the ground; and against the wind it was lost at 30 yards at the ground, at 70 yards standing up, and 160 yards at an elevation of 30 feet, although it could be distinctly heard at this latter point from a few feet higher.

It hence appears that these results agree so well with what might be expected from the theory as to place its truth and completeness beyond question.

The author then goes on to argue from the action of wind upon sound to another phenomenon which admits of a somewhat similar explanation. The effect of wind together with that of a rough surface in lifting the sound may be shown to account for many of the apparently capricious variations in the intensity with which sounds can be heard at different times; and it gives a reason for the custom which prevails of elevating church bells, platforms, &c., where the sounds are intended to be heard at a distance. But it does not explain a fact, which has often been observed, namely, that distant sounds can be heard much better during the night than during the day, and on dull cloudy days better than on bright hot days. This phenomena has engaged the attention of Humboldt, Delaroche, and recently of Prof. Tyndall, who have all assumed that the sound is obstructed or destroyed in the bright hot air, and have suggested causes which they thought might produce this effect. These suggestions are all more or less open to objection, and none of them meet the difficulty that any heterogeneous condition of the air which could obstruct sound must more or less refract or reflect light and so render vision indistinct. In this paper the author gives another explanation, in which he shows how, as in the case of wind, the sound may be lifted and not destroyed.

It is argued that since wind raised the sound simply by causing it to move faster below than above, any other cause which produces such a difference in velocity will lift the sound in the same way. And since the velocity of sound through air increases with the temperature—every degree from 32 to 70 adding 1 foot per second to the velocity—therefore an upward diminution in the temperature of the air must produce a similar effect to that of wind and lift the sound. Whereas Mr. Glaisher has shown by his balloon observations that such a diminution of temperature exists, and further he has shown that when the sun is shining with a clear sky the variation from the surface is 1° for every

* On the Refraction of Sound by the Atmosphere, By Prof. Osborne Reynolds, Owens College, Manchester. Abstract of paper read before the Royal Society April 23.—Communicated by the Author.

100 ft., and that with a cloudy sky it is only half what it is with a clear sky. These results were from the mean of his observations; under exceptional circumstances the variations were both greater and less. It is hence shown that rays of sound otherwise horizontal would be bent upwards in the form of circles, the radii of which with a clear sky are 110,000 ft., and with a cloudy sky 220,000 ft., so that the refraction is double as great on bright hot days as it is when the sky is cloudy, and still more under exceptional circumstances, and comparing day with night.

It is then shown by calculation that the greatest refraction—110,000 ft. radius—is sufficient to render sound from a cliff 235 ft. high inaudible on a ship's deck 20 ft. high at $1\frac{3}{4}$ miles, except such sound as might reach the observer by divergence from the waves above, whereas when the refraction is least—220,000 ft. radius—or where the sky is cloudy, the range would be extended at $2\frac{1}{2}$ miles with a similar extension for the diverging waves. It is hence inferred that the phenomenon which Prof. Tyndall observed on July 3, and other days—namely that when the air was still and the sun was hot he could not hear guns and sounds from the cliffs of South Foreland, 235 ft. high, for more than two miles, whereas when the sky clouded, the range immediately extended to three miles, and as evening approached much farther,—was due, not so much to stoppage or to reflection of the sound by invisible vapour as Prof. Tyndall has supposed, but to the sounds being lifted over his head in the manner described; and that had he been able to ascend 30 ft. up the mast, he might at any time have extended the range of the sound by a quarter of a mile at least. Or had the instruments on the top of the cliff been compared with similar instruments at the bottom, a very marked difference would have been found in the distances at which they could be heard.

It seems that there were instruments at the bottom, and it is singular that throughout his report Prof. Tyndall makes no comment on their performance, unless they were at once found to be so inferior to those at the top that no further notice was taken of them; this seems possible, since beyond mentioning that they were there, Prof. Tyndall throughout his report never refers to them.

It also seems that besides those results of Prof. Tyndall's experiments, there are many other phenomena connected with sound, of which this refraction affords an explanation, such as the very great distances to which the sound of meteors has been heard as well as the distinctness of distant thunder. When near, guns make a louder and more distinctive sound than thunder, although thunder is usually heard to much greater distances. In hilly countries, or under exceptional circumstances, sounds are sometimes heard at surprising distances. When the Naval Review was at Portsmouth, the volleys of artillery were very generally heard in Suffolk, a distance of 150 miles. The explanation being that owing to refraction (as well as to the other causes) it is only under exceptional circumstances that distant sounds originating low down are heard near the ground with anything like their full distinctness, and that any elevation either of the observer or of the source of sound above the intervening ground causes a corresponding increase in the distance at which the sound can be heard.

