THURSDAY, MAY 23, 1878

UNIVERSITY EXTENSION

LAST week two remarkable steps were taken affecting the prospects of universities in this country, each being a new departure from which it will be difficult to recede. On Tuesday the University of London revised its constitution so far as the convocation of graduates could do it, and the changes which were adopted unanimously, or by considerable majorities, would go some way to remove many of the evils connected with that great centre of examination. On Wednesday, the Yorkshire College, Leeds, supported by numerous representatives from the other large towns of the north, waited on the Lord President of the Council to entreat Her Majesty "*if* she is pleased to create a new university, not to give a charter to the Governors of Owens College, Manchester, but to a new Corporation, with powers to incorporate Owens College and such other institutions as may now or hereafter be able to fulfil the conditions of incorporation laid down in the charter"—and also "not to connect the new university by name with any locality." Both of these movements are due to the initiative of Owens College, and if the former should result, as there seems reason to hope, in real improvements in the University of London, the people of Manchester will have done something for sounder views on education and the reform of that system of examination apart from teaching, in which Mr. Lowe recognises the essential excellence of a university.

The Manchester proposal was that Government should grant a university charter to Manchester, which has now 500 regular day students and 800 evening students, and that that charter should entitle it to confer degrees. It was objected, on the one hand, that such a precedent might lead to an indefinite multiplication of competing universities, and a consequent degradation of degrees, and on the other, that the interests of teaching institutions in the neighbourhood, such as the Yorkshire College at Leeds, might be prejudiced by the prestige conferred upon Owens College. With the view of meeting these objections, the authorities of Manchester made two suggestions. They proposed that the examiners for their degrees should be half of them professors in the university, intimately acquainted with the teaching actually given, and half of them outsiders, practically commissioned to guarantee that the degree should not be conferred on any lower qualification than that usually required in other universities. They proposed also that the new university should be empowered to confederate with it other institutions as they arose, where adequate qualifying instruction could be permanently given, and that these institutions should then be admitted to a full proportionate representation. To guard against the danger which might have been real enough, that Owens College would decline to use this power, except upon really unpractical conditions, they proposed that the Privy Council, or other educational authority of the Government, should have the right to revise their acceptance or rejection of new institutions claiming federation. Their scheme started in this way from the basis of an actual and realised success—it proposed a charter to a body which seems generally admitted to have established for itself a real university position and character; it provided guarantees against the degradation of degrees, which would certainly have been repeated in the case of any new claimants to a similar position, and it arranged that institutions like Leeds, with no reasonable ground for expecting, for many years at least, to obtain an independent university position, might fairly anticipate confederation with Manchester, if they so desired, at an early date. The confederation part of the scheme was thus directed to guard the interests of Leeds and of other towns which might soon be in a similar position, but the Manchester people did not offer at once and without further inquiry to admit Leeds or any other college.

The Leeds memorial, on the other hand, reads as if it had been carefully drawn to gather together all possible objections to the Manchester scheme. The object of its promoters may not be, but the effect of its promotion is likely to be, mere delay. The words employed, "If Her Majesty is pleased to create a new university," are calculated to unite in support not only those who think Her Majesty ought to be advised to do so, but any number of persons who think just the opposite. It was supported by Nottingham, which expressly stated that she saw no need for anything further than an affiliation, such as she supposes she has, with the University of Cambridge, and by Dr. Acland, whose speech was entirely directed to prove that no new northern university was wanted or was likely to be useful. The deputation in fact, was for opposition to Manchester, not for the promotion of a rival scheme of a new northern university in which Manchester should only be "*prima inter pares*." The memorialists asked for nothing. They asked that "*if*" the Government were disposed to do anything, they should *not* give a charter to Manchester either in fact or by name. The positive suggestions they put forward alternatively were of the vaguest and most shadowy kind. In place of Manchester, which exists, and has submitted its claims to the consideration of the government and of the country, they suggested that the government should give a charter to "a new corporation, with powers to incorporate Manchester and such other institutions as may now or hereafter be able to fulfil the conditions of incorporation laid down in the charter." No doubt the Government could create a university by giving a charter to a certain number of eminent persons representing localities in the north of England. What, then, would be the basis of the new university? It would consist—in the conditions of incorporation laid down in the charter! "The new university," says Lord Frederick Cavendish, "is to be closely connected with the colleges of the north of England, and adapted to the circumstances of the great industrial community there." What are the colleges of the north of England? Liverpool may possibly have a college some day. Birmingham certainly will. Newcastle, being connected with Durham, makes no claim. Sheffield and Nottingham have buildings in which the work of the Cambridge extension scheme will be regularly carried on. Outside Manchester Leeds alone exists so as to have even the shadow of a claim to a more independent recognition than every one of them possesses through the University of London at the present moment.

If Leeds had wanted to be incorporated on an equal footing with Manchester from the first; if she had been conscious that her present position made that claim unreasonable; if she had utterly disbelieved the Manchester people and their promises to listen to her as soon as she liked, and been convinced that her appeal against them to the Privy Council would be in vain, she would have acted much as she has done in getting up this deputation. The promoters of a real rival scheme would have named the colleges which should at once have been confederated and constituted the new university. It was to use a weapon of war to entreat the Government "*if* they think of chartering a new university," to sit down and evolve a scheme of a "new corporation," and to sketch its fundamental principles in "the conditions of incorporation laid down in the charter."

It seems tolerably plain that the Owens College people in their anxious attempts to be reasonable, to safeguard every interest, and to take account of every susceptibility have gone too far. They have offered terms to Leeds and all similar institutions of the present and future, which Lord Frederick Cavendish, the President of the Yorkshire College, declares "fair and equitable," but which seem only to have aggravated Leeds and to have weakened their own case as against the University of London. Now that that body appears at least to think of returning to the principle of affiliated colleges, she may perhaps soon offer a better centre of affiliation than Manchester or any new college in the north. It has been her deliberate policy for the last twenty years to exercise no control over what used to be called affiliated colleges, which she does not exercise over private tutors and private students. That policy was logical, and it will be more than curious to see how the senate, if they proceed to move in the lines indicated to them in Convocation, will attempt to retrace their steps. Convocation proposes that "the list of such colleges should be revised from time to time," and that the right of "excluding from or admitting to such list" should again be exercised. But it does not say how an affiliated college in the list is to hold any better position in the University than a private "crammer" who stands upon his own capacity for successfully preparing candidates for degrees. It suggests that the authorities of such colleges be entitled to communicate with the Senate from time to time about the examinations. Such communications could not fail to be interesting, but it is difficult to see how they can be given particular effect to, so long as it is the fundamental principle of the University that the non-collegiate should be examined on the same footing as the collegiate student. It proposes that the examiners should form a board for mutual consultation with some authority, and nothing could be better. It suggests that independent research should be recognised in connection with the higher degrees, and the suggestion appears eminently reasonable and practicable. It recommends the foundation of University Chairs for the cultivation of such branches of study as can be more conveniently or more efficiently taught by a central body. It is not very easy to realise the kind of University Chairs suited to a central university with no students directly connected with it and no class rooms. Possibly the occupants of the Chair would have to give isolated courses of lectures, open, perhaps, to the general public, or to students of affiliated colleges, such as are now given at the Royal Institution. Certainly, eminent men could be found to do as much in the way of teaching in connection with the University of London as some of the distinguished occupants of the professorial Chairs of Oxford and Cambridge.

Convocation desires to move towards the rehabilitation of the affiliated colleges which were practically cast adrift twenty years ago, and it will be most interesting to see whether they can be rehabilitated consistently with the fundamental principle that the examinations of the university are to be perfectly open to all students who pay the examination fee. We venture to hazard the prediction that they cannot, and that though the affiliated colleges may be flattered with exceptional courtesies, affiliation will never mean anything very serious so long as the unattached student is not given up. Neither Manchester nor probably the airy confederation sketched out in the supposed interest of Leeds, find any room for the non-collegiate student. The promoters of both schemes will watch with the keenest interest the action of the London Senate in view of the resolutions of Convocation. But there is no such prospect of radical changes in the attitude of the University that either need be postponed.

Owens College would probably have been in a better position to-day if she had never gone out of her way to conciliate Leeds. She has only been wasting an energy that might have been better spent in combating the "Dutch auction" theory of degrees which Lord Ripon brought out with great emphasis at the deputation. The degradation of degrees would be a serious evil, for ordinary degrees are as low at present at Oxford and Cambridge and elsewhere, as any reasonable being can wish. But the multiplication of universities, so far from being an evil, is an unmixed good, and degradation and multiplication are by no means inseparable, though they have frequently been combined. German degrees were at one time in a disgraceful state; American degrees are in a bad way now; Scotch degrees lost caste when St. Andrews, which had no real medical school, sold licences to treat Her Majesty's subjects medically after an easy examination. There is one simple remedy. Let the universities give their degrees without fee or reward, and let these degrees cease to admit directly to any profession. The temptation has always been a pecuniary one. A Dutch auction is only possible in a world where people with brains and no money want to get money out of the pockets of people with no brains. Even without so radical a remedy, the Dutch auctions have been stopped in Germany and in Scotland, and to a large extent in America. They need never begin in Manchester. Let it be arranged that no new degree-granting university shall derive one halfpenny of profit from its degrees, and the whole difficulty vanishes. If there were no fear of the degradation of degrees, it would be as much for the benefit of the people of England that Manchester and Leeds and Birmingham and Liverpool should become University seats in due season, after they have fairly won their title by their own exertions, as Manchester has already done, as that everybody should learn to read and write and count. We cannot understand the real friends of education, even in Yorkshire, spending as much energy to provide the Government with a reason for doing nothing as might itself have built and endowed a college.

PHYSICAL SCIENCE FOR ARTISTS[1]

III.

LET me begin my third paper by an attempt to graphically illustrate the conclusions to which I drew attention at the end of my second. These conclusions were as follows :—(1) Very complex molecules when in vibration give us light that we call white, which light, when split up by a prism, gives us a spectrum consisting of

Red
Orange
Yellow
Green
Blue
Indigo
Violet,

going from one end to the other. We will represent this by open letters (the initials of the various colours) to show that this is a case of the giving out of light.

V I B G Y O R

We next come to the second conclusion. (2) Very simple molecules give us coloured light. When this coloured light is analysed by the prism we find associated with the sensation of colour the fact that in this case the light is not continuous; we do not get a complete spectrum represented by

V I B G Y O R

but when we deal with the molecules of one chemical element we may get only

Y

in the case of another chemical element only

R

in another

V R

and so on, the letters representing that light is only given out in those parts of the spectrum represented by them, and not generally.

This we may also indicate by using black letters for the regions in which light is not given out, and white letters for those where light is emitted, thus

VIBGY**OR**
VIBGYOR
V**IBGYO**R

We get bars of light here and there (the various mixtures of which produce different colours), instead of a *complete series* of bright bars (the mixture of which produces what we call white light).

The decomposition and recomposition of white light to which I have referred is really one of the most beautiful and at the same time most simple experiments in the whole range of optical science. The recomposition has lately been demonstrated by an elegant toy in the shape of a top, on which, while rotating with considerable rapidity, a circular disc of cardboard containing the different colours in their proper proportions painted in sectors

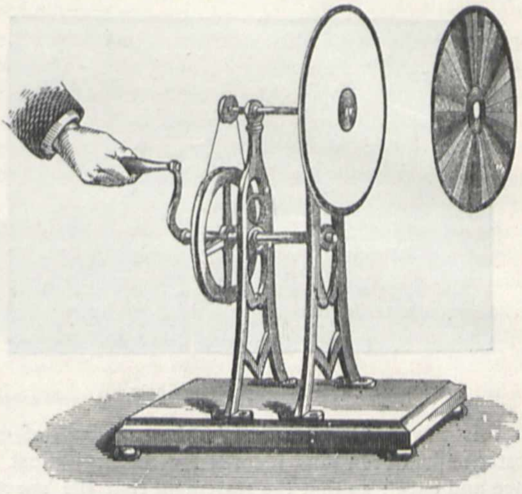


FIG. 1.—Rotating coloured disc experiment.

is placed. A lecture-room experiment of the same form is represented in the accompanying woodcut. The various colours shown on the disc at rest to the right form white light when the disc is rapidly rotated by the handle shown in the figure.

Two common lustres, or still better, two prisms (Fig. 2), enable the recomposition to be well seen. First arrange one prism as on the right in the accompanying diagram (Fig. 3). If the eye be placed where the second prism is to the left, to receive the light passing through the first prism, all the colours will be seen, but if the eye

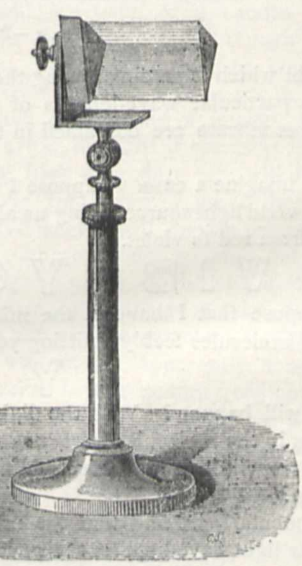


FIG. 2.—Prism mounted on stand.

is replaced by a second prism as shown, the light on emerging from the second prism will be found to be reconstituted, the colours will have again commingled, to form white light. The prism, with its refracting edge

[1] Continued from p. 61.

turned upwards, will have exactly undone the work done by the prism with its refracting edge turned downwards.

For the last fifteen years students have been occupied in mapping the spectra of coloured light sources, and the

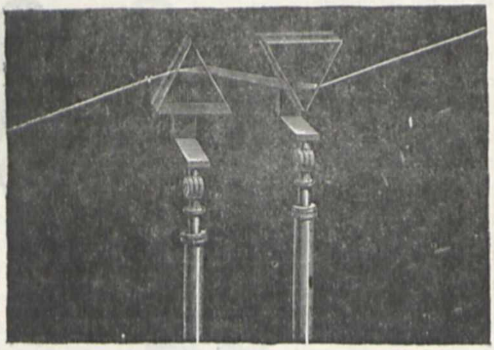


FIG. 3.—Recomposition of light.

result is now that every line in the spectrum of every substance has been thus recorded with the utmost diligence and care; so that the statement that the spectrum we get from the ultimate molecules of each different chemical substance is different, is substantiated by a most overwhelming mass of evidence.

It must be understood that in what I have stated I have represented the phenomena as being much more simple than they really are. It is quite true we can, by toning down the molecular motion, make the spectrum of each chemical element only occupy one of the spectral regions as a rule; but it is equally true that when the motion is great all the regions are filled with lines as the two following examples (Figs. 4 and 5) will show.

Here, then, is the sure and certain knowledge that we possess regarding the motions of molecules so far as one cause of the coloured phenomena observed in Nature is concerned. There is another result which has been gathered in the region of the infinitely little which helps us to another cause of these phenomena.

So far we have considered these ultimate molecules in a state of extreme vibration. As a matter of fact, so long as we are dealing with these ultimate finenesses of matter, we can still assure ourselves of the motion of the molecules when their vibrations are far less vivid. How is this accomplished?

In this way. The molecules are so apt to vibrate each in its own period that they will even take up vibrations

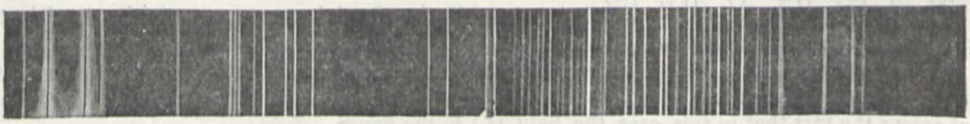


FIG. 4.—Part of the blue region in the spectrum of a mixture of incandescent aluminium, calcium, and iron vapours, showing how the images of the slit produce the appearance of bright lines.

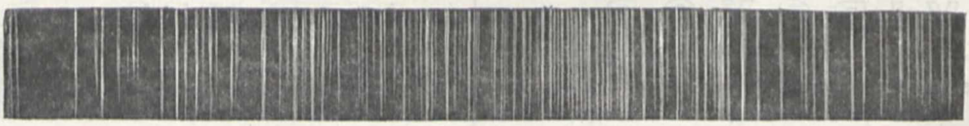


FIG. 5.—Part of the blue region in the spectrum of incandescent iron vapour.

from light which is passing among them, provided always that the particular wave-lengths of light in which they themselves vibrate are contained in the light which they receive.

Let us imagine a case. Suppose I have at one end of a room a vivid light source giving us all the possible waves of light from red to violet.

V I B G Y O R

Also suppose that I have in the middle of the room a screen of molecules feebly emitting yellow light.

Y

What will happen? Will the light come to my eye exactly as if the molecules were not there? No; it will not. There will be a difference. What then will be the difference?

Experimentally we find that the molecules which give out yellow light have kept for their own purposes—filched so to speak, from the light passing through them—the particular vibrations which they want to carry on their own motions, and we shall have

V I B G   O R

as a result; the light comes to us minus the vibrations which have thus been utilised, as we may put it, by the screen of vapour.

We have in fact an apparently dark space which may be represented in this way

V I G B Y O R

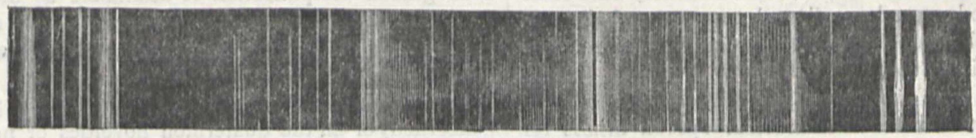
When we use a spectroscope we get the continuous spectrum with a dark band across the yellow absolutely identical in position with the bright band observed when the molecules of the vapour of which the screen is composed radiated light in the first instance.

There is an experiment in the world of sound which, perhaps, may render the physics of this action clearer. If we go into a quiet room, where there is a piano, and sing a note, and stop suddenly, we find that note echoed back from the piano. If we sing another note we find that it also is re-echoed from the piano. How is this? When we have sung a particular note we have thrown the air into a particular state of vibration. One wire in the piano was competent to vibrate in harmony with it. It did so, and vibrating after we had finished, kept on the note.

One example of the phenomena observed when we use a series of molecules as a screen, I can bring out by means of the accompanying copy of a photograph. A small mass of metallic calcium has been placed between the two poles of an electric lamp. By means of the passage of the current this mass of calcium has been raised to a very high temperature, and it has been driven to its ultimate fineness,—it has been driven, in fact, to a state of vapour competent to give out very thick bright lines in the regions marked *a*, *b*, *c* (Fig. 6.) As the vapour is gradually given off from the mass of metallic calcium, it has surrounded the interior part, and has gradually cooled as it got away from the action of the electricity. So that here we have an intensely heated mass of calcium vapour in the centre surrounded by a mass of calcium vapour which is cooling.

We have, therefore, between us and the central mass a screen of calcium molecules under exactly the same conditions as those we suggested in the screen of molecules giving out yellow light lying between us and a distant light source.

What then are the facts? On the photograph three



b *a*

Fig. 6.—Reversal of the light of hot calcium vapour by cool calcium vapour.

bright broad bands of light are seen in different parts of the spectrum, which represent three of the characteristic bands of the metal calcium. I want especially to call attention to the fact that in the middle of these bands, especially in the one lettered *a*, there is a fine line of intense blackness.

That is to say, in that particular region of the spectrum there has been no light to paint an image of the slit. What has become of that light? The light has been at work, not on the photographic plate, but among the cooler exterior molecules of calcium which have used it up.

I shall now take it for granted that the great principle, that molecules absorb the light passing through them in the same wave lengths as those which they give out when vibrating on their own account, has been rendered familiar.

We must not forget that this statement is only true so long as the molecular combinations are the same, and that we only get this result in the shape of bright lines when we are dealing with the ultimate finenesses of each chemical substance, that is, when we are dealing with each chemical substance in a state of vapour.

Without going further, then, it is clear that we are now in presence of two causes of coloured light as opposed to white light. There is, so to speak, a cause of *ef*fect and a cause of *de*fect. We now know of one reason why light may be red: the luminous vibrating substance may only be competent to vibrate at that particular rate which gives us the sensation of red light. But this is not the only reason why light may be red. If we assume a screen so constituted that all the light proceeding from a white light source, *except the red*, should be absorbed by the screen, we have there a condition in which the sensation of red would again be produced. In this case it will not be the *ef*fect of red vibrations alone in the light source, but by virtue of the *de*fect of all the others which we have assumed to be absorbed by the screen.

In both cases we arrive at

VIBGYOR

in the first case because the only light given us is

R

in the second because the screen vibrates only in

VIBGYO

and therefore only absorbs these colours.

Red fire in a pyrotechnic display is an example of the first case. The setting or rising sun is an example of the second.