SCIENTIFIC SERIALS

Memorie della Societa degli Spectroscopisti Italiani, February.—Father Secchi contributes a paper On his Observations of Solar Prominences from April 23 to October 2, 1873. From his tables it appears that the sun was observed on 127 days, when 1,052 prominences were seen, being more than 8 a day, the maximum number visible on any one day was 13, and the minimum 2. The greatest number of prominences over 64″ high occurred in lat. 30° 40′ N. and 20° 30′ S. The greatest number of prominences of all kinds were in lat. 20° 30′ N. and 10° 20′ S. The same author also makes some remarks on the spectroscopic observations of the transit of Venus.

Astronomische Nachrichten, Nos. 1,980–1,981.—These numbers contain a large quantity of observations of positions of the minor planets and comets made in 1873 by Leopold Schulhof. He also gives the positions of more than 100 variable stars, with remarks on a new variable position for 1850, RA 23° 10′ 35″ Dec. – 19° 39′·7. Prof. Peters gives the position of Planet 135, Feb. 18, 1874, at 14h. 37m. 40s., Hamilton College, M.T., RA 11h. 19m. 42·7s. Dec. + 4° 25′ 5″·11 mag. G. Spoerer gives the positions of spots and prominences for February last. J. Palisa gives the position of the planet discovered by him on March 18, 4h. 46m. 39s. RA 12h. 22m. 2·12s. Dec. – 3° 19′ 33″·4.

No. 1,982 contains a long paper On a Method of Computing Absolute Perturbation, being in great measure similar to that of Laplace.

Journal of the Franklin Institute, March.—This number contains an account, by Mr. Crew, of the "prismoidal" one-rail railway (of his invention), of which he has made two years' trial in Alabama, with encouraging results. The cars are kept securely on the prismoidal track by a combination of wheels; a centre one, at either end, on the rail, kept on the track by revolving flanged wheels at either side; and wheels on the sides of the prismoid, with strong wrought-iron bars to the side of the car; these keep the car upright. One proposed application of the system is that of elevated rapid transit by steam through crowded streets in populous cities. As to speed, Mr. Crew thinks even 100 miles an hour would be possible; there is no oscillation through lateral motion.—Mr. Richards continues his Principles of Shop Manipulation for Engineering Apprentices; treating of belts, gearing, hydraulic and pneumatic apparatus as means of transmitting power, and of "machinery of application" of power.—Mr. Isherwood points out a method of ascertaining what portion of the feed-water admitted to a boiler is entrained in the form of spray by the escaping steam.—Details with reference to the Girard Avenue Bridge (which will form the chief entrance to the West Park, at Philadelphia), are furnished by Mr. Hering.—Prof. Thurston claims for Count Rumford a higher place in connection with thermo-dynamics than has hitherto been assigned to him; affirming that he first, and half a century before Joule, determined with almost perfect accuracy the mechanical equivalent of heat, while the sole credit of discovering the true nature of heat is due to him.—We may note, in addition, a paper On Railway Crossings and Turnouts, by Mr. Evans, and one On the Sanitary Care and Utilisation of Refuse in Cities, by Dr. Leas, who describes, more especially, the system followed in Baltimore.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, April 23.—On some points connected with the Circulation of the Blood, arrived at from a study of the Sphygmograph Trace, by A. H. Garrod, B.A., Fellow of St. John's College, Cambridge.

The author commences by giving a table containing a fresh series of measurements of the ratio borne by the cardiosystole * to its component beat in the cardiograph trace. These tend strongly to substantiate the law previously published by him, viz., that the length of the cardiosystole is constant for any given pulse-rate, and that varies as the square root of the length of the pulse-beat only, being found from the equation $xy = 20\sqrt{x}$ when x = the pulse-rate and y = the ratio borne by the cardiosystole to the whole beat.

A similar series of fresh measurements are given in proof of the law previously published by him, that in the sphygmograph trace from the radial artery at the wrist, the length of the sphygmosystole † is constant for any given pulse-rate, but varies as the cube-root of the length of the pulse-beat, it being found from the equation $xy' = 47\sqrt[3]{x}$, where x = the pulse-rate, and y' = the ratio borne by the sphygmosystole to the whole beat.

By measurement of sphygmograph tracings from the carotid in the neck and posterior tibial artery at the ankle, it is then shown that the length of the sphygmograph in those arteries is exactly *the same* as in the radial; so that the above-stated law as to the length of the sphygmosystole in the latter applies to them also, and must therefore equally apply to the pulse in the aorta.

Such being the case, by comparing the equations for finding the length of the cardiosystole with that for finding the aortic sphygmosystole, the relation between the whole cardiac systolic act and the time during which the aortic valve remains open can be estimated with facility; for by subtracting the shorter sphygmosystole from the longer cardiosystole a remainder is obtained which can be nothing else than the expression of the

* The *cardiosystole* is the interval between the commencement of the systole and the closure of the aortic valve in each revolution.

† The *sphygmosystole* is the interval between the opening and closure of the aortic valve in each cardiac revolution.

time occupied by the ventricle at the commencement of its systole in raising its internal pressure to that of the blood in the aorta, which must occur before the aortic valve can open up. This interval is named the *syspasis*. Its length is found to decrease ve y rapidly with increase in the pulse-rate, and to become *nil* at a pulse-rate of 170 a minute. An attempt is made to explain these phenomena.

If the above considerations are correct, certain independently obtained measurements ought on comparison to correspond; for by reference to one of the papers in the Society's Proceedings it is shown that the length of the there-termed second cardio-arterial interval (which may be called the second cardio-radial interval, as the artery under consideration was the radial), can only represent the time taken by the second or dicrotic wave of the pulse in travelling from the aortic valve to the wrist. This being so, there is every *à priori* reason in favour of the earlier primary wave taking the same time in going the same distance; which can be expressed in other terms by saying that the length of the first cardio-radial interval, from which that of the syspasis has been subtracted, ought to be exactly the same as that of the second cardio-radial interval. That such is the case is proved by the two measurements, which have been arrived at independently, agreeing in all cases *to three places of decimals*, which is great evidence in favour of the accuracy of the methods and arguments employed.

The latter part of the paper is occupied with the description of and the results obtained by the employment of a double-sphygmograph, by means of which simultaneous tracings are taken from two arteries at very different distances from the heart. The arteries experimented on are the radial at the wrist and the posterior tibial behind the ankle, 29 and $52\frac{1}{2}$ inches respectively from the aortic valves. From the resulting traces the time occupied by the pulse-wave in travelling the differenceof distance—$(52 \cdot 5 - 29) = 23 \cdot 5$ inches is given—is found to be 0·0012 of a minute in a pulse of 75 a minute, and it is shown that this varies very little with difference in pulse-rate, as other considerations would lead us to expect; it is also proved that *there is a marked acceleration of the pulse-wave as it gets further from the heart.*

By superposing the simultaneous trace from the wrist on that from the ankle, direct verification is obtained of the earlier proposition, that the sphygmosystole at the wrist and at the ankle are of exactly similar duration. The peculiarities of the ankle trace are also referred to.

Geological Society, April 15.—John Evans, F.R.S., president, in the chair.—The following communications were read: About Polar Glaciation, by J. F. Campbell. The author commenced by referring to a reported statement of Prof. Agassiz, to the effect that he supposed the northern hemisphere to have been covered in glacial times from the pole to the equator by a solid cap of ice. He described his observations made during thirty-three years, and especially those of last summer, when he travelled from England past the North Cape to Archangel, and thence by land to the Caucasus, Crimea, Greece, and the south of Europe. His principal results were as follows:—In advancing southwards through Russia a range of low drift hills occurs about 60° N. lat., which may perhaps form part of a circular terminal moraine left by a retreating polar ice-cap; large grooved and polished stones of northern origin reach 55° N. lat. at Nijni Novgorod, but further east and south no such stones could be seen. The highest drift beds along the whole course of the Volga seem to have been arranged by water moving southwards. In America northern boulders are lost about 39°, in Germany about 55°, and in Eastern Russia about 56° N. lat., where the trains end and fine gravel and sand cover the solid rocks. Ice-action, in the form either of glaciers or of icebergs, is necessary to account for the transport of large stones over the plains, and the action of moving water to account for drift carried farther south. There are no indications of a continuous solid ice-cap flowing southward over plains in Europe and America to, or nearly to, the equator; but a great deal was to be found on shore to prove ancient ocean circulation of equatorial and polar currents, like those which now move in the Atlantic, and much to prove the former existence of very large local ice-systems in places where no glaciers now exist.—Note regarding the Occurrence of Jade in the Karakash Valley, on the southern borders of Turkestan, by Dr. Ferdinand Stoliczka, Naturalist attached to the Yarkund Mission. In this paper the author described the jade-mines on the right bank of the Karakash river formerly worked by the Chinese. There are about 120 holes in the side of the hill, and these at a little distance look like pigeon-holes. The rocks are a thin-bedded, rather sandy syenitic gneiss, mica- and hornblende-schists, traversed by veins of a white mineral, apparently zeolitic, which in turn are traversed by veins of jade.