The expenditure of a very small amount of money and time will enable any one to become acquainted with many of these phenomena. The best spectroscope after all, perhaps, ease of manipulation being taken into account, is a prism held close to the eye, and a fine slit, say one-twentieth of an inch broad and two inches long, carefully cut out of a piece of tin-foil, gummed on a plate of glass. When this slit, say a foot off, is observed with the refracting angle of the prism parallel to its length, a very brilliant spectrum of a candle just in front of the slit is obtained, even though it be wanting in definition. This latter can of course be improved if a narrower slit be employed: for in spectra all impurity comes from overlapping of images, and the operations of Nature are so fine that it seems as if a pure colour, such as a pure blue or a pure red, will for ever remain an abstraction; for, however great the dispersion, the adjacent wave-lengths will remain commingled, and commingled wave-lengths define a compound colour.

Instead of reducing the width of the slit, if it is not connected with the prism by means of a tube, as it may conveniently be, the slit can be removed further from the prism. In this way we get apparently a narrower slit without any reduction in the quantity of light which passes through it to the eye. A gas flame or a candle placed in front of this slit is all that is necessary to produce a continuous spectrum.

J. Norman Lockyer

CLIFFORD'S DYNAMIC

Elements of Dynamic. Part I. Kinematic. By W. K. Clifford. (London: Macmillan and Co., 1878.)

THOUGH this preliminary volume contains only a small instalment of the subject, the mode of treatment to be adopted by Prof. Clifford is made quite obvious. It is a sign of these times of real advance, and will cause not only much fear and trembling among the crammers but also perhaps very legitimate trepidation among the august body of Mathematical Moderators and Examiners. For, although (so far as we have seen) the word quaternion is not once mentioned in the book, the analysis is in great part purely quaternionic. And it is not easy to see what arguments could now be brought forward to justify the rejection of examination-answers given in the language of quaternions—especially since in Cambridge (which may claim to lay down the law on such matters) Trilinear Cöordinates, Determinants, and other similar methods were long allowed to pass unchallenged before they obtained formal recognition from the Board of Mathematical Studies.

Every one who has even a slight knowledge of quaternions must allow their wonderful special fitness for application to Mathematical Physics (unfortunately we cannot yet say Mathematical *Physic!*): but there is a long step from such semi-tacit admissions to the full triumph of public recognition in Text-Books. Perhaps the first attempt to attain this step (in a book not ostensibly quaternionic) was made by Clerk-Maxwell. In his great work on *Electricity* all the more important Electrodynamic expressions are given in their simple quaternion form—though the quaternion *analysis* itself is not employed:—and in his little tract on *Matter and Motion* (NATURE, vol. xvi. p. 119) the laws of composition of Vectors are employed throughout. Prof. Clifford carries the good work a great deal farther, and [if for this reason alone] we hope his book will be widely welcomed.

To show the general reader how much is gained by employing the calculus of Hamilton we may take a couple of very simple instances, selecting them not because they are specially favorable to quaternions but because they are familiar in their Cartesian form to most students. Every one who has read *Dynamics of a Particle* knows the equations of non-acceleration of moment of momentum of a particle, under the action of a single centre of force, in the form

$$\left.\begin{array}{l} x\ddot{y} - y\ddot{x} = 0 \\ y\ddot{z} - z\ddot{y} = 0 \\ z\ddot{x} - x\ddot{z} = 0 \end{array}\right\}$$

with their first integrals, which express the facts that the orbit is in a plane passing through the centre, and that the radius-vector describes equal areas in equal times. But how vastly simpler as well as more intelligible is it not to have these *three* equations written as *one* in the form

$$V\rho\ddot{\rho} = 0$$

and the three first integrals above referred to as the immediate deduction from this in the form

$$V\rho\dot{\rho} = \alpha.$$

Take again Gauss's expression for the work done in carrying a unit magnetic pole round any closed curve under the action of a unit current in any other closed circuit. As originally given, it was

$$\iint \frac{(x^1-x)(dydz^1-dzdy^1)+(y^1-y)(dzdx^1-dxdz^1)+(z^1-z)(dxdy^1-dydx^1)}{\left((x^1-x)^2+(y^1-y)^2+(z^1-z)^2\right)^{\frac{3}{2}}}$$

With the aid of the quaternion symbols this unwieldy expression takes the compact form

$$\iint \frac{S.\rho\, d\rho\, d^1\rho}{T\rho^3}.$$

The meanings of the two expressions are identical, and the comparative simplicity of the second is due solely to the fact that it takes space of three dimensions as it finds it; and does not introduce the cumbrous artificiality of the Cartesian cöordinates in questions such as this where we can do much better without them.

In most cases at all analogous to those we have just brought forward, Prof. Clifford avails himself fully of the simplification afforded by quaternions. It is to be regretted, therefore, that in somewhat higher cases, where even greater simplification is attainable by the help of quaternions, he has reproduced the old and cumbrous notations. Having gone so far, why not adopt the whole?

Perhaps the most valuable (so far at least as physics is concerned) of all the quaternion novelties of notation is the symbol

$$\nabla = i\frac{d}{dx} + j\frac{d}{dy} + k\frac{d}{dz},$$

whose square is the negative of Laplace's operator: *i.e.*

$$\nabla^2 = -\left[\left(\frac{d}{dx}\right)^2 + \left(\frac{d}{dy}\right)^2 + \left(\frac{d}{dz}\right)^2\right].$$

A glance at it is sufficient to show of what extraordinary value it cannot fail to be in the theories of Heat, Electricity, and Fluid Motion. Yet, though Prof. Clifford discusses Vortex-Motion, the Equation of Continuity, &c. we have not observed in his book a single ∇. There seems to be a strange want of consistency here, in coming back to such "beggarly elements" as

$$\delta_x u + \delta_y v + \delta_z w$$

instead of

$$- S\nabla\sigma,$$

especially when, throughout the investigation, we have σ used for

$$ui + vj + wk;$$

and when, in dealing with strains, the Linear and Vector Function is quite freely used. Again, for the vector axis of instantaneous rotation of the element at x, y, z (ρ), when the displacement at that point is $\sigma = iu + jv + kw$, we have the cumbersome form

$$\tfrac{1}{2}\left\{(\delta_y w - \delta_z v)\, i + (\delta_z u - \delta_x w)\, j + (\delta_x v - \delta_y u)\, k\right\}$$

instead of the vastly simpler and more expressive

$$\tfrac{1}{2} V\nabla\sigma.$$

It may be, however, that this apparent inconsistency is in reality dictated by skill and prudence. The suspicious reader, already put on his guard by Clerk-Maxwell's first cautious introduction of the evil thing, has to be treated with anxious care and nicety of handling:—lest he should refuse altogether to bite again. If he rise to the present cast we shall probably find that Prof. Clifford has ∇, in the form as it were of a gaff, ready to fix him irrevocably. That he will profit by the process, in the long run, admits of no doubt:—so the sooner he is operated on successfully the better. What is now urgently wanted, for the progress of some of the most important branches of mathematical physics, is a "coming" race of intelligent students brought up, as it were, at the feet of Hamilton; and with as little as may be of their freshness wasted on the artificialities of x, y, z. Till this is procured, quaternions cannot have fair play. Nut-cracking, though occasionally successful for a moment, is the most wasteful and destructive of all methods of sharpening the teeth.

What we have at some length discussed is the most prominent feature of the present work, but by no means its only distinctive one. No writer, who has any claim upon his readers at all, can treat even the most hackneyed subject without giving a new and useful turn to many a long-known truth. Many of Prof. Clifford's proofs are exceedingly neat, and several useful novelties (*e.g.* Three-bar Motion) are introduced. We have to complain, however, of a great deal of unnecessary new and very strange nomenclature :—for a large part of which the author is not responsible, his error (for such we cannot help considering it) consisting in giving this stuff a place of honour in his book. One does not require to be very violently conservative to feel dismayed at an apparently endless array of such new-fangled terms as Pedals, Rotors, Cylindroids, Centrodes, Kites, Whirls, and Squirts ! Yet these are but a few gleaned at random from the book. Something, it seems, *must* be hard in a text-book—simplify the Mathematic, and the Anglic (*i.e.* the English) immediately becomes perplexing. P. G. TAIT

PHYSICS OF VOLCANOES

Beitrag zur Fysik der Eruptionen und der Eruptiv-Gesteine. Von Dr. Ed. Reyer, Docent an der Universität in Wien. (Vienna : Alfred Hölder, 1877.)

DR. Reyer, of Vienna, has already made his mark in geological literature by the admirable work entitled "Die Euganeen : Bau und Geschichte eines Vulcans," in which he has given a very clear and instructive interpretation of the phenomena presented by that grand tertiary volcano of Northern Italy, of which the internal structure has been so well displayed to the geologist through the agency of denuding forces. Those who are acquainted with the merits of the first published work of Dr. Reyer will eagerly take up the volume which has now made its appearance, the title of which stands at the head of the present notice ; nor will their anticipations that a difficult question will meet with masterly and original treatment at the hands of its author be disappointed.

A starting-point for a series of discussions of the phenomena of volcanic action and the causes to which these are due is found by Dr. Reyer in the demonstrated capacity of various substances in a state of igneous fusion for absorbing certain gases. If the suggestion that in this peculiar property of bodies in a state of fluidity under the action of heat we find a key to many of the most remarkable phenomena of volcanic eruptions be not altogether new, it must at least be admitted that it has never before received such ample discussion and illustration as it now undergoes in the hands of Dr. Reyer, and even still less has hitherto been done in applying the explanation in question to these numerous minor and concomitant phenomena which precede, accompany, and follow volcanic outbursts.

In the first part of the work before us, the author, after citing the interesting observations of Gay Lussac, Fournet, Thenard, Réaumur, and other chemists, in proof of the property of absorption as displayed by substances in a state of igneous fusion, goes on to show that many of the striking appearances exhibited during volcanic eruptions clearly point to the conclusion that a highly-heated magma within the earth's crust has, through infiltration, become charged with liquid and gaseous materials. He then proceeds in the second part of the volume to show how many of the phenomena of volcanoes—such as the succession of events in the history of their formation and in that of each individual eruption, the peculiarities of the internal structure of volcanoes and of the masses of lava extruded from their vents, and the nature of the gaseous exhalations which accompany the outbursts during their several stages—receive a simple explanation from this remarkable property exhibited by substances in a state of fusion.

Apart, however, from the value of its more speculative portions, Dr. Reyer's work will be welcomed by geologists as bringing together in a connected form all the most important of the recent observations which have been made upon the nature and products of volcanic activity. It is in this respect that the third part of the work before us, that which deals with the peculiarities of volcanic rocks, appears to us to be especially worthy of attention. The author not only admits that the principle which has been so long followed by German petrographers, of basing the classification of igneous rocks on their geological age, is altogether untenable, but he goes farther and strongly denounces the mischievous tendencies of this method in obscuring some of the most striking inferences to be derived from the exact study of such rocks. Strongly insisting on the fact that portions of the same magma may, under different physical conditions, assume a granitic, a porphyritic, or a vitreous structure, Dr. Reyer shows clearly how the various igneous intrusions found associated with sedimentary deposits were in all probability originally connected with centres of volcanic activity ; and he also shows the grounds for the inference that masses of granitic structure are being formed at the present day by the slow consolidation under pressure of portions of the magma below the existing volcanic vents.

Of the urgent necessity for reforms in our petrographical nomenclature, the author of this work, holding the views he does, clearly perceives the necessity ; and his suggestions upon the subject deserve, as they doubtless will receive, the careful attention of geologists. Some of the interesting relations between the structure and composition of rocks are, we may remark in passing, very well illustrated by the series of ingenious diagrams which accompany this volume. J. W. J.

OUR BOOK SHELF

Travels in the Footsteps of Bruce in Algeria and Tunis; Illustrated by Facsimiles of his Original Drawings. By Lieut.-Col. R. L. Playfair, H.B.M. Consul-General in Algeria. (London : C. Kegan Paul and Co., 1877.)

THE northern regions of Africa that border on the Mediterranean Sea would form a deeply interesting study for the historian. Perhaps no other portion of the world's surface has passed through more marked phases of civilisation, yet all of these have passed away and left but small trace behind them. Placed between a wondrously teeming offshoot of the Broad Atlantic and a markedly sterile desert, this strip of territory seemingly wanting in none of Nature's riches save flowing rivers, has been conquered successively by the Romans, the Vandals, the Byzantines, the Greeks, and the Arabs. All these several possessors came and conquered and settled on these lands; but the first four civilisations died away, and the last is disappearing, in at least the large central portion of this district known as Algeria, and now under French rule. Who can tell whether this new phase will have any more vitality than the rest?—for the native tribes seem to be as unreclaimable as their own Sahara.

The many architectural ruins scattered over this district still attest the greatness of her conquerors, and the visitor to any of the provinces of Algeria, more especially to Algiers, will be astonished at the size and grandeur of these remains. In 1765 the traveller Bruce, as he tells us in an autobiography, was told by my Lord Halifax, "that the way to rise in the king's favour was by enterprise and discovery; that all Africa, though just at our door, was yet unexplored; that every page of Dr. Shaw, a writer of undoubted merit, spoke of some magnificent ruins which he had seen in the kingdoms of Tunis and Algiers, and that now was the age to recover these remains and add them to the king's collection." With this suggestion Bruce was offered the post of consul at Algiers, with a good salary. Bruce at once put aside for the moment all thoughts of the fountains of the Nile, "as involving an enterprise above the powers of an untried ordinary man," and setting out for Italy, he passed through France, and was carried in H.B.M. frigate *Montreal* from Naples to Algiers. The story of Bruce's life is yet to be written; probably no traveller has ever had to contend against a greater amount of ill-deserved obloquy. His account of his travels, we know, was received with the greatest incredulity, and yet there are very few of his statements that have not, since he published them, been abundantly confirmed. It would seem but an act of justice that we should, in the light of modern discovery, have a new edition of Bruce's Travels thoroughly well annotated, and we can think of no one so well qualified for this task as the author of this volume, which gives us an account of how Col. Playfair came to travel in the footsteps of this great father of African travel.

Bruce, we have seen, was British Consul-General at Algiers in 1765, and he received this appointment to enable him to examine and describe the many fine ruins said so truly by Dr. Shaw to be scattered over Tunis and Algeria. An account of these travels, with detailed descriptions and drawings of these ruins, was prepared by Bruce, with the intention of publishing them; but it is probable that the manner in which the simple narrative of his travels was received by the public had the effect of making him abandon this idea.

We must refer the reader to this volume for information as to how Col. Playfair, who now occupies Bruce's place as H.M. Consul-General at Algiers, discovered Bruce's manuscripts and drawings in the library of Lord Thurlow, whose wife is the great-great-granddaughter of the traveller as well as heiress of Kinnaird. As a result of this discovery, Col. Playfair determined to follow Bruce's footsteps in Tunis and Algeria, to visit every ruin which he had illustrated, and so to plan his route as to include all that was most picturesque and instructive in a country that is even yet hardly at all known to the modern traveller; and well he does all this in the sumptuous quarto volume before us.

This volume will form a lasting monument to the memory of Bruce, and some five-and-twenty of the large quarto illustrations, being facsimiles from Bruce's drawings, will serve to show how accurate as an architectural draughtsman he was, and how independent he might—had it not been for the fashion of the times—have been of the "adornments" of his Italian artist.

E. P. WRIGHT

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

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

On the Availability of Normal-Temperature Heat-Energy

1. I WAS interested to see the letter of Prof. A. S. Herschel, in NATURE, vol. xviii. p. 39, referring to my papers on the subject of the derivation of work from normal-temperature heat (NATURE, vol. xvii. p. 31, and vol. xvii. p. 20). There is one qualification (not affecting the reasoning in my papers) I should like to make here, viz., the case there dealt with does not appear necessarily to be out of harmony with what is termed the "second law of thermodynamics," though it may be questioned whether it quite harmonises with certain modes of stating the law. As the *facts* are of course the most important, it may perhaps be well just briefly to recapitulate here under what conditions normal-temperature heat can be converted into work, as affecting the problem dealt with.

2. Firstly, we observe that the diffusion of matter (gases) enables us to derive work solely at the expense of normal-temperature heat (*i.e.*, without an artificially-produced fall of temperature or a source and a refrigerator); and through this process a mass of gas may (by unchanged total volume) acquire a capacity for work without the performance of work. I say that the work is derived *solely* at the expense of normal temperature heat, because, although the mixing or diffusion is a necessary accident to the derivation of the work, it is in no way the *source* of the work, or the heat lost is the exact mechanical equivalent of the work derived, and the diffusion has nothing to do with furnishing the work. Still the system, after diffusion, is evidently not restored to its original state in all respects, *except the transference of heat*, although the passage of the system from its original to its final state did not furnish any of the work. To violate the second law of thermodynamics, the system would require to be restored to its original state, and if a method could be discovered for doing this, clearly no work would be theoretically required merely to effect this result (since the total volume of the gases is unchanged by the mixing).

3. It would seem scarcely to be brought into sufficient prominence in connection with the statement of the "second law of thermodynamics," how far it is possible (without a source or refrigerator) to convert normal-temperature heat into work, which is really the practical point; for there are many cases where it is of no consequence to us whether the matter from which the heat is derived is mixed or not. The great point is to derive the heat or convert it into useful mechanical energy. This is what it was my main object to treat of in the two papers referred to.

4. No doubt in nature normal-temperature heat is thus largely utilised or converted into work. For in the functions of plants and animals, two gases of different molecular weights, oxygen and carbonic acid, are largely concerned, and animal and vegetable structures are notably *porous*, so that no doubt normal-temperature heat may be converted into work through diffusion in this way—*i.e.*, by the different rates of diffusion of the two gases across the porous tissues. Indeed this principle might conceivably have more to do with animal and vegetable functions than is imagined. There are also mixtures of gases used in industrial operations, such as for explosion in gas-engines, &c. No doubt in such cases before exploding the gases, normal-temperature heat might be converted into work through diffusion (by means of a porous diaphragm connected with suitable machinery, in the manner roughly sketched), and the utility of the process would depend simply on the quantity of gas at disposal.

5. In regard to the means afforded by a porous diaphragm for (as it were) manipulating molecules and sifting them according to their velocities; no doubt this (as Prof. A. S. Herschel remarks) somewhat resembles the functions performed by the ideal being or "sprite" described by Prof. Maxwell in his "Theory of Heat," but it does not quite attain that result, for the diaphragm can only effect an unequal distribution of energy *combined with* an unequal distribution of *matter*, so that the

second law of thermodynamics is not violated, as it would be if the diaphragm effected *only* an unequal distribution of *energy*. The great point, however, to notice is that the sifting power of the diaphragm enables us to derive work from the gas at the expense of its heat, or we obtain thereby a capacity for work without the performance of work, which is the *practical* result we require, and so long as we obtain this result, we may not care so much about any inquiry whether a certain statement of a law is thereby violated or not (at least this inquiry is of *secondary* importance). The main point evidently is to realise how work may be derived from normal temperature heat without a source or refrigerator. Also it cannot surely be kept too much in view that the "second law of thermodynamics" is not *theoretically* a necessary truth, but its truth only depends (as Prof. Maxwell showed) on our inability to grasp or handle molecules. For if molecules were of such a size that we could handle them separately, then there is no doubt that we could transfer their motions to masses (without the necessity for mixing the molecules of different masses together). The attempts to prove the second law of thermodynamics as an abstract truth independently of considering the *molecular* state of matter, can therefore scarcely be considered as legitimate, as it is upon the *molecular* state of matter that the impracticability of the effect expressed in the law depends. Also it would be, perhaps, difficult to give a perfectly satisfactory *à priori* proof that no process can be discovered for utilising normal temperature heat without permanently mixing or altering the distribution of the matter concerned, more especially when it is considered how much can be already done in the way of manipulating molecules (or sifting their velocities) and deriving their heat by means of porous diaphragms in the case of diffusion. The practicability of the result would admittedly not be contrary to the principle of the conservation of energy.

6. One of the most important considerations, perhaps, connected with diffusion, would appear to be that the tendency to the uniform diffusion of matter, or rather of *velocity* [since chemically different molecules of *equal* mass do not necessarily tend to become uniformly diffused], can upset the tendency to the uniform diffusion of energy, *i.e.*, energy could not be uniformly diffused until matter (capable of diffusion) was also uniformly diffused, or homogeneous. Another important consideration would appear to be (and which, if noticed, would seem to be worthy of greater attention) that the gases of the atmosphere from the fact of their being of *different* molecular weights, tend *forcibly* to become uniformly diffused, or the danger of unequal mixture is averted, which would inevitably occur sometime or somewhere, if the gases were of the *same* molecular weights (or *dynamically* alike), and so diffusion were left to the pure contingencies of chance. I may return (by permission of the Editor) to this point at a future opportunity.

S. TOLVER PRESTON

"Underground Temperature"

THE Report of the British Association Committee on Underground Temperature appearing in NATURE, vol. xvii. p. 476, gives me an opportunity of questioning the treatment of the matter and urging the rejection of any figures obtained. This opportunity I had often wished for when reading over the allusions to underground temperature which spoil text-books, but would scarcely avail myself of now were not the "report" apparently "accepted" in significant silence.

To any one familiar with the state of circumstances down in mines, who has accumulated thought on the question of the temperature of the rocks in depth, the observations noted in this report must appear, not to say absolutely inadequate to further the inquiry, but altogether missing the point of it—that is to say, if I am right as I take it, that the purpose of the Committee is to ascertain, not mere "underground temperature" readings, but the proper temperature of the rocks as due to intra-terrestrial conditions. In all the observations conducted in mines, the temperature of the mine ventilation or a temperature almost wholly inter-dependent is expressed by the figures obtained; these figures no more indicate the true state of the case, and are therefore of no more value to the geologist or the general physicist, than the temperature of a greenhouse would assist the meteorologist. The figures obtained in bores express the temperature of the waters standing therein—which temperature cannot at all be assumed to be coincident with the rock temperature; these figures are determined by a variety of factors, the true rock temperature not being necessarily the greater. In fact, we can never arrive at the temperature of the rocks in depth through the media of water or air. To state this truth is to establish it.

A few remarks, however, bearing directly on the details of the observations in the report, may aid inquirers to arrive at a true state of thought on the subject. In the first place, and as of general application, I have to demand attention to the matter of the mine area, to depths exceeding the observation stations, being depleted of the waters naturally appertaining thereto—and for this reason even a rock temperature ascertained over such an area would be abnormal. A thermometer hung up in a mine way will unquestionably register the temperature of the ventilation in that particular place; nobody expects any other result. Can the temperature of the ventilation be demonstrated to be inter-dependent in a great measure on the temperature of the surrounding rocks, which is itself abnormal as above submitted? Certainly not! and this fact is so obvious to those having a true acquaintance with mine ventilation, that it seems to me too absurd to elaborate proofs of it. Particular stress is laid on the point that currents of air and well-aired situations were avoided. It is hard to see any outcome of this other than still more abnormal readings. Surely observers do not imagine they can penetrate the rocks so far by cornering in mines as to leave the atmosphere wholly behind. Figures obtained in still air express the temperature of dying ventilation, or of gases of exudation, or partly of both. As to the employment of a few inches of water in a hole, as supposed to secure more direct contact with the rocks, or to isolate from air; the temperature of the small body of water so employed is that obtained, and it is obvious it depends on the air temperature, and (worse) the water may possibly be decomposing. These remarks apply, for the most part, alike to the ingenious method employed down Boldon Colliery as to the more simple method of Schemnitz. Then, with regard to the Boldon Colliery observations in particular, the curious in these matters will be led to speculate as to what was going on up the ten-foot hole, and whether the "stagnant" ventilation of the district was not tending towards the explosive conditions. All the circumstances previously set down, supplemented by the exudation of gases, and the subsidence of strata following on coal working, combine to render this one of the unhappiest conceivable situations for the research on rock temperature.

A thermometer down a mine is of no utility beyond qualifying barometric readings.

The bore observations are, I venture to think, a crude phase of the method which may lead to success ultimately. As hitherto conducted, they are open to many obvious objections, which, if stated at length, would be little more than a reiteration of the above in part.

I will venture to suggest that the next steps in advance be the permanent placing of instruments in deep bores, broken rock being rammed over as over powder in blasting operations, so that all water and air, except such as may be fairly considered as entering into the structure of the rocks, be entirely excluded, and the application of thermo-electric apparatus devised by specialists in electric science, all constituting a special, and, for many reasons, invaluable attachment to an observatory or kindred institution.

WILLIAM MORRIS

Earlshill Colliery, Thurles

Helmholtz's Vowel Theory and the Phonograph

THE results obtained by Messrs. Jenkin and Ewing in their experiments with the phonograph, as described in NATURE, vol. xvii. p. 384, are so different from those reached in some experiments recently performed by Dr. Clarence J. Blake, of this city, in connection with myself, that I venture to call attention to the fact.

With the design of testing the question of change of quality in vowel tones by increasing the rate of rotation of the phonograph cylinder, we performed a number of experiments, of which I mention a few as briefly as possible.

1. The vowels *ou* and *ō* were spoken into the mouth-piece of the instrument, each four times in succession, while the cylinder was rotated at the rate of one revolution per second, as timed by the beats of a clock-pendulum. On rotating the disc so as to reproduce the vowel-sounds, these were as spoken, *ou*, *o*, each repeated four times, when the rate of rotation was one revolution per second, but on increasing the velocity to two revolutions per second, the first sounds were indistinct, while the last gave the

vowel $\breve{e}$ very clearly. At half revolution per second, *ou*, *au*, were distinctly heard.

2. The vowel $\bar{o}$ was sung while the cylinder rotated at different rates of speed. On reproducing the sounds, the cylinder being revolved more slowly than at first, the vowel *au* was heard, changing to $\bar{o}$, $\bar{e}$, $\breve{e}$, falling to $\breve{e}$ again as the velocity was slackened a little.

3. The vowel *ä* was spoken while the cylinder made one revolution per second. On reproducing the sound, the rate being half a revolution per second, *au* was heard, changing to *ä* when the rate increased to one revolution, and at three revolutions per second $\breve{i}$ was heard.

4. The vowel $\bar{o}$ was spoken several times in succession, the rate of the cylinder being gradually accelerated. On reproducing the sound by a uniform and slow rotation, *au* and *ou* were heard; on rotating faster, $\breve{e}$ and $\breve{i}$.

Several other experiments were tried in the short time during which the instrument was at our service, all of which were strikingly confirmatory of Helmholtz's theory. Difficulty was experienced in reproducing the highest vowels $\bar{e}$, $\breve{i}$, probably on account of want of readiness of response in the disc. The bell of a reed-pipe was placed over the mouth-piece of the instrument when the sound was to be reproduced, for which a horn of pasteboard was substituted in some of the trials.

We hope to render these experiments more rigorously quantitative, as the phonograph promises to be a valuable aid to research in this field. Very probably others may have worked with the same end in view, and if so it would be interesting to learn what has been their experience. CHAS. R. CROSS

Boston, U.S., April 29

The Telephone

WITH reference to the letter of Lieut. Savage which appeared in your last impression (p. 77) respecting the telephone, this gentleman has noticed that on removing the ferrotype disc of the sending instrument and tapping the magnet with a diamagnetic body, such as a piece of copper, the taps are distinctly heard at the receiving end. I have repeated this experiment. Not only can a diamagnetic substance be used for tapping, but the magnet may be removed altogether and a bar of soft iron substituted without causing any material difference in the results, and this bar of soft iron may be placed at right-angles to the line of dip. The vibrations of a tuning-fork are transmitted very distinctly. When held in the line of dip the results obained are more marked. Taps and the tuning-fork vibrations are readily heard, and by covering with the ferrotype disc a conversation was actually carried on through this bar of soft iron. There is perhaps nothing very surprising in obtaining these phenomena with the bar in the "dip" line, but when the same bar of perfectly soft and recently annealed iron can be held in any position in a plane at right-angles to that line and used as a sender for powerful vibrations, such as those of a tuning-fork or the taps of a diamagnetic body on the naked end of the bar, we cannot but be struck by the surprising delicacy of the telephone as a test for the earth's magnetism.

The receiving instrument used in the abve experiments was an ordinary bell telephone $2\frac{1}{2}$ in. disc ·007 of an inch in thickness.

9, St. John's Road, Bristol, May 18 ALFRED CHIDDEY

Hereditary Transmission

IN 1837, Capt. D'Urban of H.M.S. *Griffin*, having captured, off the south coast of Martinique, a Portuguese slaver, called the *Don Francisco*, landed in this colony the living freight of 437 human beings, who, about two months previously, had been forced from their homes on the banks of the Congo, to be sold in Cuba.

William Laidlaw, one of the liberated slaves, who is now in a position of some trust on the Goodwill sugar plantation in the island, gives to me the following interesting details of hereditary transmission in the African, which I believe will be interesting to the readers of NATURE.

"I am about sixty or sixty-five years of age, and was born with six fingers on each hand. Soon after 'my freedom' I married a woman from 'our country.' We had four children, two being boys and two girls; they were born with six fingers on each hand, and one of the girls had six toes on each foot.

"My eldest son Robert, who is married and settled in Demerara, is the father of two boys, who have six fingers on each hand. My second son, William, who is working with me on the Goodwill estate, married, and his wife had five children; they were born having the same peculiarity; but I regret to say none are living."

I yesterday sent for William Laidlaw, and have substantiated his father's statements. I measured the sixth fingers: the one on the right hand is exactly $1\frac{1}{4}$ inch in length, and has a perfectly formed nail, the one on the left showed traces of having been partially amputated. EDMUND WATT

Resident District Magistrate

Dominica, British West Indies, April 27

What is a "Water-shed"?

SOME time ago the term "water-shed" was somewhat vaguely used to imply either the dividing ridge between two river basins or the slopes down which the water poured into the rivers themselves. Latterly, if I mistake not, it has generally been used by geographers in the former sense only. Mr. George Grove, F.R.G.S., however, in his excellent little Primer on Geography, uses the term "water-parting" for the ridge, and water-shed for the whole of the ground between the water-parting and the stream;—very clearly illustrating his meaning by reference to the ridge tiles and the slope of the roof of a house respectively.

There may be some reason, especially in a work of the kind, for substituting "water-parting" for "water-shed," in the sense first quoted, but is the use of the latter, to indicate the flow of water down the slopes, justified either by etymology, or even by the correct use of the word "shed" in ordinary conversation?

The derivation from Anglo-Saxon *sced-an* or *scead-an*, indicates the primary meaning to *divide* or *sever*. It is also used metaphorically in some of the north-country dialects, as "there is no *shed* (difference) between us." No doubt, by a very natural ellipsis it often implies flowing or falling. A woman sheds tears, or a tree sheds its leaves, and the consequent flowing down the cheeks, or fluttering down to the ground need not be specially expressed. But in this case the word is used distinctively, and should surely be used, if used at all, in its stricter and primary sense, while the fall or flow of water can be appropriately distinguished.

Of course this is merely a question of terminology, but I think it is one worth noticing if only for the sake of the youthful millions who are being brought to some knowledge of elementary geography, and will hardly be helped to appreciate the exactness of science if they find the same word is used by different authorities to describe things so different as the dividing ridge and the hill slopes of the land they live in. R. H

Savile Club, Savile Row, W.

Abnormal Coccyx

IN NATURE for September 21, 1876, I gave an account of a peculiar abnormality in a girl aged eight, in whom the coccyx was turned backwards and upwards, and a little above it there was a circular depression in the skin, about $\frac{1}{4}$ inch in diameter, and about $\frac{1}{4}$ inch deep. On being dragged downwards the skin in this hollow became everted and formed a covering to the point of the coccyx. Shortly afterwards I had an opportunity of examining the other children of the family, with the following results:—

Boy aged six, normal.

Girl aged four, depression in the same spot as in the eldest sister, coccyx normal.

Girl aged two, normal.

Boy aged seven months, fairly deep hole (not measured) in same position, coccyx less curved forward than usual.

The parents were said not to possess this peculiarity; I could get no information as to the other members of the family.

A few days ago I met with another case of the same kind in a boy eight months old. The coccyx was curved sharply backwards, and there was a circular depression in the skin, about 5 mm. in diameter, a little higher up than in the other cases, which was easily raised to the level of the surrounding parts, and effaced by a little traction. ANDREW DUNLOP

Jersey

Lecture Experiment

A glass flask of about a litre capacity is partially filled with water and closed with a cork, through which a tube passes which terminates flush with the lower side of the cork. Above, the tube is bent twice at right angles, the other extremity of the tube dipping below the surface of water of ordinary temperature.

The water of the flask is now boiled, and as soon as the air has been driven from the flask remove the flame and allow the water of the vessel to recede into the flask. At the first entry of the cool water the steam will be so greatly condensed that a brisk ebullition will take place, which for a few seconds checks the inflow of the water, driving it down the tube; further cooling quickly causes more water to enter, when the same phenomenon is repeated. After two or three oscillations of this kind the water runs continuously, and with great velocity, into the flask, which should not be allowed to fill, as it is in that case usually broken by the shock, which terminates the experiment. FRANCIS E. NIPHER

St. Louis, April 12

Sound-emitting Crustaceans

IN an article in NATURE, vol. xviii. p. 53, you say: "Everybody who had searched for animals on coral-reefs, or had dredged in tropical seas, was familiar with the 'clicking' sounds emitted by the *Alphei* and their allies."

Those who wish to hear this sound need not go to coral reefs, or tropical seas—as the shores of Guernsey, Herm, or the other Channel Islands, produce *Alpheus ruber* and other *Alphei* in abundance.

Keeping them as I do in aquaria, it is startling sometimes in the evening to hear the loud snap, produced by sharply striking together the two claws on the larger leg.

May 10 H. STUART WORTLEY

GEOGRAPHICAL NOTES

AFTER the suppression of the Mahometan rebellion in the Chinese province of Yünnan, a number of the so-called Panthays took refuge in British Burmah to avoid the indiscriminate cruelty of their conquerors; but they have recently migrated, apparently *en masse*, to another region. This, we gather from a Rangoon paper, is a tract of country on the north-east of Upper Burmah, which belongs neither to the Siamese nor the Burmese, and over which the Chinese have never pretended to exercise any authority. This district is ruled over by a number of Shan and Kachyen chieftains, some of whom were at first inclined to oppose the Panthay settlement, but have ceased to make any opposition to it. The immigrants are said to be nearly 3,000 in number, and are divided into two settlements about ten miles apart. They have intermarried with the women of the country, and in course of time will, no doubt, form a considerable community among these savage tribes. Their principal occupation is agriculture, though a few of them have taken small quantities of goods from Mandalay, and have laid the foundation of a trade with the surrounding tribes. These Panthays, it seems, prefer the rude independence of their colony in the wilds to settling in either Upper or British Burmah.

NOTWITHSTANDING the embarrassed position of Russia at the present time, there seems to be no falling off in the exemplary activity of the Russian Geographical Society; indeed, it is well known that while its researches in Asia are of high scientific value, they are also not without political utility, and perhaps significance. The April meeting, the official abstract report of which is just to hand, was Asiatic all over. It was reported that the expedition to explore the divide between the waters of the Obi and Yenessei had set out on March 12, and that M. Smirnow was to set out on April 15 for the Petchora, to spend the summer in investigating the magnetic elements. The Society has projected two other expeditions for this summer, one of an ethnographical character in European Russia, the other purely geographical to Mongolia. M. Potanin, who had just returned, gave a summary of the results of his explorations in the Altai regions, some details of which we have already given. For the first time we have something like an adequate account of the extent, the offshoots, the physical geography, and the ethnology of the Altai region. The second part of the third volume of the results of the Siberian expedition of the Society has been published, and contains a study, by Prof. Oswald Heer, of the flora of the jurassic beds of the government of Irkutsk and the region of the Amoor. The eighth volume of the *Memoirs* of the Society, also recently published, ought to interest ethnologists, containing as it does a large collection of information on "customary law" as it exists in various districts of Russia and among some of the tribes on her borders.

THE *Times* Paris correspondent states that according to the German papers Hermann Soyaux, the botanist of the German Expedition to the Loango coast, 1873-76, will set out in July or August on another expedition to equatorial Western Africa to explore the Gabun and Ogovai country in the interests of natural science, and at the same time, under the patronage of the Hamburg firm of Wörmann, to make experiments with a view to the starting of plantations. A long account of Herr Soyaux's travels in Loango and Angola is about to appear, published by Messrs. Brockhaus.

TECHNICAL EDUCATION IN UNIVERSITY COLLEGE, LONDON

IN November, 1876, a short paragraph was inserted in NATURE (vol. xv. p. 69) which contained a notice of the commencement of technical teaching at University College in connection with the classes of mathematics, physics, engineering, and drawing. It may be of interest to state what progress has been made in the workroom up to the present time under rather unfavourable conditions. This we endeavour to do after a recent visit paid at the request of M. Robin, M.Sc., the able and painstaking superintendent of the department, under the direction of the professorial staff. At present the workroom is open on each week-day from ten to five, except on Saturdays, when it is closed at two. The superintendent is present from ten to three on three of the days. Students, who make use of the room, may choose their own hours for work.

Following the order indicated in the syllabus, we first examined the models in the mathematical section. Here we were specially interested in the models illustrative of most of the propositions of modern geometry; pencils of planes and of lines (to show the simple contrivances employed, we may say these models were made of knitting-needles with small spherical ends of sealing-wax of different colours, thus enabling the student to see their different directions; in other cases joins were indicated by ties of differently coloured wool, thus allowing motion to the figures, as in a model showing that the corresponding points of two perspective triangles meet in a line). Projective rows of points made of pricked wood, the corresponding points joined by india-rubber threads; models exhibiting the generation of ruled surfaces of the second order, movable models made of silk threads stretched by weights, parallel pencils of lines making the paraboloid. The generation of curves by the intersection of pencils of lines; this was shown by two flat pencils of lines made of coloured silk in mahogany frames, one of which moved upon the other; at the intersection of certain pairs of threads were placed small indices which clearly showed to the eye various forms of ellipses and hyperbolas. This model we remember attracted considerable attention at the *conversazione* in June last, whilst Prof. Henrici was manipulating it so as to give the curves named. Curves are also produced, whose forms are shown by the aid of sawdust or of sand scattered on a glass plate; these were mostly got as envelopes. In this department, also, are several models of linkages giving approximate and true straight lines, illustrating the discoveries of Watt, Peaucellier, Tchebycheff, Sylvester, Hart, and Kempe; also examples of Sylvester's and Kempe's isoclinostats. These last models are made, some in zinc, but most of them of printer's rules, the articulation being effected by brass pipes. We close our recollections of this section with the bare mention of an ingenious application of the zoetrope to illustrate certain mechanical combinations in motion.

In the engineering department was a collection of elementary plane mechanisms as described in Prof. Kennedy's translation of Reuleaux's "Kinematics": links, made as before of printers' rules; cylinder-pair of brass pipes, prism-pair of wood and brass allowing *any* joint to be fixed, and a complete motion, all the motion truly complane; also a contrivance used for fixing a link when its plane of motion is between two others. Among instances of other mechanisms given in Reuleaux, we noted a duangle moving in a triangle, triangle in a square, &c.; models of glass, centroids stuck on them, so making the conception clear; several examples of spherical quadrilaterals made of zinc. Here also we mention the model of a steam-engine excentric, showing the reversion of motion.

Among matters in preparation we examined with interest a pendulum apparatus which presented some novel features, but it would take too much space to dwell further upon what we saw under the courteous guidance of M. Robin. What we have said—and here we acknowledge our indebtedness to the superintendent's clear exposition, and to a short account of some of the models given in "Engineering" for June 15, 1877, descriptive of the scientific objects exhibited at the professor's *conversazione*—will sufficiently indicate the way that has been made in the short space of one year, under the careful supervision of the professors. Very many of the models are the work of the students. We had not time to examine the physical section, which is devoted to the construction of simple physical apparatus.

THE SETTLE CAVE EXPLORATION

THE Settle Cave Exploration Committee have again nearly exhausted the funds at their disposal, and are preparing a statement of accounts and a fresh appeal to the public.

The great thickness of beds already excavated in the Victoria Cave has taken us down so far into the past that it would be a thousand pities to close the work prematurely before getting down to the cavern floor. But unless the Committee receive help soon they will be obliged to stop and leave the rest of the cave's history in obscurity. We have appealed to our readers in behalf of this important undertaking before, and we are sure we shall not do so in vain again. There must be many readers of NATURE interested to see the final results of the exploration of these interesting caves, and who are at the same time able and willing to give substantial help to the Committee. We are sure the smallest contribution will be thankfully received, and we trust the Committee will, without delay, be encouraged and enabled to continue their researches. The Treasurer, Mr. John Birkbeck, junr., will receive donations at the Craven Bank, Settle, Yorkshire.