Zoological Society, April 21.—Viscount Walden, F.R.S., president, in the chair.—The secretary read a report on the additions that had been made to the Society's Menagerie during the month of March 1874. Amongst these particular attention was called to a scarce Parrot (*Chrysotis finschi*), of which a specimen had been presented by Mrs. Chivers.—A communication was read from Mr. Morton Allport On the capture of a Grilse in the River Derwent, in Tasmania, showing that the salmon had really been successfully introduced into the colony.—Communications were read from Dr. J. E. Gray, F.R.S., On the very young of the Jaguar, *Felis* (*Leopardus*) *onca*; On the short-tailed Armadillo, *Muletia septemcincta*; On the young of the Bosch Vark, *Patomochœrus africanus*, from Madagascar; and On the Skulls of the Leopard in the British Museum.—A communication was read from Dr. O. Finsch, containing the description of a new species of Penguin, from New Zealand, which he proposed to call *Eudyptula albosignata*.—Mr. Edwin Ward exhibited the skull and horns of a fine specimen of the Persian Stag (*Cervus maral*) from the Crimea.—A communication was read from Capt. W. H. Unwin, containing an account of the breeding of the Golden Eagle (*Aquila chrysaetos*) in North-Western India.—Mr. J. E. Harting read a paper On a new species of *Tringa*, from St. Paul's Island, Alaska, which he proposed to name *Tringa gracilis*.—A communication was read from Lieut. R. Wardlaw Ramsay, giving the description of an apparently new species of Woodpecker, which he had obtained in a teak-forest, about six miles to the north of Tanghoo in British Burmah. Mr. Ramsay proposed to name it *Gecinus erythropygius*.—Messrs. W. T. Blanford and H. E. Dresser read a monograph of the genus *Saxicola*, Beechstein, being an attempt to reduce into some order the excessively confused nomenclature of the species composing this genus.

Royal Horticultural Society, April 15.—Scientific Committee.—M. T. Masters, M.D., F.R.S., in the chair.—Mr. Worthington Smith exhibited a drawing of a very curious fasciation in the aërial roots of *Aerides crispum*, in which the roots presented the curious flattened appearance so often met with in the branches of the ash, the shoots of asparagus, &c.—Mr. W. G. Smith also showed a drawing of the very rare *Angræcum ellisii*, from the collection of Mr. Day, of Tottenham. Mr. Smith remarked that the flowers turn brown when bruised.—Mr. Smith also showed a wood-engraving made on the wood of green ebony, *Brya ebenus*. Mr. Smith reported that for engraving purposes this was as good as bad box.—Prof. Thiselton Dyer showed dried specimens of a variety of *Hibiscus rosa-sinensis* from Zanzibar, where it was found wild by Dr. Kirk. The petals are palmately cut, as in *Clarkia*, *Schizopetalum*, &c. Dr. Masters made some remarks on the analogy the divided petals of this plant presented with the stamens of mallows, which it is now supposed consist of five primary organs, subsequently dividing into numerous anther-bearing filaments. It is doubtful whether *Hibiscus rosa-sinensis* has been heretofore observed in a truly wild condition. The discovery of the plant in east tropical Africa is therefore particularly interesting. It is possible, however, that it may prove a distinct species.—Prof. Thiselton Dyer also showed an elegant white fungus, having the appearance of lace, from Santarem. The Rev. M. J. Berkeley considered it probable that it was the fungus published by Kunze as *Rhizomorpha corynephora*. —Mr. Andrew Murray exhibited a fungoid production existing on trees over a considerable space in the Yosemite Valley, in California. Mr. Berkeley considered it near to the fungus called *Dothidea morbosa*, but there was also a gall on the same shoot.—Mr. Murray exhibited larvæ of a beetle closely allied to *Hammaticherus heros*, a beetle very destructive to timber in Germany, found feeding on the roots of fir near Enfield. Specimens of the perfect living insect have from time to time been found in the gun-stocks of walnut wood in the small-arms factory. It seems, therefore, a fair inference that the insects had escaped thence, and may perhaps have become naturalised—a most undesirable thing, for the larva is very destructive to timber. Mr. Blenkins remarked that he was familiar with the insect in the Crimea.