ORGANISATION OF FRENCH METEOROLOGY

ON May 7 the Academy of Sciences adopted in its secret meeting the draft of a letter to M. Bardoux, the Minister for Public Instruction, asking him to state whether he was to establish a separate administration for meteorology or continue the existing system. The answer to this was considered as an essential preliminary to the selection of the candidates for the directorship of the Paris Observatory. The candidates have not been nominated yet, but a definite answer has been given to the Academy of Sciences. The decree organising the meteorological division of the observatory into a distinct service was signed by the president on the 13th and gazetted on the 14th. It is prefaced by a summary of the several steps taken by Leverrier (whose name has been carefully omitted) to give the meteorological organisation its existing form.

The decree can hardly be considered as an innovation, and may be more aptly termed a resuscitation of a former stage in the evolution of official meteorology in France. In 1864 Leverrier had under him three subordinates: one was the head of the warning department; M. Rayet, the head of that which investigated general movements of the atmosphere; and the third M. Sonrel, the head of meteorological stations, their inspector, and general computer. M. Sonrel having died and M. Rayet having resigned, their offices were suppressed for the sake of economy. The whole of the work was executed on a reduced scale by subordinates. M. Bardoux has recalled into existence these two services, which are styled "Study of the General Movements of the Atmosphere" and "Climatology with Inspection of Meteorological Stations." The head of these two services will be a meteorologist, and one of the three meteorologists will be appointed director of the Central Bureau.

This appointment will not take place immediately, as the advice of a special council of the Central Bureau must be taken by the Minister. This council will be formed of members of the Institute and the large public administrative departments—Telegraphy, Admiralty, Public Instruction, War Office, &c., connected in any way with meteorology.

The greatest innovation is the authority given to the Central Bureau over the several meteorological observatories which have been established or will be established in the various districts of France, either at the expense of Government, of departments, or of townships. The more important of these observatories now in existence are Montsouris (Paris), Lyons, Puy-de-Dôme, and Pic du Midi. It is not stated whether the decree will extend to Algerian observatories, which publish a special journal and have their observations taken with a special system.

The Bureau Central will be in direct communication with the departmental commissions which M. Leverrier has established in almost every department. Each of these commissions will have the control of the agricultural stations in its own district. If the president requires it, he will receive *franco* a daily telegram to help him to issue special warnings, as the practice is daily gaining ground. In many parts of France departmental commissions have been grouped into regional organisations according to the initiative taken by Leverrier. The directors of regional meteorological observatories, delegates of regional commissions, and delegates of the Meteorological Society of France, meet once a year to deliberate on topics of interest for the progress of meteorology. The Meteorological Society is a free society supported by voluntary contributions. It is the first time that such a body has been endowed with official privileges.

The departmental commissions, although established mostly by the prefect and the local engineers of the Ponts-et-Chaussées, are supported by private exertions and contributions, as well as donations from departments and townships. M. Leverrier established an observatory in each normal school in France (there is one normal school in each department). All these observatories are to be visited by the delegates of the Bureau Central and their observations published by it. These normal school observatories will issue warnings for their localities. Some of them have already begun.

The Champ de Mars meteorological pavilion contains a number of valuable documents already sent by normal schools and departmental commissions, whose exertions will be regulated under the new system.

COMPOSITE PORTRAITS[1]

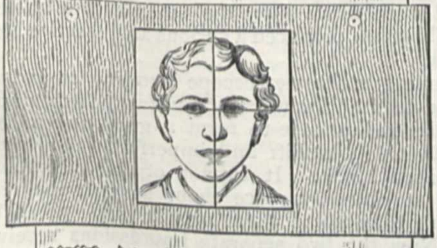
I SUBMIT to the Anthropological Institute my first results in carrying out a process that I suggested last August in my Presidential Address to the Anthropological Subsection of the British Association at Plymouth, in the following words:—

"Having obtained drawings or photographs of several persons alike in most respects, but differing in minor details, what sure method is there of extracting the typical characteristics from them? I may mention a plan which had occurred both to Mr. Herbert Spencer and myself, the principle of which is to superimpose optically the various drawings and to accept the aggregate result. Mr. Spencer suggested to me in conversation that the drawings reduced to the same scale might be traced on separate pieces of transparent paper and secured one upon another, and then held between the eye and the light. I have attempted this with some success. My own idea was to throw faint images of the several portraits, in succession, upon the same sensitised photographic plate. I may add that it is perfectly easy to superimpose optically two portraits by means of a stereoscope, and that a person who is used to handle instruments will find a common double eyeglass fitted with stereoscopic lenses to be almost as effectual and far handier than the boxes sold in shops."

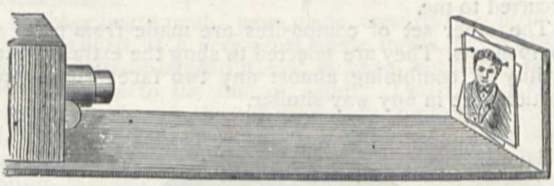
Mr. Spencer, as he informed me, had actually devised an instrument many years ago, for tracing mechanically, longitudinal, transverse, and horizontal sections of heads on transparent paper, intending to superimpose them and to obtain an average result by transmitted light.

Since my Address was published, I have caused trials to be made, and have found as a matter of fact that the photographic process of which I there spoke, enables us to obtain with mechanical precision a generalised picture; one that represents no man in particular, but portrays an imaginary figure, possessing the average features of any given group of men. These ideal faces have a surprising air of reality. Nobody who glanced at one of them for the first time, would doubt its being the likeness of a living person. Yet, as I have said, it is no such thing; it is the portrait of a type, and not of an individual.

I begin by collecting photographs of the persons with whom I propose to deal. They must be similar in attitude and size, but no exactness is necessary in either of these respects. Then by a simple contrivance I make two pin-holes in each of them, to enable me to hang them up one in front of the other, like a pack of cards, upon the same pair of pins, in such a way that the eyes of all the portraits shall be as nearly as possible superimposed; in which case the remainder of the features will also be superimposed nearly enough. These pinholes correspond to what are technically known to printers as "register marks." They are easily made; a slip of brass or card has an aperture cut out of its middle, and



threads are stretched from opposite sides, making a cross. Two small holes are drilled in the plate, one on either side of the aperture. The slip of brass is laid on the portrait with the aperture over its face. It is turned about until one of the cross threads cuts the pupils of both the eyes, and it is further adjusted until the other thread divides the interval between the pupils in two equal parts. Then it is held firmly, and a prick is made through each of the holes. The portraits being thus arranged, a photographic camera is directed upon them. Suppose there are eight portraits in the pack, and that under existing circumstances it would require an exposure of eighty seconds to give an exact photographic copy of any one of them. The general principle of proceeding is this, subject in practice to some variation of details, depending on the different brightness of the several portraits. We throw the image of each of the eight portraits in turn upon the same part of the sensitised plate for ten seconds. Thus, portrait No. 1 is in the front of the pack; we take



the cap off the object-glass of the camera for ten seconds, and afterwards replace it. We then remove No. 1 from the pins, and No. 2 appears in the front; we take off the cap a second time for ten seconds, and again replace it. Next we remove No. 2, and No. 3 appears in the front, which we treat as its predecessors, and so we go on to the last of the pack. The sensitised plate will now have had its total exposure of eighty seconds; it is then developed, and the print taken from it is the generalised picture of which I speak. It is a composite of eight component portraits. Those of its outlines are sharpest and darkest that are common to the largest number of the components; the purely individual peculiarities leave little or no visible trace. The latter being necessarily disposed equally on both sides of the average, the outline of the composite is the average of all the components. It is a band, and not a fine line, because the outlines of the components are seldom exactly superimposed. The band will be darkest in its middle whenever the component portraits have the same general type of features, and its breadth or amount of blur will measure the tendency of the components to deviate from the common type. This is so for the very same reason that the shot-marks on a target are more thickly disposed near the bulls-eye than away from it, and in a greater degree as the marksmen are more skilful. All that has been said of the outlines is equally true as regards the shadows; the result being that the composite represents an averaged figure, whose lineaments have been softly drawn. The eyes come out with appropriate distinctness, owing to the mechanical conditions under which the components were hung.

A composite portrait represents the picture that would rise before the mind's eye of a man who had the gift of pictorial imagination in an exalted degree. But the imaginative power even of the highest artists is far from precise, and is so apt to be biased by special cases that may have struck their fancies, that no two artists agree in any of their typical forms. The merit of the photographic composite is its mechanical precision, being subject to no errors beyond those incidental to all photographic productions.

I submit several composites made for me by Mr. H. Reynolds. The first set of portraits are those of criminals convicted of murder, manslaughter, or robbery accompanied with violence. It will be observed that the features of the composites are much better looking than those of the components. The special villainous irregu-

[1] Made by combining those of many different persons into a single resultant figure. By Francis Galton, F.R.S. Paper read before the Anthropological Institute, April 30.

larities in the latter have disappeared and the common humanity that underlies them has prevailed. They represent, not the criminal, but the man who is liable to fall into crime. All composites are better looking than their components, because the averaged portrait of many persons is free from the irregularities that variously blemish the looks of each of them. I selected these for my first trials because I happened to possess a large collection of photographs of criminals through the kindness of Sir Edmund Du Cane, the Director-General of Prisons, for the purpose of investigating criminal types. They were peculiarly adapted to my present purpose, being all made of about the same size and taken in much the same attitudes. It was while endeavouring to elicit the principal criminal types by methods of optical superimposition of the portraits, such as I had frequently employed with maps and meteorological traces,[1] that the idea of composite figures first occurred to me.

The other set of composites are made from pairs of components. They are selected to show the extraordinary facility of combining almost any two faces whose proportions are in any way similar.

The accompanying woodcut is as fair a representation of one of the composites as is practicable in ordinary printing. It was photographically transferred to the wood, and the engraver has used his best endeavour to translate the shades into line engraving. This composite is made out of only three components, and its three-fold origin is to be traced in the ears, and in the buttons to the vest. To the best of my judgment the original photograph is a very exact average of its components; not one feature in it appears identical with that of any one of them, but it contains a resemblance to all, and is not more like to one of them than to another. However the judgment of the wood engraver is different. His rendering of the composite has made it exactly like one of its components, which it must be borne in mind he had never seen. It is just as though an artist drawing a child had produced a portrait closely resembling its deceased father, having overlooked an equally strong likeness to its deceased mother, which was apparent to its relatives. This is to me a most striking proof that the composite is a true combination. [I trust that the beauty of the woodcut will not be much diminished by the necessarily coarse process of newspaper printing.]

It will, I am sure, surprise most persons to see how well defined these composites are. When we deal with faces of the same type, the points of similarity far outnumber those of dissimilarity, and there is a much greater resemblance between faces generally, than we who turn our attention to individual differences are apt to appreciate. A traveller on his first arrival among people of a race very different to his own, thinks them closely alike, and a Hindu has much difficulty in distinguishing one Englishman from another.

[1] "Conference at the Loan Exhibition of Scientific Instruments," 1878. Chapman and Hall. Physical Geography Section, p. 312, "On Means of Combining Various Data in Maps and Diagrams," by Francis Galton, F.R.S.

The fairness with which photographic composites represent their components is shown by six of the specimens. I wished to learn whether the order in which the components were photographed made any material difference in the result, so I had three of the portraits arranged successively in each of their six possible combinations. It will be observed that four at least of the six composites are closely alike. I should say that in each of this set the last of the three components was always allowed a longer exposure than the second, and the second than the first, but it is found better to allow an equal time to all of them.

The stereoscope, as I stated last August in my address at Plymouth, affords a very easy method of optically superimposing two portraits, and I have much pleasure in quoting the following letter, pointing out this fact as well as some other conclusions to which I also had arrived. The letter was kindly forwarded to me by Mr. Darwin; it is dated last November and was written to him by Mr. A. L. Austin from New Zealand, thus affording another of the many curious instances of two persons being independently engaged in the same novel inquiry at nearly the same time, and coming to similar results.

"*Invercargill, New Zealand, Nov.* 6, 1877.

"To Charles Darwin, Esq.

"SIR,—Although a perfect stranger to you, and living on the reverse side of the globe, I have taken the liberty of writing to you on a small discovery I have made in binocular vision in the stereoscope. I find by taking two ordinary *carte-de-visite* photos of two different persons' faces, the portraits being about the same sizes and looking about the same direction, and placing them in a stereoscope, the faces blend into one in a most remarkable manner, producing in the case of some ladies' portraits in every instance a *decided improvement* in beauty. The pictures were not taken in a binocular camera, and therefore do not stand out well, but by moving one or both until the eyes coincide in the stereoscope, the pictures blend perfectly. If taken in a binocular camera for the purpose, each person being taken on one half of the negative, I am sure the results would be still more striking. Perhaps something might be made of this in regard to the expression of emotions in man and the lower animals, &c. I have not time or opportunities to make experiments, but it seems to me something might be made of this by photographing the faces of different animals, different races of mankind, &c. I think a stereoscopic view of one of the ape tribe and some low caste human face would make a very curious mixture; also in the matter of crossing of animals and the resulting offspring. It seems to me something also might result in photos of husband and wife and children, &c. In any case the results are curious if it leads to nothing else. Should this come to anything you will no doubt acknowledge myself as suggesting the experiment and perhaps send me some of the results. If not likely to come to anything a reply would much oblige me.

"Yours very truly,

"A. L. AUSTIN, C.E., F.R.A.S."

Dr. Carpenter informs me that the late Mr. Appold, the mechanician, used to combine two portraits of himself, under the stereoscope. The one had been taken with an assumed stern expression, the other with a smile; and this combination produced a curious and effective blending of the two.

Convenient as the stereoscope is, owing to its accessibility, for determining whether any two portraits are suitable in size and attitude to form a good composite, it is nevertheless a makeshift and imperfect way of attaining the required result. It cannot of itself combine two images; it can only place them so that the office of attempting to combine them may be undertaken by the brain. Now the two separate impressions received by the brain through the stereoscope do not seem to me to be relatively constant in their vividness, but sometimes the image seen by the left eye prevails over that seen by the right, and *vice versâ*. All the other instruments I am about to describe accomplish that which the stereoscope fails to do; they create true optical combinations. As regards other points in Mr. Austin's letter, I cannot think that the use of a binocular camera for taking the two portraits intended to be combined into one by the stereoscope would be of importance. All that is wanted is that the portraits should be nearly of the same size. In every other respect I cordially agree with Mr. Austin.

The best instrument I have as yet contrived and used for optical superimposition is a "double image prism" of Iceland spar. The latest that I have had were procured for me by Mr. Tisley, optician, 172, Brompton Road. They have a clear aperture of a square, half an inch in the side, and when held at right angles to the line of sight will separate the ordinary and extraordinary images to the amount of two inches, when the object viewed is held at seventeen inches from the eye. This is quite sufficient for working with *cartes-de-visite* portraits. One image is quite achromatic, the other shows a little colour. The divergence may be varied and adjusted by inclining the prism to the line of sight. By its means the ordinary image of one component is thrown upon the extraordinary image of the other, and the composite may

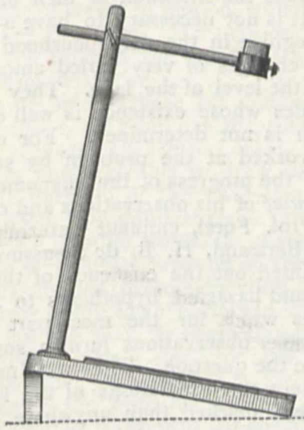


FIG. 1.

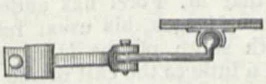


FIG. 2

FIG. 3.

FIG. 1 shows the simple apparatus which carries the prism and on which the photograph is mounted. The former is set in a round box which can be rotated in the ring at the end of the arm and can be clamped when adjusted. The arm can be rotated and can also be pulled out or in if desired, and clamped. The floor of the instrument is overlaid with cork covered with black cloth, on which the components can easily be fixed by drawing pins. When using it one portrait is pinned down and the other is moved near to it, overlapping its margin if necessary, until the eye looking through the prism sees the required combination; then the second portrait is pinned down also. It may now receive its register-marks from needles fixed in a hinged arm, and this is a more generally applicable method than the plan with cross threads, already described, as any desired feature—the nose, the ear, or the hand, may thus be selected for composite purposes. Let A, B, C, . . . Y, Z, be the components. A is pinned down, and B, C, . . Y, Z, are successively combined with A, and registered. Then before removing Z, take away A and substitute any other of the already registered portraits, say B, by combining it with Z; lastly, remove Z and substitute A by combining it with B, and register it FIG. 2 shows one of three similarly-jointed arms, which clamp on to the vertical rod. Two of these carry a light frame covered with cork and cloth, and the other carries FIG. 3, which is a frame having lenses of different powers set into it, and on which, or on the third frame, a small mirror inclined at 45° may be laid. When a portrait requires foreshortening it can be pinned on one of these frames and be inclined to the line of sight; when it is smaller than its fellow it can be brought nearer to the eye and an appropriate lens interposed; when a right-sided profile has to be combined with a left-handed one, it must be pinned on one of the frames and viewed by reflection from the mirror in the other. The apparatus I have drawn is roughly made, and being chiefly of wood, is rather clumsy, but it acts well.

be viewed with the naked eye or through a lens of long focus, or through an opera-glass (a telescope is not so good) fitted with a sufficiently long draw-tube to see an object at that short distance with distinctness. Portraits of somewhat different sizes may be combined by placing the larger one further from the eye, and a long face may be fitted to a short one by inclining and foreshortening the former. The slight fault of focus thereby occasioned produces little or no sensible ill-effect on the appearance of the composite.

The front and profile faces of two living persons sitting side by side or one behind the other, can be easily superimposed by a double image prism. Two such prisms set one behind the other can be made to give four images of equal brightness, occupying the four corners of a rhombus, whose acute angles are 45°. Three prisms will give eight images; but this is practically not a good combination, the images fail in distinctness, and are too near together for use. Again, each lens of a stereoscope of long focus can have one or a pair of these prisms attached to it, and four or eight images may be thus combined.

Another instrument I have made, consists of a piece of glass inclined at a very acute angle to the line of sight, and of a mirror beyond it, also inclined, but in the opposite direction to the line of sight. Two rays of light will therefore reach the eye from each point of the glass; the one has been reflected from its surface, and the other has been first reflected from the mirror, and then transmitted through the glass. The glass used should be extremely thin, to avoid the blur due to double reflections; it may be a selected piece from those made to cover microscopic specimens. The principle of the instrument may be yet further developed by interposing additional pieces of glass successively less inclined to the line of sight, and each reflecting a different portrait.

I have tried many other plans; indeed, the possible methods of optically superimposing two or more images are very numerous. Thus I have used a sextant (with its telescope attached); also strips of mirrors placed at different angles and their several reflections simultaneously viewed through a telescope. I have also used a divided lens, like two stereoscopic lenses brought close together, in front of the object-glass of a telescope.

I have not yet had an opportunity of superimposing images by placing glass negatives in separate magic-lanthorns, all converging upon the same screen; but this or even a simple dioramic apparatus would be very suitable for exhibiting composite effects to an audience, and if the electric light were used for illumination the effect on the screen could be photographed at once. It would also be possible to construct a camera with a long focus, and many slightly divergent object glasses, each throwing an image of a separate glass negative upon the same sensitised plate.

The uses of composite portraits are many. They give us typical pictures of different races of men, if derived from a large number of individuals of those races taken at random. An assurance of the truth of any of our pictorial deductions is to be looked for in their substantial agreement when different batches of components have been dealt with, this being a perfect test of truth in all statistical conclusions. Again, we may select prevalent or strongly marked types from among the men of the same race, just as I have done with two of the types of criminals by which this memoir is illustrated.

Another use of this process is to obtain by photography a really good likeness of a living person. The inferiority of photographs to the best works of artists, so far as resemblance is concerned, lies in their catching no more than a single expression. If many photographs of a person were taken at different times, perhaps even years apart, their composite would possess that in which a single photograph is deficient. I have already pointed out the experience of Mr. Appold to this effect. The analytical tendency of the mind is so strong that out of any tangle of superimposed outlines it persists in dwelling preferably on some one of them, singling it out and taking little heed of the rest. On one occasion it will select one outline, on another a different one. Looking at the patterns of the papered walls of our room we see, whenever our fancy is active, all kinds of forms and features; we often catch some strange combination which we are unable to recall on a subsequent occasion, while later still it may suddenly flash full upon us. A composite portrait would have much of this varied suggestiveness.

A further use of the process would be to produce from many independent portraits of an historical personage, the most probable likeness of him. Contemporaneous statues, medals, and gems would be very suitable for the purpose, photographs being taken of the same size, and a composite made from them. It will be borne in mind that it is perfectly easy to apportion different "weights" to the different components. Thus, if one statue be judged to be so much more worthy of reliance than another that it ought to receive double consideration in the composite, all that is necessary is to double either the time of its exposure or its illumination.

The last use of the process that I shall mention is of great interest as regards inquiries into the hereditary transmission of features, as it enables us to compare the average features of the produce with those of the parentage. A composite of all the brothers and sisters in a large family would be an approximation to what the average of the produce would probably be if the family were indefinitely increased in number, but the approximation would be closer if we also took into consideration those of the cousins who inherited the family likeness. As regards the parentage, it is by no means sufficient to take a composite of the two parents; the four grandparents and the uncles and aunts on both sides should be also included. Some statistical inquiries I published on the distribution of ability in families[1] give provisional data for determining the weight to be assigned in the composite to the several degrees of relationship. I should, however, not follow those figures in the present case, but would rather suggest for the earlier trials, first to give equal "weights" to the male and female sides; thus the father and a brother of the male parent would count equally with the father and a brother of the female parent. Secondly, I should "weight" each parent as 4, and each grandparent and each uncle and aunt as 1; again, I should weight each brother and sister as 4, and each of those cousins as 1 who inherited any part of the likeness of the family in question. The other cousins I should disregard. The weights as previously mentioned, would be bestowed by giving proportionate periods of exposure.[2]

Composites on this principle would undoubtedly aid the breeders of animals to judge of the results of any proposed union better than they are able to do at present, and in forcasting the results of marriages between men and women they would be of singular interest and instruction. Much might be learnt merely by the frequent use of the double image prism, as described above, which enables us to combine the features of living individuals when sitting side by side into a single image.

I have as yet had few opportunities of developing the uses of the composite photographic process, it being difficult without much explanation to obtain the requisite components. Indeed, the main motive of my publishing these early results is to afford that explanation, and to enable me to procure a considerable variety of materials to work upon. I especially want sets of family photographs all as nearly as possible of the same size and taken in the same attitudes. The size I would suggest for family composites is that which gives one-half of an inch interval between the pupil of the eye and the line that separates the two lips. The attitudes about which there can be no mistake are: full face, an exact profile, say, always showing the right side of the face, and an exact three-quarters, always showing the left; in this, the outer edge of the right eye-lid will be only just in sight. In each case the sitter should look straight before him. Such portraits as these go well into *cartes de visite*, and I trust that not a few amateur photographers may be inclined to make sets of all the members of their family, young and old, and of both sexes, and to try composites of them on the principles I have described. The photographs used for that purpose need not be in the least injured, for the register marks may be made in the case into which they are slipped, and not in the photographs themselves.

[1] "Hereditary Genius," p. 317. Column D. Macmillan, 1869.

[2] Example:—There are 5 brothers or sisters and 5 cousins whose portraits are available; the total period of desired exposure is 100 seconds. $5\times4+5=25$; $\frac{100}{25}=4$; which gives $4\times4=16$ seconds for each brother or sister, and 4 seconds for each cousin $(5\times16+5\times4=100)$.

THE SEICHES OF THE LAKE OF GENEVA[1]

AMONG the best-established phenomena of terrestrial physics is that which from ancient times has been known at Geneva under the name of *seiches*. Its true nature has been only recently recognised, and the obscurity which still envelops its causes gives it an interest calculated to attract the attention of men of science of every country. It is not necessary to have a knowledge of science to recognise in the neighbourhood of Geneva sudden irregular changes of very varied amounts, which sometimes affect the level of the lake. They are analogous to small tides whose existence is well established, but whose origin is not determined. For eight years Prof. Forel has worked at the problem by studying the characteristics of the progress of the phenomenon. The following is a *résumé* of his observations and conclusions.

Previous to Prof. Forel, eminent naturalists, among them Jallabert, Bertrand, H. B. de Saussure, J. P. E. Vaucher, had pointed out the existence of these *seiches*, described them, and hazarded hypotheses to account for them, hypotheses which for the most part cannot be maintained. Former observations furnish some guiding points to examine the question. They were made mainly near Geneva, where the oscillations of the level of the lake are much more marked than anywhere else on its shores. It is, however, at a much less favourably situated point of the shore that M. Forel has undertaken his regular investigations. Morges, his usual residence, is situated on the north shore of the lake, opposite its greatest breadth, and a little to the east of the line dividing its total length into two equal parts. There, by means of ingenious instruments, the movements of the liquid surface have been registered with regularity and sagacity, and veritable discoveries have been the result of the work.

Vaucher, at the beginning of the century, had already surmised that *seiches* must exist in all lakes, that they take place at all seasons and at all hours of the day, that they are more frequent in spring and in autumn, more frequent especially when the atmosphere is subject to strong variations in pressure. He valued approximately their duration, and predicted their character of permanence, which assimilated them to the incessant oscillations of the fluid mass. He believed, as H. B. De Saussure announced in 1779, that "prompt and local variations in the weight of the air could contribute to the phenomenon and produce momentary fluxes and refluxes by causing unequal pressures on the different parts of the lake." The movement of the liquid will then be an oscillation of libration. Vaucher admitted that this oscillation was progressive. His conclusion did not appear justified; he did not take into account the rhythm of the *seiches*, which, in reality, shows itself with a remarkable regularity whatever be their amplitude, and the duration of which is connected with the dimensions of the lake in length and depth.

[1] Researches by Dr. F. A. Forel, Professor at the Academy of Lausanne. *Bulletins de la Section Vaudoise des Sciences Naturelles*, 1873 and 1875. *Arch. des Sc.*, 1874–76.

It is to elucidate this question that the experiments of M. Forel tend. They were referred to in NATURE, vol. xii. p. 134, and a paper on them was read at the Physical Society, May 27, 1876 (NATURE, vol. xiv. p. 164). Working with an artificial basin, then on several Swiss lakes, he has proved the constancy of the duration of the wave of libration; the increase of this duration with increase of length of the basin; its diminution with increase of depth. The character of the wave of libration is, that the water rises at one extremity of the basin while it sinks at the other, and *vice versâ*. As to the intensity of the wave it varies much, either under the influence of the mysterious cause which produces it, or according to the region of the basin where it extends. The *seiches* are much more pronounced at Geneva than in the broader part of the lake, either on account of the contraction of the mass of the water on the south-west shore, or of the considerable decrease in its depth.

If we examine the *seiches* at Morges, their theory becomes infinitely more complicated, because, besides the phenomenon of the longitudinal *seiche*, mainly visible at the two extremities of the lake, the changes of level present other periods in relation with the transverse libration of the liquid mass. They are also modified by oblique or cross reflections of waves in motion, which are connected with the form of the basin. We may only expect a real regularity in the form of the waves of libration if that form of the basin is regular.

In order to be able to base his conclusions on more varied observations, M. Forel has measured the duration of the *seiches* of seven other Swiss lakes, besides that of Geneva, and he has been able to draw the following inference:—The duration of the wave increases with the length of the basin, and diminishes in proportion as the depth increases. In other words, the rhythm of the longitudinal *seiches* is a direct function of the length of the different lakes and an inverse function of their depth. From the figures which have permitted the inference of this general law, we may, by neglecting the influence of the depth, approximately conclude the duration of a *seiche* corresponding to a lake of a given length; and reciprocally infer the probable kilometric length of a *seiche* whose duration is known. It will then be possible to infer the direction of any particular wave, among those which show themselves on the shore of the Lake of Geneva, for example. The above enunciation is then generalised, and is thus modified:—The duration of *seiches* is a direct function of the length and an inverse function of the depth of the section of the lake along which they oscillate.

M. Forel has found a mathematical formula relative to the movement of liquids in basins in the works of a Bâle *savant*, Dr. J. R. Mérian (1828), completing the formula given by Prof. Guthrie, and applicable to the movement of *seiches* (NATURE, vol. xv. p. 91). It may be stated thus:—The duration of *seiches* is proportional to the length of lakes and inversely proportional to the square root of their mean depth.

By experiments made in the first place on the Lake of Neuchâtel, it was found that the movements of libration of the water were alternate and simultaneous. The water rises at one of the extremities, while it falls at the other. The amplitude of these movements is very variable, but their constancy is proved, preserving the same rhythm; their cessation or their absence would be the abnormal fact.

These conclusions have been extended and confirmed in a remarkable manner since the establishment of automatic instruments, intended to take a graphic tracing of these phenomena. A pencil in constant connection with the level of the lake draws a line on an endless paper, which is unrolled by a clockwork movement. Following the forms of this line, we discern in a very exact manner the influence of the various waves of oscillation, whose amplitude may vary from a few millimetres to a metre and more, if it has to do with the extremity of the lake, near Geneva. At Morges the first model of this apparatus was set to work, named by its inventor "registering limnimetre;" the curves obtained are compounded of the actions of various categories of *seiches*. They are more or less difficult to discern, but ordinarily recognisable and in connection with the rhythm corresponding to each. At Sécheron, near Geneva, where M. Ph. Plantamour has had an apparatus of the same kind constructed, the longitudinal *seiche* shows itself in a much more sensible manner, corresponding to a duration of about seventy-three minutes. The vibrations which affect the level of the lake under the influence of the wind or the passing of steamers disturb here much less than at Morges the study of the rhythm of libration, and above all, the measurement of the amplitude of this libration, which is, as we have said, much more considerable than at Morges.

This second registering limnimetre has only been working regularly since June, 1877. It has already served to confirm the fact of the alternation of the movement of the water, which rises at Geneva, while it falls at Morges, and *vice versâ*, following the period of seventy-three minutes for the great longitudinal *seiche* of the lake, thus confirming the presumption of an oscillation of the liquid mass around a median line, normal to its length. Morges, being situated at a short distance to the east of this line, offers a movement of the water of very inferior extent to that of the terminal part of the lake near Geneva. It is desirable that a similar apparatus be set up at the eastern extremity of the lake, between Vevey and Villeneuve, with a barometer comparable to that at Geneva, and giving constant indications.

It is generally presumed, in fact, that it is to changes of pressure on various parts of the lake that the variations in the intensity of the oscillatory movement of the water are due. These variations are nearly always marked during stormy weather. Before the storm comes on, before even the barometric column is disturbed, the libration increases in amplitude. But concordant observations at the two ends of the surface which is agitated have not yet been made to furnish data to determine if an increase of pressure at one of the extremities of the lake coincides with a depression at the other. The point remains, meantime, very doubtful, and very worthy of being investigated.

As to the oscillations of exceptional amplitude, such as those of October 3, 1841, when the difference of level observed at Geneva exceeded 2·14 metres, the presumption was that we ought to seek for the cause in some movement of the earth's crust, of the basin of the mass of oscillating fluid. Great, then, was the anxiety of Swiss observers, when, on October 8, 1877, they were awakened at 5·16 A.M. by a strong shock of earthquake, on running to their limnimetre, which they found working very regularly. But no trace of the action of that violent commotion was shown by the registering pencil. Not only must that absence of effect make us seek elsewhere for the cause of these mysterious accidents, but we have reason to be astonished at the insensibility of a liquid surface which remains calm though balanced on ground which was so agitated as to crack the woodwork of houses, ring bells, and displace furniture in all the neighbouring region. This disappointment is a new motive to continue this interesting research, and to enlist the physicists of every nation, all the more that wherever there are lakes there ought to be *seiches*. E. G.

EXAMINATION OF THE PHONOGRAPH RECORD UNDER THE MICROSCOPE[1]

MR. FRAZER referred to previous results obtained by him of some examinations of the tin foil which had been indented by the stylus, or needle point, of the pho-

[1] Abstract of paper presented at the meeting of the Franklin Institute April 17, 1878, by Persifor Frazer, Jun., A.M.

nograph. His object was to ascertain the shapes of the indentations made by different known sounds. The vowels and diphthongs were spoken into the mouthpiece of the apparatus with small panels in the order seen on the diagram.

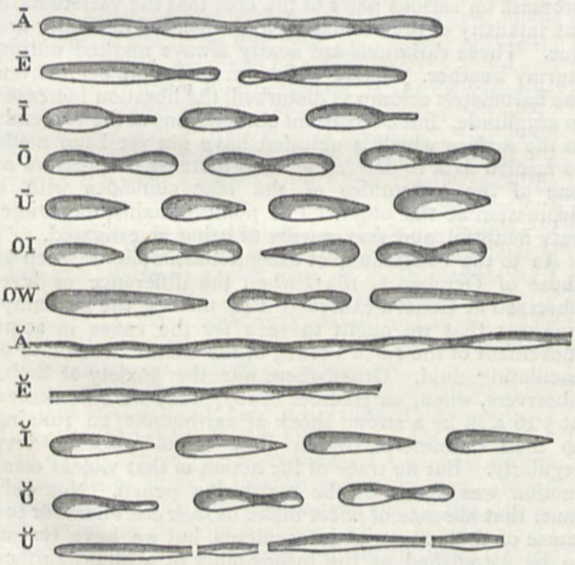
These sounds were repeated thrice on each of three foils. They were then mounted on glass plates, separated, and labelled. Finally, they were cut out and mounted on another piece of glass vertically, instead of horizontally, in order that a number of the dents produced by any given sound might be on the screen at once.

Lissajous, Leon Scott, and König have provided the means of transforming sounds into form, in various ways, viz., by bright points on the ends of steel bars of different thicknesses; by vibrating membranes at the extremity of a "phonautograph," and by flames reflected in a rotating mirror. It was natural to conclude that the same vibrations, imparted to a steel point by means of a metal diaphragm, would leave an equally characteristic trace.

The same voice (that of Dr. Plush), speaking the following vowels and diphthongs as nearly as possible at the same distance from the mouthpiece, was relied upon for the matrices.

The first records tried, to ascertain whether the pronunciation was perfect, were afterwards thrown away, and the records which were studied were not in any way injured by a second passage of the point of the stylus.

By following along the nearly vertical line of impressions, which are at the same time in focus, it will be observed that this line consists of one long followed by two shorts (or two shorts followed by one long), the indentations bearing a general resemblance to each other and to seeds. This is long A, or "Ah." A glance at



[NOTE.—In the wood-cut, the forms made by the excursions of the stylus for the short letters are wider than they should be.]

short ă (as in "bat"), will show the same thing, but the seed-shaped hollows are narrower, and there are no abrupt terminations of the hollows by intervening parts of the foil, which have not been touched by the needle-point.

E (or ay), on the screen, looked like the magnets of two Bell telephones, with the small ends turned towards each other. In the diagram they look like two Indian clubs with the handles together. The same general resemblance is observed in E short, except that, as in ă short, the volume of sound being less, the intensity was less, or (what is the measure of intensity) the path of the needle-point was shorter, and it seldom entirely cleared the foil, the consequence being a continuous groove of irregular, but normally irregular, width.

Ī and Ĭ are much alike in general form, as also are Ō and Ŏ, the coupling of the pairs of the latter being the most striking feature. Ū and Ŭ, in the drawing, best show the difference in shape produced by less intensities, the short being drawn out, and more acicular.

OI is very interesting. The diphthong consists of ŎĬ, and the very moulds which characterise their sounds are to be observed in the cut.

OW presents a composite character, but its derivation has not yet been made out.

The above presentation of the subject is necessarily crude and imperfect, but will illustrate the possibilities of an exhaustive investigation.

THE LIFE-HISTORY OF A SEPTIC ORGANISM[1]

THIS was an account of a hitherto unrecorded organism, belonging to the septic series, which was found in the earlier stages of the decomposition of the macerating body of a vole. It was studied by the aid of the "continuous stage" used by the author and Dr. Drysdale in their "Researches on the Life History of the Monads,"[2] by means of which a drop of the septic fluid containing the organism can be kept under examination for an indefinite time, without evaporation; and be studied with the most delicate and powerful lenses. The method pursued was continuous study, first of the details of the several metamorphoses, and by the light thus gained, a continuous study, subsequently, of their sequences in the same individual form.

The majority of the most difficult and delicate work was done with a new $\frac{1}{35}$-inch lens, made for the author, with a special view to this class of observation, by Messrs. Powell and Lealand. He also had the advantage of the fine "new formula" lenses, made by the same firm recently, that is to say, two $\frac{1}{8}$ths, a $\frac{1}{12}$th, and a $\frac{1}{16}$th. He also used their $\frac{1}{25}$th and $\frac{1}{50}$th inch objectives.

The organism never exceeds the $\frac{1}{4000}$th of an inch in long diameter: it is oval, with a constriction slightly in front of its short diameter: and at its anterior extremity has a head-like protrusion, to which is attached a long delicate flagellum. At the sides of the shorter, or front segment of the oval, somewhat in the position of "shoulders," two long fine flagella proceed, and as a rule trail with exquisite grace behind; one on either side. It swims with great rapidity and has every variety of motion in the fluid: and in the accomplishment of its evolutions its lateral flagella are largely concerned. But besides its swimming power, it has the capacity to anchor both its trailing flagella to the floor, or the stage, or to a decomposing mass, and by coiling these flagella, and bringing itself down upon the body to which it is anchored, and then suddenly darting up so as to make its flagella, together, the radius of a circle, it darts down on the decomposing substance, and by the enormous numbers that are constantly doing it, aids in the rapid breaking up of the tissues.

By steadily following it in the free-swimming condition it was seen to undergo fission or self-division, which was a very complex and extremely delicate process; the division beginning in the front flagellum and proceeding until, by longitudinal division, a new lateral flagellum was, in the act of self-division, made for each half; and by the snapping of this both halves went free as perfect organisms, soon to commence the process again. A great deal of close and careful detail was given of this process, and was accompanied by illustrations drawn from nature. There were also accounts of a series of

[1] Abstract of Paper read before the Royal Society on the Life-History of a Minute Septic Organism: with an Account of Experiments made to determine its Thermal Death Point. By the Rev. W. H. Dallinger, F.R.M.S.

[2] *M. M. J.*, vol. xi. pp. 97—99.

observations on the frequency of the recurrence of the process of fission, by the continual following of one segmental product of the act; and also from its beginning to its cessation, in a series of separate organisms, making manifest the periods of greatest fissional intensity; and also showing the result following on the cessation of fission. In the majority of cases it was an exhaustion of vital action and death: but in a certain proportion, in which fission was not so long continued, it was a rapid change to an amœboid condition, resulting in the absorption or fusing of the lateral flagella with the body, and a change of form; the organism becoming now quite oval and having only an anterior flagellum. It swims easily, but has lost all the power and freedom of motion possessed before, moving only in a straight line. But it soon comes into contact with a colony of the organism in the springing condition, attaches itself to one of them, which then soon unanchors and both swim away. In the course of time their movements become sluggish; the sarcode of the bodies is palpably blending, they become quite still, except for amœboid movements, and then become one mass, oval in form, which elongates into a spindle-shape, remaining motionless and still in all respects for three or four hours; when, as was ultimately, and by long continued effort made out, it pours out exquisitely minute, opaque, apparently round specks, which, when carefully and steadily followed with the best appliances, were seen to develop into the adult form and size.

The author then desired to discover the relative heat-resisting power of the perfect form, and the germ or spore. The adult forms were proved by a very direct method, which was fully detailed, to be wholly destroyed at a temperature of 142° F. Two methods of heating were employed to test the resistance of the spore. One was the "dry" method which had been employed in the former researches; but which was somewhat modified and used with special precautions; and the result of an elaborate series of experiments proved, that by this mode of heating, the spore could resist a temperature of 250° F.

It was next determined to test the heat resistance of the spore when they suffered the heat, diffused in a fluid. The difficulty of accomplishing this, so as to secure an unmistakable result was carefully pointed out and dwelt on; and the opinion recently expressed by Dr. Bastian that it was "perfectly easy" shown to be an error.

The apparatus employed for the purpose was specially delicate, but enabled the author to test directly the results of heat on the spores as well as on the adult organism, without exposure after the vessel was once sealed. The form used was specially devised for these observations. The temperatures up to the boiling point of water were got in melted paraffin, and higher temperatures in a digester. The result was that 220° F. was found to be the limit of temperature which the spore of this organism could endure without destruction of vitality. That is to say 30° F. lower than the same spores could bear in a "dry" heat. But it was pointed out, that to endure this temperature, implied protection of some kind: but that this in the *undeveloping* germ, was not only capable of being understood, but would doubtless prove of immense value to the organism.