General Meeting.—H. Little in the chair.—The Rev. M. J. Berkeley commented on the plants exhibited. *Arthropodium cirrhatum* was an interesting plant of striking habit from New Zealand. When first introduced into this country, some years ago, it was supposed to have come from New Holland.

Physical Society, April 18.—Dr. Gladstone, F.R.S., in the chair.—Dr. W. H. Stone read a paper On Wind Pressures in the human chest during performance on wind instruments. The author's object was to ascertain (1) what was the extreme height of a column of water which could be supported by the muscular act of expiration transmitted by the lips: this was found to be about 6 ft.; and (2) what was the actual pressure corresponding to the full production of a note on each of the principal wind instruments. It was found that with the majority of wind instruments the pressure required for the high notes is considerably greater than that required for the low notes, each instrument having a pressure-ratio of its own. The clarinet is an exception to the rule.—Mr. Tribe illustrated by experiments the action of hydrogen upon finely divided metals, such as are produced by precipitation.

Edinburgh

Royal Physical Society, April 22.—R. Scot Skirving, president, in the chair.—Recent Modes of determining the Impurity of Milk, by J. Falconer King, City Analyst. The only sure way to determine the quality of milk is to make a proper and careful chemical analysis of it.—Additional Note on the Suspension of Clay in Water, by Wm. Durham. Finely-powdered silica was found to behave in a manner generally similar to clay. Experiments seem to show that each solution has a specific capacity of sustaining clay, and also that this capacity varies in a specific manner according to the strength of the solution.—Note on the Formation of Boulder Clay, by D. J. Brown. Mr. Brown advocated that the usually accepted theory of the land origin of boulder clay would not explain the nature of this remarkable deposit, and considered that it was formed at the line of junction of the Arctic glacier with the sea.—On Fused Stones, showing Columnar Structure from a Pictish Tower, by the Rev. Jas. M. Joass, Golspie. These stones, in their columnar structure, illustrate, though on a small scale, an important geological phenomenon. The instance usually cited in illustration of the development of columnar structure in a melted mass is that of grain-tin, which forms rude columns on cooling. The author ventures to think that these fused stones afford a new and rather better illustration of the geological phenomenon, more closely analogous to the case of lavas, inasmuch as we have, in fact, a fused silicate, an artificial lava, forming columns the same in character as those of the Giant's Causeway, Samson's Ribs, or the pillars of Fingal's far-famed cave.