OUR ASTRONOMICAL COLUMN

THE UNIVERSITY OBSERVATORY, OXFORD.—Prof. Pritchard has published No. 1 of *Astronomical Observations made at the University Observatory, Oxford*. It comprises observations made between the autumn of 1875, when the establishment was first organised, and the end of 1877. They relate to the satellites of Saturn, double stars, and the five comets discovered in 1877, by Borrelly, Winnecke, Swift, Coggia, and Tempel, for which provisional elements and, in the case of Winnecke's comet, an extensive ephemeris are added; also elements of the orbits of ξ Ursæ Majoris, 70 Ophiuchi, and μ^2 Boötis, and comparison of the same with the interpolation curve drawn according to the method of Sir J. Herschel. The observations of the satellites of Saturn consist of differences of R.A. and N.P.D. from the centre of the primary, facilitated by the ephemerides which Mr. Marth has regularly supplied; together with the other observations now printed, they have been made with the refractor of 12¼-inches aperture, constructed for the observatory by Mr. Howard Grubb, of Dublin, Mr. W. E. Plummer, the first assistant, being credited with the greater part of them. In addition to the above work, it is mentioned that nearly twelve hundred measurable photographs have been secured by means of Dr. De la Rue's reflector, which he presented to the Observatory, and which is mounted in the eastern dome, and a very beautiful instrument for completing the measurement of these photographs has been recently received through the liberality of the same gentleman. The institution is under the control of a Board of Visitors, as usual in so many of the more important astronomical establishments at the present day, the Board being composed of the Vice-Chancellor, the Proctors, the Astronomer-Royal, the Director of the Cambridge Observatory, the Radcliffe Observer, and four other members elected by the Convocation of the University; these members are at present, Dr. De la Rue, Prof. Bartholomew Price, J. A. Dale, M.A., and W. Esson, M.A.

The position of the University Observatory is in latitude 51° 45′ 34″·15, and longitude 5m. 0·40s. west of Greenwich.

THE CINCINNATI OBSERVATORY.—No. 4 of the publications of this observatory, just issued, contains the results of measures of double stars made in the year 1877, with the 11-inch refractor, the object-glass of which was replaced early in the year after having been successfully refigured by Alvan Clark and Sons; in addition to this improvement a new driving clock was added. The stars measured are, with very few exceptions, situate between the equator and 40° of south declination, and this selection of objects gives a rather special value to the Cincinnati observations, though it has been notified from Melbourne that the remeasurement of Sir John Herschel's southern stars is in progress there. The methods of observing at Cincinnati, and the investigation of personal equation, are explained in the introduction, and the larger differences in the measured angles and distances, found on comparison with the catalogues of Struve, Sir John Herschel, Jacob (Poona), and Dembowski's measures of doubles discovered by Mr. Burnham, are indicated. Some of these larger differences occur in the case of well-known rapidly-moving binaries; but there are others which deserve further attention, to decide upon the cause of the observed changes. The following may be mentioned:—

Star.	Sir J. Herschel's Measures.	Pos.	Dist.	Cincinnati Measures.	Pos.	Dist.
		°	″		°	″
h 2036	1836·54...	40·4	—	1877·76...	25·1	1·40
Lalande...2416	36·96...	—	1·82			
h 3447	1837·11...	75·5	—	1877·80...	90·1	2·20
Lacaille ...462	37·51...	—	3·12			
h 3461	1836·54...	69·6	—	1877·85...	59·0	4·84
ε Sculptoris ...	36·70...	—	5·53			

Of stars observed by Sir J. Herschel with the 20-feet reflector, for Nos. 2,904, 3,494, and 5,113 (which are respectively Lacaille 8,262, 702, and 8,098), the Cincinnati measures show differences greater than 20°. The positions of these stars for 1880 are:—

	Right Ascension. h. m. s.	S. Declination. ° ′
h 2036	1 14 4	16 26
,, 3447	1 30 35	30 31
,, 3461	1 40 1	25 39
,, 3494	2 14 46	35 59
,, 5113	19 17 30	29 32
,, 2904	19 47 7	24 14

The "mean results" at the end of this publication apply to upwards of 500 objects.

THE REAPPEARANCE OF ENCKE'S COMET.—Dr. von Asten, in an extract from the *Bulletin* of the St. Petersburg Academy, has circulated an ephemeris of Encke's comet for the return in the present year, and it is also printed in No. 2,197 of the *Astronomische Nachrichten*. The elements have been perturbed to April 24, 1878, taking into account the attraction of the six old planets and the effect of a resisting medium. The perihelion passage takes place July 26·1159, G.M.T., and Dr. von Asten especially insists upon the importance of observations in the southern hemisphere after perihelion, for the improvement of the theory, and urges that at least two complete series of observations with moderately powerful instruments should be obtained, for reasons which he states are explained in a memoir now in the press. The following positions are interpolated from his ephemeris for Berlin noon, corresponding to 8h. 46m. mean time at Melbourne:—

	Right Ascension. h. m. s.	North Polar Distance. ° ′	Log. Distance from the earth.
August 1	... 9 46 0	... 79 19·8	... 0·0824
,, 5	... 10 17 23	... 83 53·8	... 0·0597
,, 9	... 10 47 39	... 88 28·0	... 0·0399
,, 13	... 11 17 24	... 92 58·0	... 0·0248
,, 17	... 11 47 0	... 97 18·8	... 0·0155
,, 21	... 12 16 30	... 101 24·3	... 0·0123
,, 25	... 12 45 47	... 105 8·7	... 0·0151
,, 29	... 13 14 34	... 108 27·3	... 0·0233
Sept. 2	... 13 42 30	... 111 17·4	... 0·0359

The elements of the orbit for April 24, 1878, are: longitude of perihelion, 158° 19 41″, ascending-node, 334° 39′ 10″ (M. Eq. 1878·0), inclination, 13° 6′ 40″, eccentricity, 0·8491669, semi-axis major, 2·210691. The perihelion distance is 0·33344, the aphelion distance, 4·08794, and the semi-minor-axis, 1·16752. The sidereal period at the above date is 1200·8 days.

NOTES

THE funeral of the late Prof. Henry, at Washington, was an imposing pageant, being attended by the President and the members of the Cabinet and the Congress—the latter body adjourning from respect to his memory—with a large number of prominent men from all parts of the country. Prof. Spencer F. Baird succeeds Prof. Henry as secretary to the Smithsonian Institution.

A MONUMENT to the late eminent physicist, Dr. Robert von Mayer, will be erected at Heilbronn, in Würtemberg. Herr Gustav Rümelin, the Chancellor of Tübingen University and well-known critic of Shakespeare, will shortly publish a biography of Dr. von Mayer.

PROF. HELMHOLTZ has written to the Royal Institution to obtain a bust of Faraday, and to the French Academy of Sciences for busts of Ampère and Regnault. No bust of Regnault being in existence, one will be executed at the expense of the Government, by M. Noel, and placed in the Hall where the Academy meets. A cast will be sent to Berlin as requested.

THE honorary membership of the Geographical Society of Italy, at Rome, has recently been conferred on Dr. George Bennett, of Sydney, who is well known as a naturalist and traveller, and who it seems had been exceedingly active in the furthering of Signor L. M. d'Albertis' late expedition to New Guinea.

PROF. ERNST HAECKEL has been nominated honorary member of the Geographical Society of Lisbon and of the Microscopical Society of San Francisco.

THE system of science and art education which centres at South Kensington and branches to the remotest parts of the kingdom, has years ago assumed the dimensions of a national organisation and done more, probably, than any other means, to foster a wide-spread artistic taste and a desire for scientific knowledge among the people. The well-trained teachers of the department are everywhere doing their humanising and elevating work. This immense organisation, every one now admits, is mainly due to the energy, intelligence, and foresight of one man, Sir Henry Cole, who has happily survived much that would have daunted a less enthusiastic and public-spirited man—survived to receive, as he did last Thursday, a well-earned and appropriate honour. On that day a large number of ladies and gentlemen assembled at Grosvenor House, by the permission of the Duke of Westminster, for the purpose of presenting to Sir Henry Cole a testimonial, the result of an effort originated some years ago. The memorial was in the form of a marble bust and memorial tablet in della robbia ware, containing a portrait of Sir Henry in mosaic. The total amount of subscriptions was 2,924*l.* 13*s.* 4*d.* After paying expenses for the monument, portrait, and bust, Sir H. Cole had already received 2,000*l.* The Duke of Westminster, in presenting the testimonial, bore testimony to the advantages which Sir Henry Cole had conferred upon the nation in his efforts to promote the development of science and art. Sir Henry Cole, in acknowledgment, said his words could but feebly express his hearty thanks to the princes, peers, commoners, men of science, art, and literature, industrial producers and handworkers, who had joined in this testimonial. After fifty years of public life, with his health declining from the constant strain of official work, he (Sir H. Cole) felt it right to resign his duties. He was not idle in his leisure. His health had improved, and he hoped still to do some useful public work. He was trying to obtain a national recognition for music, the first and most popular of all fine arts, to help elementary education to become the work of the people rather than of the State, and to promote improved health throughout the country. The portrait in mosaic of Sir Henry is to be offered to the South Kensington Museum. The marble bust will be presented to his Royal Highness the Prince of Wales, as president of the Albert Hall, with a request that it should have a suitable place in the Hall.

A STRANGE jubilee is proposed to be celebrated in Italy during 1879. Our readers know that next year 1,800 years will have elapsed since the two cities of Pompeii and Herculaneum were destroyed by earthquakes and eruptions from Mount Vesuvius. It is now intended to celebrate the anniversary of that year of destruction, and the site of the celebration is to be at Pompeii itself, as being the better known of the two buried cities.

IN the April number of the *Bulletin* of the Imperial Academy of St. Petersburg it is stated that a clergyman named Pervouchine has proved that the number $2^{2^{12}} + 1$ is divisible by $7 \cdot 2^{14} + 1$. Bouniakowsky has verified the result at the request of the Academy. Hitherto the only exception known to Fermat's statement, that all numbers of the form $2^{2^m} + 1$ are primes, is that of $m = 5$ where Euler showed that 641 is a divisor.

M. C. TH. LIEBE (*Proc.* Imper. Geol. Instit., Vienna, March 5, 1878) has found a considerable quantity of remains of the Marmot in the Diluvium near Gera (Thuringia), indicating the existence of a larger form than the existing species, and intermediate in character to the European marmot and the bobak, and he regards it as representing the primordial stock from which the living species have proceeded in the course of time. The region in which these remains have been found bears a *steppe* character, the fauna and flora of steppes being met with both in mountainous regions and on plains. M. Liebe, who is a votary of Baron Richthofen's sub-aerial theory, admits the diluvial district of Germany to have been once a steppe region with an extreme climate and analogous to the present steppes of the Altaï.

THE French Ministry for Public Instruction has completed in the Central Palace of the Exhibition the installation of the "Salle des Missions Scientifiques." A large map has been exhibited on which all the names of the scientific missionaries are inserted on the countries which they have explored on behalf of the French Government. The collection of works published by the living members of the "Corps Enseignant" (French University) is ready; it is composed of more than 4,000 volumes neatly bound. This library is open every day from 8 to 10 in the morning. Admission to the palace is obtained at this early hour by a double ticket (price 9 francs). Not a single gallery in the Trocadero Palace has been yet opened. The success of the Exhibition is increasing daily. The average number of admissions on payment has been more than 40,000 a day for the first fourteen days. The sale of tickets by the agents is more than 1,200,000. The number of season-ticket holders was 1,000 in the beginning of last week, although no real advantage is offered to them. The system of conveyance by trams, railways, and steamers is excellent, and working very well. M. Bardoux has proposed a credit of 100,000 francs for the purpose of sending to Paris a number of *instituteurs* who will take part in their special congress during the Exhibition.

THE *Proceedings* of the Literary and Philosophical Society of Liverpool for 1876–77 forms, as usual, a thick volume, containing several papers well worthy of careful reading. The paper of chief scientific interest in this volume is that of Mr. A. J. Mott on Haeckel's "History of Creation," which, with the elaborate discussion that followed, is likely to interest all who are interesed in the subject.

A FIRM at Melbourne, New South Wales, claims to have improved the Abyssinian tube-well by attaching a drill to the first tube, and cutting through rock by imparting a rotary motion to it, instead of merely hammering it through as heretofore, which plan has been found not to succeed in hard soils.

IN confirmation of our remarks on the recent progress sciencewards in Spain, we may state that we have received further papers. One a pamphlet of thirteen pages is a paper entitled *El Alcorán*, by Señor D. Eduardo Saavedra, read at the eighth conferencia (February 25th, 1878) of the *Institucion libre de enseñanza*. The other is the prospectus of the *Revista General de Legislacion y Jurisprudencia*, publicada por D. José Reus y Garcia con la coloboracion de distinguidos Jurisconsultos y publicistas (now in the twentieth year of its publication).

FROM a Japan contemporary we learn that copper-smelting works are being built by Japanese near Kobe. The ore to be used will come from a mine near Ikeda, and is said to contain a considerable quantity of silver which is to be extracted first. Coal and copper appear to have been recently discovered in several places in this part of Japan.

A BRILLIANT meteor was seen at Geneva at 9.45 P.M. on Sunday week. It moved very rapidly from east to west, was in the shape of a pear, and was of a greenish hue, leaving behind it a slight train of light. This was evidently the same meteor that was seen by our correspondents referred to in last week's NATURE; the time was the same, making allowance for the difference of longitude between Geneva and this country.

THE total production of silk cocoons in Europe amounted upon an average to 58,000 tons per year during the last five years. Italy stands first in the list of silk-producing countries; it produces 39,000 tons per year. France produces about 10,000 tons, Turkey 4,000, Spain 2,200, Austria 1,900, Portugal 250, Greece 200, Russia 150, Germany 100, and Belgium and Switzerland only 100 tons together.

THE King of Italy has conferred the Cross of the Order of SS. Maurice and Lazarus upon Prof. Mommsen, of Berlin.

THE well-known geologist and academician, Gregor von Helmersen, of St. Petersburg, celebrated the fiftieth anniversary of his entering the Russian army, on the 5th instant.

IT is telegraphed from New York, May 14, that a despatch from Havannah announces that a terrific earthquake has occurred at Cua, in Venezuela, 600 persons having been killed. A heavy shock was also felt at Caracas. An earthquake is reported from Göttingen. On May 6 two shocks were felt, one at 10.34 the other at 10.37 P.M. The former was of greater force than the latter, and their duration was three and two seconds respectively. An earthquake was also felt in a large number of places in Morbihan (Britanny), on the 14th instant, in the morning; the hours vary according to the places. At Hennebout, a small seaport on the Blavet, it occurred at 7h. 3m., duration six seconds; at Vannes, 5h. 40m. local time (6h. 20m. Paris time). The direction was from west to east. Commotions were also felt in Lorient and Port Louis almost at the same hour as at Vannes.

WE have already referred to the *American Journal of Mathematics* promised us from the Johns Hopkins University, and were able to mention the names of some of the contributors, all of them of the first rank. We have not yet received the first number, but from a note in the *Nation* we see it has appeared, and that the programme will delight our mathematical friends. The first number contains, in 104 handsomely-printed quarto pages, eight articles, two of them from foreign contributors, in which the separate departments of astronomy, mechanics, physics, and pure mathematics are all represented. The first article is a short note of three pages, containing the proof of the proposition, that "if a fourth dimension were added to space, a closed material surface (or shell) could be turned inside out by simple flexure, without either stretching or tearing." This is followed by the first part of a paper upon the lunar theory, by Mr. G. W. Hill. Prof. Eddy, of Cincinnati, presents a simplified equation to express the relationship between the moments of flexure of a straight elastic girder at three successive points of support. An algebraic solution of the so-called irreducible case in cubic equations, with examples, covers eighteen pages. A short note on the theory of groups is communicated by Prof. Cayley, of Cambridge. Prof. Rowland's paper is a contribution to our knowledge of the theory of electric absorption. A very favourable review of Ferrero's treatise on the method of least squares is given by Mr. C. S. Peirce, and the balance of the number is occupied by Prof. Sylvester with a paper in which the new atomic theory of chemistry is applied to the graphical representation of certain mathematical conceptions. A paper on this subject, by Prof. Sylvester, has already appeared in NATURE.

WE notice the appearance of the concluding part of the *Jahresbericht der Chemie* for 1876. This almost indispensable companion of the chemist, founded by Liebig and Kopp, is now under the editorship of Prof. Fittica, of Marburg, assisted by a corps of twelve other leading German and Austrian chemists, and has reached its twenty-ninth volume. A glance at the space allotted to the various sub-divisions gives a general idea of the tendencies of modern chemical research. General and physical chemistry occupy 160 pages, inorganic chemistry 140, organic chemistry 650, analytical chemistry 100, technical chemistry 170, chemical geology 40, and mineralogy 60. Over 1,000 authors are referred to in the course of the work. It is a strange circumstance that German should be the almost exclusive medium for the publication of exhaustive and elaborate annual reports of the progress made in each branch of natural science.

PROF. KOLBE, of Leipzig, has just added another to the numerous German text-books of inorganic chemistry, and justifies its appearance by the opinion that the existing works, with the exception of the translation of Roscoe's Chemistry, contain far too much material for elementary treatises. A vigorous warfare is waged against the now so prevalent use of Latin and Greek names among German chemists, a custom certainly from a foreign standpoint not to be regretted, bringing as it does the scientific nomenclature more in unison with that of England, France, and Italy. We notice also that Prof. v. Richter, of Breslau, has just issued a second edition of his Text-book of Inorganic Chemistry, and that Prof. Wislicenus is engaged on a new and modernised edition of Regnault's Chemistry, the ninth edition of this classical little work which has appeared in Germany.

A SECOND edition of Prof. Klenke's well-known work on the adulteration of food is now being published at Leipzig (Weber). The author has chosen the dictionary form for this edition, and the title is now "Illustrirtes Lexikon der Verfälschungen der Nahrungsmittel und Getränke."

THE last part published of the *Sitzungsberichte der Münchener Academie für* 1877 contains an interesting report by Herr Hermann Schlagintweit-Sakünlünski upon the ethnographical material in the large collections made by the brothers Schlagintweit on their celebrated travels, and gives a detailed account of its distribution at the royal "Burg" at Nürnberg.

THE publication of the eighth edition of Ed. v. Hartmann's "Philosophie des Unbewussten" is now announced. It is a long time since a purely philosophical work has run through eight editions.

THE experiment of using superheated water for locomotives has been successfully tried on the tramway connecting Reveil and Marly-le-Roi, in France. The engines are charged with water heated to 180° C., which is allowed to vaporize as fast as required; and by doing away entirely with furnaces in the locomotives, the dangers of explosion, as well as the causes of terror to passing horses, are easily avoided. A locomotive, propelled in this manner, and attached to two carriages, ascended a gradient of 5½ in the hundred at the rate of sixteen miles an hour.

M. L. A. FORSMANN shows, in a recent communication to the Swedish Academy, that solenoïds are able to produce the same unipolar induction currents as magnets, and that the same laws rule in both cases.

AN immense deposit of guano has recently been discovered in the Wershchowskij grotto near Oizowo, in the Russian government of Kjelze. Chemical analysis proved the quality of the guano to be in no way inferior to that of Peru. It is stated that Prussian agriculturists have already sent agents to Oizowo to purchase large quantities of this guano.

IN the April session of the Deutsche geologische Gesellschaft Prof. Beyrich exhibited two specimens of *Ammonites iphicerus*, one of which came from Lichtenfels, in Bavaria, and the other from Mombassa, in South Africa. On account of their close similarity he assigned to the Jura formations of Mombassa the same age as that of the Bavarian deposits. The specimens attracted especial interest on account of the complete preservation in both cases of the aptychus, the origin and use of which still remain an unsolved problem. Herr Römer presented a specimen of Archæocyathus from the strata in the Sierra Nevada immediately above the archaic deposits. It is the first fossil found in these formations, and places them probably in the old silurian. Papers were likewise presented by Herr Ladebeck on the regularity in the deformation of markasite crystals, and by Herr K. Lossen on the albite gneiss of Schweppenhausen.

SOME experiments have lately been made by M. Grehant with regard to endosmose of gases through lungs separated from an animal. He finds in the phenomenon two distinct phases; in the first, the lungs swell till they even touch the walls of the bell-jar in which they are contained, while a manomoter shows there is considerable increase of pressure. Then comes a second phase, in which the lung returns to its original volume and the pressure diminishes. From observations on the living animal, however, M. Grehant concludes that in this case the phenomenon is very slight indeed.

PROF. KIRCHHOFF has presented to the Berlin Academy a series of considerations on the movement of the electric current in submarine cables, based on Helmholtz's well-known equations for the components of the intensity of a current, and the electrostatic moment dependent on the capacity for dielectric polarisation. The conclusions deduced are, that the rapidity of propagation of the electric waves increases with the conductivity of the gutta-percha covering, while the breadth of the undulations decreases in the same ratio.

A GERMAN translation of Father Secchi's work, "On the Astronomy of the Fixed Stars," will shortly be published by F. A. Brockhaus, of Leipzig. It will form the thirty-fourth volume of the International Scientific Library.

IN No. 8 of the *Journal* of the Russian Chemical Society are two papers, by M. Lermontoff, on the employment of two galvanometers provided each with a Töpler's apparatus for reducing the oscillations of a magnet, and on the methods employed by M. Brauer for the construction and verification of balances of precision. This latter paper is a detailed description of the methods devised by the skilful optician of the Pulkova Observatory for manufacturing and adjusting the prisms of balances, special apparatus having been devised by him and constructed for these purposes. The verifying apparatus discovers any deviation from the straight line on which the prisms should be placed, if it exceeds 30″, and the equality of the length of the arms of the balance is verified with a precision of 0·0000125 of their length. We are all the more pleased to see the appearance of such a description, as the methods used by constructors of precise scientific apparatus are generally unknown. We notice also in the same number a note, by M. Borgmann, on Maxwell's theory on the tensions in the magnetic field; and a note, by M. Geschus, on the various theories proposed for explaining the radiometer.

A. ARZRUNI communicates, in arecentt number of Groth's *Zeitschrift für Crystallographie*, a number of interesting results from a study of the crystalline properties of various organic bodies. Triphenyl-benzene is found to possess the property of double refraction in a degree surpassing that of any other crystalline body yet known. In substituted compounds he shows also that the introduction of the nitro-group invariably causes a much slighter change in crystallographic properties than when hydrogen is substituted by bromine or iodine.

THE Phylloxera, which has been in Spain and Portugal for some time, is now reported to have got as far as Greece.

THE additions to the Zoological Society's Gardens during the past week include a Syrian Fennec Fox (*Canis famelicus*) from

Arabia, presented by Commander F. Catton; a Wood Owl (*Syrnium aluco*), European, presented by Mr. C. B. Wharton; a Copper Head Snake (*Cenchris contortrix*) from North America, presented by Dr. Painter; a European Bearded Vulture (*Gypaëtus barbatus*), South European, a Rattlesnake (*Crotalus durissus*) from North America, deposited; a Collared Fruit Bat (*Cynonycteris collaris*), a Reindeer (*Rangifer tarandus*), a Chinchilla (*Chinchilla lanigera*), born in the Gardens.

RECENT RESEARCHES ON THE PHENOMENA OF FLUORESCENCE

SOME time ago Herr E. Lommel drew attention to the fact that certain substances do not follow the rule mentioned by Prof. Stokes, viz., that each ray of light produces fluorescent rays of smaller refrangibility only; recently Herr Lommel found several other substances which partly follow and partly deviate from Stokes's rule, which is thus proved to be of somewhat limited validity. Herr Lommel communicated his further researches on this subject at a recent meeting of the Physical Society of Erlangen. He now divides all fluorescent bodies into three classes: the *first class* comprises those substances upon which each homogeneous ray of light, capable of producing fluorescence, produces the whole fluorescent spectrum (fluorescence of the first order); the *second class* contains those substances upon which the same ray of light produces only those rays of the fluorescent spectrum which are of a smaller (or at most of an equal) refrangibility than the ray itself (fluorescence of the second order). The *third class* finally, embraces those bodies whose fluorescent spectrum consists of two parts, one of which corresponds to fluorescence of the first, and the other to fluorescence of the second order (compound fluorescence). Herr Lommel enumerates nine substances of class I., twenty-five of class II., and seven of class III., and gives the commencement of their fluorescence in the spectrum and the extent of the latter in tables accompanying his paper.

If we examine the series of substances enumerated by Herr Lommel, we find no less than fifteen different ones, which deviate from Stokes's rule, *i.e.*, depart from it altogether (the nine substances of class I.) or only in part (the first six substances of class III.). Of course the substances in class II. which follow this rule are more numerous. Investigating the peculiarities of these three classes more closely, and in various directions, we arrive at the following conclusions:—

1. The first class comprises substances with very strong bands of absorption only, of which one remains visible even when the solution is greatly diluted and after the absorption in other parts of the spectrum has become imperceptible. Accordingly these substances are strongly and intensely coloured (green, red, orange, yellow). The absolute maximum of fluorescence corresponds to this absolute maximum of absorption in the fluorescence-spectrum.

2. The second class embraces all fluorescent substances which show only a one-sided absorption of the more refrangible end of the spectrum. They therefore appear yellow, brown, or colourless, the latter principally if the absorption bands lie only in the extreme violet and ultraviolet.

To this class certain bodies belong which show absorption bands to which maxima of fluorescence correspond at the same time. But these absorption bands appear broad and indistinct (so-called shadows) and they are not really maxima. If the solution is diluted they disappear very soon, and long before the absorption in the violet ceases to be perceptible. Nitrate of uranium shows a number of strongly marked absorption bands, which, however, are in nowise related to fluorescence. Uranium glass as well, which belongs to the first class, shows absorption bands in the red and yellow which have nothing to do with its fluorescence. The green colour of the fluor spar from Alston Moor is caused by an absorption band in the red, and this also has no reference to fluorescence.

3. The third class, like the first, contains only bodies with strong absorption bands and of intense coloration (green, blue, violet, red, orange).

Fluorescence of the first order therefore seems to be in causal connection with the existence of a prominent maximum of absorption and fluorescence.

4. The fluorescent spectrum of the substances in class I. is of equal colour everywhere, if we neglect the slight changes in the shades of colour, which are caused by the absorption exercised by the substance upon its own fluorescent light. At the parts which are less fluorescent, a proportionate diminution of the fluorescent rays most subject to absorption takes place, and hence a deepening of the shade; these rays are at the same time the more refrangible ones in all bodies belonging to this class.

5. The fluorescent spectrum of the substances in class II. is of unequal colour, changing gradually its tone of colour, and it only becomes equal where the spectrum of the fluorescent light ends. But even here the fluorescent spectrum may seem of equal colour everywhere to the naked eye. This is the case where the spectra of the exciting and the excited rays are superposed on one another only a little (morine-alumina solution; nitrate of uranium), or if the fluorescence begins in the blue or in the violet.

6. The fluorescent spectrum of the bodies in class III. consists of two parts, viz., one equally coloured in its whole length (less refrangible), and one coloured differently, with gradual change of colour (more refrangible), becoming equally coloured only where the total spectrum of the fluorescent lights ends. At the boundary of the two parts an almost sudden change of colour takes place.

7. The substances of class III. behave like mixtures of a substance of class I. and one of class II.

The solutions of orchil and litmus appear as mixtures of two fluorescent substances, from the fact that, according to the dissolving medium, now one and now the other fluorescence is prominent, and the aspect of the total fluorescence changed. From two different kinds of litmus Herr Lommel obtained alcoholic extracts, of which the one showed orange and the other greenish-yellow fluorescence in daylight; their fluorescent spectra, however, showed no difference, except that the yellowish-green part was proportionately more developed in the second specimen. Fluoride of aniline may also be considered as a mixture of two fluorescent substances. That brasileïne is a mixture of this kind is rendered very probable by the circumstance that the fluorescence of the second order is destroyed by the addition of soda, but strengthened by the addition of ammonia, while that of the first order remains intact. Whether the chamaeleïne colouring matters are really chemical compounds, as they certainly appear to be, must first be decided by a closer investigation of these substances.

If it could be proved beyond doubt that all these substances are mixtures of two fluorescent substances, we might abolish class III. altogether, and enumerate the separated substances in classes I. and II. But, since this separation has not yet been actually effected, and since the possibility, that a unit (*einheitlich*) molecule may possess both kinds of fluorescence simultaneously, cannot be discarded *à priori*, Herr Lommel felt compelled still to retain class III., *i.e.*, bodies possessing compound fluorescence.

By artificially mixing substances of the first and second class, fluorescences of the third order may be obtained in great variety. In this way wonderful effects of colour are often obtained, and they may be rendered still more astonishing by the addition of strongly coloured non-fluorescent substances.

Thus we see that yet other compound fluorescences than those belonging to class III. are possible, and may, indeed, be produced artificially; viz., confining ourselves to only two fluorescent substances, by mixing two substances of the first or two substances of the second class. A mixture of the first kind (of naphthaline-red with fluoresceïne, or with eosine, for instance) may be easily recognised as such when examined by its spectrum; their fluorescent spectrum consists of two parts separated by a minimum, neither of which follows Stokes's rule, but of which the second refrangible part (belonging to the fluoresceïne or eosine) disappears, as soon as the incident homogeneous light has been diminished down to that limit, where it ceases to cause fluorescence in these substances. It is, however, more difficult to recognise a mixture of two substances of the second class as such, as it behaves like a simple substance of that class. It is possible that amongst the substances enumerated in class II. there are mixtures of this nature, consisting of two or more substances not separated hitherto. The varying behaviour of the extracts of soot could, for instance, be easily explained by the supposition that in soot there are contained two or more fluorescent substances of the second class, which are dissolved in varying proportions by the dissolving media.

Herr Lommel did not feel justified in establishing separate classes for the two kinds of compound fluorescence just described, since no natural instance of the former kind is known up to the present, and since the latter kind cannot be recognised as compound fluorescence by any optical means.

THE ARTIFICIAL TRANSFORMATION OF THE ALPINE SALAMANDER

THE success of Madame von Chauvin in producing the development of Amblystoma from the Mexican axolotl by gradually accustoming it to live in air, induced her to attempt a very interesting interference with the life-history of the black or Alpine salamander, *Salamandra atra*. This is an ovoviviparous species, and although its young possess large gills while within the body of the mother, they are born to commence a land life immediately; while other species of salamander, especially the spotted one, *S. maculata*, found in adjacent districts to the subject of inquiry, bring forth their young with gills, and they pass a considerable period in water before taking to land. The problem which it was desired to solve was, whether the young of the black salamander, taken from the mother before the normal time of birth, and placed in water under favourable conditions, could become adapted to an aquatic life. It is interesting to note that while only two eggs out of many come to full development in the black salamander, forty or fifty develop in the spotted one; yet individuals of the two species are about equally numerous in their respective localities. This shows the value of the avoidance of life in water with its attendant risks, though probably the diminution of terrestrial enemies in the more elevated localities frequented by the black salamander is a considerable influence in its favour.

Madame von Chauvin's researches are detailed in a recent number (vol. xxix. p. 324) of the *Zeitschrift für wissenschaftliche Zoologie*. They commenced on July 30, 1875, with twenty-three larvæ taken in various stages of development; eight were about $1\frac{1}{2}$ centimetres long, twelve were from $4\frac{1}{2}$ to 5 centimetres, and had almost completed their metamorphosis into land salamanders. One was a little less developed, 4·3 centimetres long, the gills and skin-glands were less perfect, and the skin was very transparent and unwrinkled. This larva, unlike the rest, appeared at ease when placed in water, and made no attempts to get out of it. The next problem was to feed the little creature, and the first attempt was made by supplying a number of various minute water insects; but although it evinced some desire to catch them, the insects were able to escape capture, while the larva seemed to become annoyed by their presence. Later on, a minute earthworm being offered, it was taken and swallowed, and the problem was solved. A daily supply of the same food was thenceforth taken by the young salamander.

The gills which the creature possessed in the oviduct appeared from the first little adapted for life in water; they were of so thin a texture that they could hardly be expected to endure exposure and motion, while their great extent evidently hampered the movement of the animal. Consequently the gills first became pale and bloodless, then shrank, and on the third day were entirely thrown off, down to the very base. But on the same day on the right side, a day later on the left, minute buds appeared, three on each side, which gradually enlarged into ball-like protuberances; from these, after three weeks, gill-fringes were put forth, which finally numbered nine on the first pair of gills. The fringes were mostly arranged along the external border of the gills, and they assumed a brown-spotted character, while the blood-circulation through them became plainly perceptible. They were very much less extensive than the previous set of gills, but appeared to perform the work of respiration perfectly; the creature remained completely beneath the surface of the water, without ever coming up to breathe air. While the new gills were being developed the larva remained at rest as if dead, only eating the earthworms when they were offered.

When the gills had attained a length of 2·2 mm. the larva became lively, and concurrent with this was the completion of another transformation. The delicate and transparent swimming membrane of the tail was lost, and replaced by a less transparent and stouter one, of greater dimensions. The creature now seemed to enjoy life much more than before, exhibiting greater interest in its living food, with which it would play before swallowing it. Finally, after six weeks' residence in the water, a skin-shedding commenced, the skin coming away piecemeal for a fortnight.

The larva continued to grow satisfactorily without undergoing further modification, until it had been fourteen weeks in the water, having attained a length of 6 centimetres. The gills then began to shrink, and the tail to assume a rounder form, and in three days the skin was shed, revealing the normal black and wrinkled skin of the land salamander. In nine days from their first shrinking the gills were nearly absorbed, only little stumps remaining. At last it crawled out of the water, and on the fourteenth day the gills were completely absorbed and the gill clefts closed. The remaining larger larvæ of this experiment lost their primary gills less satisfactorily and in a greater length of time. New gills commenced to bud, but the creatures were gradually destroyed by fungus-growths attacking various parts of their skin. The fact that they were altogether more advanced in their metamorphosis rendered them unable to adapt themselves quickly to their new conditions.

A second series of researches on the Alpine salamander was carried on in the summer of 1876, when a large number of individuals were collected at Thusis, at the confluence of the Rhine and the Nolla. The animals were collected thirteen days earlier than in the previous year, so that the development of the young was not so forward. Thirty-three larvæ were taken from the oviducts, eight of which were from 8 mm. to 10 mm. long, two 12 mm., and twenty-three from 35 mm. to 40 mm. All had their skin still transparent and their gills not yet of full size. After twelve of them had refused insects, minute earthworms were administered to them, but they did not eat them till after some hours. Two larvæ, immediately after being taken out of the mother and placed in the water, fastened respectively on the head and tail of a worm that was wriggling at the bottom of the water. Their difficulty was solved by cutting the worm in two, and each obtained half. This method of immediate feeding was thereafter successfully adopted, and it appeared to develop a good appetite in the larvæ.

One noteworthy circumstance in regard to these creatures was that, at a time when they would normally be still within the body of the parent, they were as active and as eager for food as new-born larvæ of the spotted salamander. They were often so greedy for their prey that they seized hold of the limb of a neighbour of their own kind instead of the desired worm. But nevertheless these creatures did not develop in the desired direction, the gills did not begin to shrink quickly, and when they did they were not got rid of as a whole, but the dead portions, remaining attached to the body, became the seat of fungus growth, which speedily increased and spread so as to kill the animal. Thus none of the subjects of investigation really became adapted to their life in water. In two cases it was attempted to succeed artificially by cutting off the gills nearly at the base; one died soon, owing to fungus growths, the other quickly became a land salamander.

Experiments like the foregoing have the highest interest, for they mark out for us the actual path of adaptation to changed physical conditions. It appears highly probable that the spotted and the Alpine salamanders were at no very distant period of time one species, and that as physical conditions became changed one variety became more and more adapted to more elevated and rocky habitats, where water for the early life of the larvæ was not commonly to be met with. Thus gradually the birth of the young was postponed, and they became non-aquatic; concurrently fewer and fewer of the many eggs were developed. The spotted salamander, meanwhile, became more and more specialised to inhabit the lowland districts. Such cases as Madame von Chauvin's, if they remained single instances, would suffice to establish natural selection as a *vera causa* of the mutation of species.

G. T. BETTANY

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

BRISTOL.—The Council of University College have resolved to found an Engineering School in connection with the scientific and technical courses of instruction already established. It is announced that the scheme will meet with the support of the local engineering firms. In accordance with this scheme the lectureships in Mathematics and Experimental Physics have been elevated into professorships, and the present holders of the lectureships, J. F. Main, M.A., D.Sc., and S. P. Thompson, B.Sc., B.A., have been elected to the new chairs.

It is stated that the new buildings of the College will be commenced at once, an excellent site having been secured several months ago. The number of students attending the present term exhibits a considerable increase upon the corresponding term of the preceding year.

SOCIETIES AND ACADEMIES

London

Royal Society, May 2.—"On the Reversal of the Lines of Metallic Vapours," by G. D. Liveing, M.A., Professor of Chemistry, and J. Dewar, M.A., Jacksonian Professor University of Cambridge. No. II.

Since their last communication to the Society the authors have succeeded in reversing characteristic lines of the vapours of rubidium and cæsium. They operated in glass tubes into which some dry rubidium or cæsium chloride was introduced, and a fragment of fresh cut sodium, and afterwards either dry hydrogen or dry nitrogen admitted, and the end of the tube sealed off at nearly the atmospheric pressure. Through these tubes placed lengthways in front of a spectroscope a lime-light was viewed. On warming the bulb of a tube in which rubidium chloride had been sealed up with sodium, very soon there appeared two dark lines near the extremity of the violet light identical in position with the well-known violet lines of rubidium. Next appeared faintly the channelled spectrum of sodium in the green, and then a dark line in the blue, very sharp and decided, in the place of the more refrangible of the characteristic lines of cæsium in the flame spectrum. As the temperature rose these dark lines, especially those in the violet, became sensibly broader; and then another fine dark line appeared in the blue in the place of the less refrangible of the cæsium blue lines. During this time no dark line could be observed in the red, but as the temperature rose a broad absorption band appeared in the red with its centre about midway between B and C, ill-defined at the edges, and though plainly visible not very dark. The lines in the violet had now become so broad as to touch each other and form one dark band. On cooling the absorption band in the red became gradually lighter without becoming defined, and was finally overpowered by the channelled spectrum of sodium in that region. The double dark line in the violet became sharply defined again as the temperature fell. There are two blue lines in the spectrum of rubidium taken with an induction-coil very near the two blue lines of cæsium, but they are comparatively feeble, and the two dark lines in the blue which the authors observed in the places of the characteristic blue lines of cæsium they believe must have been due to a small quantity of cæsium chloride in the sample of rubidium chloride.

When a tube containing cæsium chloride and sodium was observed, in the same way as the former, the two dark lines in the blue were seen very soon after the heating began, and the more refrangible of them broadened out very sensibly as the temperature increased. The usual channelled spectrum of sodium was seen in the green, and an additional channelling appeared in the yellow, which may be due to cæsium or to the mixture of the two metals. They have at present no metallic cæsium wherewith to decide this question. Indeed the cæsium chloride used was not free from rubidium, and the dark lines of rubidium were distinctly seen in the violet.

It is remarkable that these absorption lines of cæsium coincide with the blue lines of cæsium as seen in the flame, or in the spark of an induction-coil without a jar, not with the green line which that metal shows when heated in an electric spark of high density. In like manner both the violet lines of rubidium are reversed in the tubes, and both these violet lines are seen when the spark of an induction-coil, without jar, is passed between beads of rubidium chloride fused on platinum wire, though only one of them appears when a Leyden jar is used.

The authors have extended their observations on the absorption of magnesium and of mixtures of magnesium with potassium and sodium, using iron tubes placed vertically in a small furnace fed with Welsh coal, as described in their former communication.

The result of several observations, when commercial magnesium (*i.e.*, magnesium with only a small percentage of sodium in it) was used, is that the absorption produced by magnesium consists of—

1. Two sharp lines in the green, of which one, which is broader than the other, and appears to broaden as the temperature increases, coincides in position with the least refrangible of the *b* group, while the other is less refrangible and has a wave-length very nearly 5,213. These lines are the first and the last to be seen and very constant, and they at first took them for the extreme lines of the *b* group.

2. A dark line in the blue, always more or less broad, difficult to measure exactly, but very near the place of the brightest blue line of magnesium. This line was not always visible, indeed rarely when magnesium alone was placed in the tube. It was better seen when a small quantity of potassium was added. The measure of the less refrangible edge of this band then gave a wave length of very nearly 4,615.

3. A third line or band in the green, rather more refrangible than the *b* group. This is best seen when potassium as well as magnesium is introduced into the tube, but it may also be seen with sodium and magnesium. The less refrangible edge of this band is sharply defined, and has a wave-length about 5,140, and it fades away towards the blue.

These absorptions are all seen both when potassium and when sodium are used along with magnesium, and may be fairly ascribed to magnesium, or to magnesium together with hydrogen.

But besides these other absorptions are seen which appear to be due to mixed vapours.

4. When sodium and magnesium are used together, a dark line, with ill-defined edges, is seen in the green, with a wave-length about 5,300. This is the characteristic absorption of the mixed vapours of sodium and magnesium, it is not seen with either vapour separately, nor is it seen when potassium is used instead of sodium.

5. When potassium and magnesium are used together, a pair of dark lines are seen in the red. The less refrangible of these sometimes broadens into a band with ill-defined edges, and has a mean wave length of about 6,580. The other is always a fine sharp line, with a wave-length of about 6,475. These lines are as regularly seen with the mixture of potassium and magnesium as the above-mentioned line (5,300) is seen with the mixture of sodium and magnesium, but are not seen except with that mixture.