Paris

Academy of Sciences, April 20.—M. Bertrand in the chair.—The following communications were read:—Letter relating to a calculation, by Pouillet, on the cooling of the sun's mass, by M. Faye. The author showed that Pouillet's calculation tacitly implied that the sun's mass was not susceptible of contraction, and again restated his belief that solar radiation is not maintained by external causes, but is to be looked for in the formation of the sun itself, and in the enormity of its mass.—Observations concerning a communication, by M. Crocé Spinelli, on the lines of aqueous vapour in the solar spectrum, a letter from P. Secchi to the perpetual secretary. The author stated, that although the elements of water would be dissociated at the high temperature of the sun, their combination might take place in the ascending currents accompanying spots and eruptions owing to the lowering of temperature in these currents produced by expansion.—Tenth memoir on the formation of various crystalline substances in capillary spaces, by M. Becquerel.—New researches on the cyanogen series, by M. Berthelot. A continuation of this author's valuable researches in thermo-chemistry.—Heat of formation of the Cyanogen compounds, by M. Berthelot.—On Phylloxera and the American vines at Roquemaure (Gard), a note by M. J. E. Planchon.—Collimating level and its employment for foggy horizons, by M. G. M. Goulier.—On Orometric dials, specially applicable to pocket barometers, by the same author.—On partial differential equations which can be integrated without arbitrary functions, by M. de Pistoye.—On the "singular points" of algebraical plane curves, by Mr. Halphen.—On the rôle of salts in the action of potable waters on lead, by M. Fordos. The author recommended, as the results of his experiments, the filtration of all water issuing from leaden conduits.—Mode of preservation of the wood employed in large manufactures and in railways, by M. Hubert. The preservative is hydrated ferric oxide.—On the absorption of oxygen and the emission of carbonic acid by leaves kept in darkness, by MM. P. P. Dehérain and H. Moissan. The authors have proved that leaves kept in the dark give off a quantity of CO_2 increasing with the temperature, that the quantity of CO_2 given off is comparable to that given off by cold-blooded animals, that the leaves absorb more oxygen than they give off CO_2, and that they continue to evolve CO_2 in an atmosphere deprived of oxygen.—Facts concerning the vibration of the air in sonorous pipes, by M. E. Gripon.—On a new thermo-electric pile, by M. C. C. Clamond.—On a volume regulator for gas currents, by M. H. Giroud.—On tetra-iodide of carbon, by M. G. Gustavson. This substance has been obtained by the action of tetrachloride of carbon upon di-aluminic hexiodide, according to the equation $3Cl_4 + 2Al_2I_6 = 3CI_4 + 2Al_2Cl_6$; the two substances being dissolved in carbon disulphide. It was described as a red crystalline substance decomposed by heating in the air into CO_2 and free iodine.—New researches on black phosphorus, by M. Blondlot.—Action of pure hydrogen on silver nitrate, by M. H. Pellet. The author stated that a neutral or slightly acid solution of the salt is not reduced in the cold by pure hydrogen, and that an alkaline solution is reduced in the cold to an extent proportional to its alkalinity, elevation of temperature increasing the reducing action.—Researches on soluble phosphates used in agriculture, by M. A. Millot.—On the direct determination of the degree of intensity of explosive mixtures: application of the method to gunpowders, by M. Chabrier.—Action of bromine on dibromsuccinic acid; tribromsuccinic acid, by M. E. Bourgoin. The following substances are obtained by the action of bromine and water on the acid: tribromsuccinic and dibrom-maleic acids and dibrominated ethylene dibromide.—On the alcohols contained in the acid liquors of starch manufactories and in the products of the butyric fermentation of glucose, by M. G. Bouchardat. These are ethylic, normal propylic, and butylic alcohols.—On the determination of alcohol in water, wines and saccharine liquors, by M. Salleron.—General method for the transformation of alcohols into nitric ethers, by M. P. Champion. The reagent employed is nitro-sulphuric acid.—On phenyl-allyl, by M. B. Radziszewski.—On pyrogallol in presence of iron salts, by M. E. Jacquemin.—On the colouring matter of wine, by M. E. Duclaux.—On the volatile acids of wine, by the same author.—Movements excited in the stamens of *Mahonia* and *Berberis*; anatomical conditions of this movement, by M. E. Heckel.—On the direction of the wind in the high and low (atmospheric) regions during the storm of April 13, 1874, by M. Chapelas.—During the meeting a commission was appointed to prepare a list of candidates for the vacancy of foreign associate caused by the death of M. De la Rive.

BOOKS RECEIVED

English.—Handbook of Practical Telegraphy. 6th edit.: R. S. Culley (Longmans).—Mental Physiology: W. B. Carpenter (H. S. King & Co.).—The Design and Construction of Harbours: Thos. Stevenson (A. & C. Black).—Our Inheritance in the Great Pyramid: C. Piazzi Smyth (Isbister & Co.).—Longevity: John Gardner (H. S. King & Co.).—The New Chemistry: Josiah P. Cooke (H. S King & Co.).—Hydrostatics and Pneumatics: Lardner and Loewy (Lockwood).—Geology of Suffolk: J. R Taylor (White).—The Universe and the Coming Transits: R. A. Proctor (Longmans).—Haydn's Dictionary of Dates. 14th edit.: B. Vincent (Moxon).

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