6. On one occasion, with a mixture of potassium and magnesium, another dark line was seen in the blue, with a wave-length nearly 4,820. This line is very near one of the bright lines, seen when sparks from an induction-coil, without a Leyden jar, are taken between electrodes of magnesium, and may very likely be due to magnesium alone, and not to the mixture of vapours, as we only observed it on one occasion.

There is a certain resemblance between the absorptions above ascribed to magnesium and the emission spectrum seen when the sparks of a small induction-coil, without Leyden jar, are taken between electrodes of magnesium. This emission spectrum is the same, with the addition of some blue lines, as that seen when the sparks are taken from a solution of magnesium chloride, as accurately described by Lecocq de Boisbaudran, and as that seen in burning magnesium (Dr. Watts, *Phil. Mag.*, 1875).

The pair of lines (1) correspond nearly with the *b* group, but slightly displaced towards the red; the shaded band (3) corresponds less closely to the series of seven lines 5,000 to 4,930, which progressively decrease in brightness towards the blue, and is also a little less refrangible than that series; the broad line in the blue (2) corresponds to the pair of lines 4,570 and 4,590, and the remaining line (6) to the line 4,797; also both displaced a little towards the red. No absorption corresponding to the extreme lines 4,481 and 5,528 was observed. There is plainly no exact reversal except of the line b_1, and even in that case it may be an accident if we suppose the two dark lines (1) to represent the extreme lines of the group *b*. It may be noted in connection with this that the absorption lines described by the authors in their former communication as seen with sodium and potassium (wave-lengths 5,510 and 5,730) are near to, but *more* refrangible than, well-known emission lines of those elements.

They observe that there is in the solar spectrum an absorption line, hitherto unaccounted for, closely corresponding to each of the above-described absorption lines. Thus, on Angström and Thalèn's map there are dark lines at 6,580 and 6,585, with more or less continuous absorption between them, a broad dark line between 6,474 and 6,475, and a dark line at 5,300. There are also dark lines nearly, if not exactly, coincident with the series of seven bright lines of magnesium above described, which they have not seen strictly reversed. The coincidences of the series of the solar spectrum hitherto observed have, for the most part, been with lines given by dense electric sparks; while it is not improbable that the conditions of temperature, and the admixtures of vapours in the upper part of the solar atmosphere, may resemble much more nearly those in their tubes.

They intend to pursue their observations, using higher temperatures, if they can obtain tubes which will stand under those circumstances.

May 2.—"On the Determination of the Scale Value of a Thomson's Quadrant Electrometer used for Registering the Variations in Atmospheric Electricity at the Kew Observatory," by G. M. Whipple, B.Sc., Superintendent of the Kew Observatory.

The Meteorological Council, being desirous of discussing the photographic traces produced by their electrograph at the Kew Observatory some time since, requested the Kew Committee to institute a series of experiments, with the view of determining the scale value of the instrument, in order to prepare a suitable scale for measuring the curves.

The author having found, in some preliminary experiments with 300 Bunsen's elements, that the greatest potential to be obtained with these was inadequate for his purpose, he was enabled through the kindness of Dr. De la Rue, to make use of that gentleman's large chloride of silver battery for determining the scale value of the electrometer. There were in all nine experiments made, in five of which the deflections were read off with the eye, whilst in the remaining four they were registered by photography. Deflections were measured for potentials varying from 0 to 900 cells positive, and from 0 to 300 negative.

By combining the results of these experiments and taking the means for every hundred cells, the following table is obtained :—

POSITIVE.				NEGATIVE.	
No. of Cells.	Deflection in Inches.	No. of Cells.	Deflection in Inches.	No. of Cells.	Deflection in Inches.
100	0·93	600	3·95	100	1·04
200	1·77	700	4·20	200	2·34
300	2·48	800	4·42	300	3·75
400	3·09	900	4·69		
500	3·57				

On laying down these values in a curve, making use only of those between the limits of − 200 and + 700, as the others are beyond the capability of correct registration by the electrograph, a regular smooth curve is produced, which, being projected upon one of the ordinates, gives a scale by means of which the electrograms are now easily tabulated.

The value of the electromotive force of one De la Rue chloride of silver cell being 1·03 volt, as determined by Messrs. De la Rue and Müller (*Proc.* Roy. Soc., vol. xxvi. p. 324), the scale thus formed has been assumed to represent volts with sufficient accuracy for the required purpose.

Chemical Society, May 2.—Dr. Gladstone, F.R.S., president, in the chair.—A lecture on the chemical aspects of vegetable physiology was delivered by Sidney H. Vines. The lecturer commenced by giving a historical sketch of our knowledge of the absorption of carbonic acid and the evolution of oxygen by plants, the circulation of starch grains, and the functions and nature of chlorophyll. Sachs first proved that starch grains were not formed in plants which are bleached, from the absence of light, and that their formation in the chlorophyll corpuscles depended on the exposure of the plant to bright sunlight. Godlewski showed that if no carbonic acid was present no starch grains were formed. So there are two sets of phenomena, viz., the evolution of oxygen (with absorption of carbonic acid) and the formation of starch grains, for both of which three conditions are essential, viz., sunlight, chlorophyll, and carbonic acid. These two sets of phenomena are therefore probably connected and belong to the same function. Great diversity of opinion exists both as to the composition and functions of chlorophyll. The lecturer gave a short account of the views brought forward by Pringsheim, Karl Kraus, Pfaundler, Wiesner, &c., and entered more in detail into the statements and theories advanced by Sachse. In the second part the lecturer considered the formation of vegetable acids, and pointed out that the views of Liebig and Mulder had not been confirmed by subsequent experiments. The part played by pyrocatechin, asparagin, &c., in the formation of carbohydrates was next considered, and the lecturer concluded by pointing out the necessity for quantitative work before we could hope to attain clearer and more certain views on the important functions of assimilation, excretion, &c., in the vegetable kingdom.

Anthropological Institute, April 9.—John Evans, F.R.S., president, in the chair.—The following new Members were announced :—Messrs. G. J. Romanes and R. J. Hutton.—Mr. W. M. Flinders Petrie read a paper on inductive metrology, the purpose of which, as explained by him, is to deduce the units of measure employed by ancient peoples from the dimensions of existing remains. Where units derived from several different buildings coincide, a high probability of the accuracy of the result in units is obtained. This principle has been tested by application to the monuments existing among the peoples of the Mediterranean. Mr. Petrie had also applied it to the earthworks of this country. At Hill Devereux he had obtained an unit of 691 inches. At Steeple Langford, an unit had been derived which varied only by 5 inches. Near Orcheston is an earthwork forming a perfect ellipse. From this Mr. Petrie argued a considerable knowledge of mensuration on the part of the flint-workers, by whom it had been constructed. He urged the necessity of accurate measurement on the part of observers.—Dr. E. B. Tylor read a paper on the game of Patolli, in ancient Mexico, and its probable Asiatic origin. The game is a combination of dice and draughts. It was similar to a game called Patcheesi, in use in India, played by throwing cowries on to a board divided into squares of a certain pattern. So devoted are the natives to this game, that a story is told of a Provincial Governor who habitually won back his servants' wages from them at it, and thus got served for nothing.

Linnæan Society, May 2.—Dr. W. B. Carpenter, F.R.S., vice-president, in the chair.—M. C. Chambre and Mr. T. Comber were elected Fellows of the Society, and five Foreign Members, to fill the annual vacancies, were likewise unanimously elected.—Mr. J. R. Jackson exhibited specimens of fruits, leaves, and portions of the stem (used as a substitute for soap) illustrating peculiarities of *Yucca baccata*, Torrey. This plant extends from South Colorado far into Mexico. Northwards it is acaulescent, southwards it develops a trunk ten feet high. The fruit, a dark purple berry, is preserved and eaten as winter provision, and the plant is commonly known as the Rocky Mountain Banana.—A note was read from the Rev. H. H. Higgins concerning a large new Tubularian Hydrozoon (probably allied to Clava?) from New Zealand.—On behalf of Mr. Thomas Higgin there was exhibited a photograph of *Chitina ericopsis*, Carter, and also microscopic specimens of this rare species of the Hydractiniidæ from New Zealand.—Mr. J. C. Galton called attention to a spined dermal plate of the Ray tribe of fishes, mistaken for a fossil, and obtained near the Barking Priory.—The Secretary read in abstract a paper on Marupa, a genus of the Simarubaceæ, by Mr. J. Miers. This is founded on a curious fruit and specimens of wood exhibited in the Brazilian department of the Paris Exhibition, 1857. Signor Netto, in 1856, described a Brazilian plant under the designation *Odina francoana*, and bearing the vernacular name "Pão Pombo," as did the above-mentioned woods. Mr. Miers, however, is of opinion that Netto's species cannot belong to Odina as that genus is Anacardiaceous, and quite foreign to the American Continent. Then follows the technical characters of the new species *Marupa francoana* and *M. paraensis*.—A short paper was read by Mr. R. Irwin Lynch on the seed-structure and germination of a species of Pachira. The seeds were received at Kew, July, 1877, and labelled the "Provision Tree." Varying in size, they consist chiefly of one fleshy-lobed cotyledon, the second being exceedingly diminutive and functionless. Germination occurs in a fortnight after sowing, and in one instance the larger persistent cotyledon did not appear to be exhausted for nearly six months.—The main facts of a detailed communication on the occurrence of conidial fructification in the Mucorini, illustrated by Choanephora," by Dr. D. D. Cunningham, was, in his absence, read by the Secretary. According to observations and experimental investigations conducted for a series of years in India, Dr. Cunningham proved that Choanephora is a genus of Mucorine, and not Mucedine fungi, as Currey had regarded it in 1872. It is, moreover, capable of producing four kinds of fructification, as follows :—By (1.) Zygospores = sexual fructification; by (2.) Conidia; (3.) Sporangial spores; and (4.) Chlamydophorous = asexual fructification. These phenomena afford a possible explanation of certain otherwise conflicting conclusions which have been arrived at by such competent observers and authorities as Brefeld, Van Tieghem, and Le Monnier. At all events, it yields a note of warning that classification of fungal organisms based alone on one form of fructification may lead to false conclusions. The present researches likewise show that M. de Bary's suggested analogy between the Mucorini and Ascomycetes, in respect of their fructification, is well founded, although the observations which originally suggested it have since been shown to be fallacious. Dr. Cunningham states that the presence of Choanephora on plants certainly greatly accelerates decay, but it is a cause, not a consequence, of advanced putrefaction.

Physical Society, March 30.—Prof. W. G. Adams, president, in the chair.—The following candidates were elected Members of the Society:—S. Bidwell, M.A., LL.B., W. Grant, E. Gurney, and J. H. Smith.—Mr. W. H. Preece described Byrne's pneumatic battery and exhibited some of the results that may be obtained by its means. It is especially devised with a view to provide the medical profession with a portable battery capable of producing a considerable amount of heat, as is required for cauterising operations. The negative plate consists of a very thin plate of platinum to which a lead backing is soldered, and this is covered with a sheet of thick copper also coated with lead, the whole being then covered with a non-conducting varnish with the exception of the exposed platinum face; such an arrangement is found to be advantageous in that it increases the conductivity of the negative plate. Two of these plates are arranged to face the zinc plate as in Wollaston's form of cell, and the exciting liquid consists of twelve ounces of bichromate of potash, one pint of sulphuric acid, and five pints of water. By using such a mixture the sulphuric acid attacks the zinc and the three atoms of very loosely combined oxygen exercise a depolarising effect by absorbing the evolved hydrogen. A fine tube dips into the exciting liquid and is so arranged that it conducts a current of air, from a small pair of bellows, against the face of the negative plate; by this means any bubbles of hydrogen are, as it were, brushed off, and the current obtained from a given electromotive force is materially augmented, since the resistance is diminished. Mr. Preece then referred to several old forms of battery in which such an agitating principle is introduced, notably those of Grenet, Chutaux, and Comacho, and he went on to describe a series of experiments he has made with a view to ascertain the cause of the great heating and illuminating effects that could be obtained with the apparatus exhibited. He showed that the effects were due to the mechanical agitation of the liquid on the face of the negative plate; but whether the great production of heat in the battery, and the great lowering of its internal resistance were chemical, thermal, or electrical effects, remains for further investigation. By means of a small battery of four cells, in which the plates were 4 inches by 2 inches, a length of 6 inches of platinum wire, No. 18 (0·05 inches), could be heated to bright redness, and much more powerful effects were obtained by a large battery of ten cells made by Ladd; in this case, about 2 feet of a No. 14 (0·089 inches) wire were heated, and it was shown that, when connected with an 18-inch inductorium, kindly lent by Mr. Spottiswoode, sparks of over 17 inches could be obtained, but this length was reduced to about 8 inches on stopping the current of air. A similar effect was also very marked when the poles were connected with two carbon points, the light given out when the air-current was introduced being remarkably bright and steady.—Mr. Preece then exhibited an ingenious method of showing the vibrations of a telephone plate to an audience, which has been devised by Mr. H. Edmunds. A vibrating plate is employed to break contact as in Reiss's original telephone, and is introduced into the primary circuit of a small induction coil. The induced current is employed to illuminate a rapidly-rotating Gassiot's tube, and, on making and breaking contact by speaking into the resonator, an illuminated star is observed, the number of whose arms varies with the pitch of the note; with a very low note it may resolve itself into a single straight line.—Lord Rayleigh exhibited and explained an arrangement which he has employed with advantage in certain acoustical experiments, in order to secure absolute uniformity in the rate of rotation of an axle. After referring to the mathematical principles involved in such a problem, he explained that the only hope of its solution lay in the employment of a vibratory movement, which by some suitable device must be converted into a motion of rotation. The axle whose motion it is required to maintain uniform is usually driven, at an approximately uniform rate, by means of a small horizontal water-wheel, or, in some cases, the electro-magnetic regulating apparatus presently described is sufficient by itself to supply the necessary power. At equal distances round the axle are arranged four soft iron armatures which successively come in front of the poles of a horse-shoe electro-magnet placed in the circuit of a four-cell Grove's battery. The current is rendered intermittent by the following arrangement. Passing into the body of a tuning-fork vibrating about forty times per second, it leaves by a small platinum stud which is touched at each vibration of the fork; the current then traverses a second small electro-magnet between the prongs, and by this means the vibrations are maintained; passing to the magnet above referred to the current then returns to the battery. The velocity of the axle is such that it performs about one complete revolution for every four vibrations of the fork, and the exact adjustment is effected as follows. If the driving power be just sufficient to produce the desired speed, the armatures will be so attracted by the magnet as to be exactly opposite to it at the middle of its period of magnetisation, and so long as this position is maintained the magnet will not (on the whole) affect it. But if a disturbance occur in the driving power the armature will be displaced from its former position and will be attracted by the magnet until the error is compensated. Besides the armatures this axle also carries, concentric with it, a hollow metallic ring filled with water, and as this possesses a certain momentum in virtue of its rotation, it will act as a drag tending to check the velocity in case it increases, and in the converse manner when a diminution occurs. A blackened disc perforated with rings of holes of various numbers also rotates with the axle and by placing the eye behind the ring of *four* holes and observing a prong of the fork it is easy to ascertain whether the uniformity is maintained, since in that case the prong will appear to remain stationary.

Entomological Society, May 1.—H. W. Bates, F.L.S., F.Z.S., president, in the chair.—Henry John Elwes, F.L.S., F.Z.S., of Cirencester, was elected an ordinary member, and Mr. Peter Cameron, jun., was elected a subscriber. Mr. Dunning drew attention to the fact that the present meeting marked the forty-fifth anniversary of the foundation of the Society.—Mr. Distant exhibited a specimen of the Hemipteron, *Tetroda bilineata*, Walk., as a remarkable instance of immunity from the effects of damp, the same having been kept in a relaxing-pan for more than four months.—Mr. Distant also communicated a paper "Notes on some Hemiptera-Homoptera, with Descriptions of New Species," in which he drew attention to the uncertainty of generic calculations as to geographical distribution, the Homoptera affording a good illustration in the family Cercopida, especially the genus Cercopis. Part 1 of the *Transactions* for 1878 was on the table.

Royal Microscopical Society, May 1.—H. J. Slack, president, in the chair.—Four new Fellows were elected, and Professor Abbe, of Jena, was elected an Honorary Fellow of the Society.—A paper by Mr. Michael, on new British Cheyleti was read by the Secretary. It minutely described the structure and habits of the insect, and was illustrated by drawings. The name proposed by its discoverer was *Cheyletus flabellifer*.—Mr. Chas. Stewart gave a *résumé* of a paper which had been received from Dr. Oscar Schmidt, of New Orleans, in continuation of a former communication on the blood-corpuscles of Amphiuma, frog, and man. The president suggested to the meeting a series of experiments, which he thought might be of value in the interpretation of optical images, by the examination of microscopic drawings of Lissajous curves under various powers. He also brought before the notice of the Fellows a species of fungus which he had found infesting the leaves of the bay, but which did not appear to derive its nutriment from the leaf itself. After some discussion, the fungus was identified by Dr. M. C. Cooke as *Capnodium*, Footii, which was stated to live upon the honey-dew found upon the surface of the leaves of a large number of trees, particularly in the autumn months.

Institution of Civil Engineers, May 7.—Mr. Bateman, president, in the chair.—The paper read was on the construction of steam boilers adapted for very high pressures, by Mr. James Fortescue Flannery.

WELLINGTON, N. Z.

Philosophical Society, December 11, 1877.—Mr. Carruthers, C.E., the vice-president, occupied the chair.—Dr. Buller read a further paper on the ornithology of New Zealand. Among the species treated of were the Kaka parrot, with an interesting account of the Maori mode of trapping it by means of decoy birds; the two species of migratory cuckoo, with observations on their parasitic habits; the black fantail, the occurrence of which as far north as Auckland has been communicated by Mr. Cheesman; the knot (*Tringa canutus*) which has lately been met with in this island; the sandpiper (*Limnocinchis acuminatus*), and many others. Among the latter was the New Zealand godwit, of which the author gave an interesting sketch. This bird spends a portion of the year in Siberia, and visits in the course of its annual migration the islands of the Indian Archipelago, Polynesia, Australia, and New Zealand. In summer it frequents the south coast of the Sea of Ochotsk, and it has likewise been observed in China, Japan, Java, Celebes, Timor, Norfolk Island, and the New Hebrides. They leave New Zealand towards the end of March or beginning of April, and return to us towards the end of November.—On *Nephrodium decompositum* and *N. glabellum* by T. Kirk, F.L.S.—On *Hymenophyllum montanum*, a new species discovered by Mrs. Mason in the mountains between Lake Wakatipu and the West Coast, by T. K. Kirk, F.L.S.—On the relative ages of the Australian, Tasmanian, and New Zealand coalfields, by Dr. Hector, F.R.S. The speaker's remarks were illustrated by diagrams and maps, and by a large collection of fossils which he had obtained during a recent tour in the Australian colonies. After describing the extent and position of the various coalfields at present worked, he stated that from a comparison of the fossils he had arrived at the following results:—*Cretaceous epoch:* Chief New Zealand coal; wanting in Tasmania and Australia, except perhaps in Queensland. *Jurassic epoch:* Mataura series of New Zealand; Cape Paterson coalfields of Victoria; Clarence River coal of New South Wales; and the coalbeds at Hobarton. *Liassic epoch:* Clent Hill beds of New Zealand; wanting in Tasmania and Australia, except Queensland. *Triassic epoch:* Wairoa beds of New Zealand; upper coal formation of New South Wales; and wanting in Tasmania. *Permio-carboniferous:* Maitai series of New Zealand; lower coal formation of New South Wales; Mersey coalfields of Tasmania. This view of the relative ages of those formations had just received remarkable confirmation by a late discovery. Mr. McKay, of the Geological Survey, who has recently been at work in the Canterbury Alps, having found plant beds beneath the spirife beds of Mount Potts that are full of the leaves of glossopteris, a fern very characteristic of the upper and middle coal formation of New South Wales, and with them beds of graphite of considerable commercial value, which represents in an altered form the Newcastle coal seams. Along with these occur remains of saurian reptiles of immense size, of which large collections have been made. In conclusion, it was stated that only a very small portion of the area coloured on the map of New South Wales as coal formation contained valuable coal seams, and that they were not without drawbacks. At Newcastle, where the principal collieries are situated, the seams have to be worked to an increasing depth by shafts, and require pumping. In the southern coalfield the coal is worked by adits into the face of the mountain, and lowered by steep inclines in the same manner as our own Buller coal will be worked; but it has to be shipped from an exposed coast. The western district coal has all to be carried over the Blue Mountains by a railway that ascends and descends by zigzags, that answer well enough for passengers and light traffic, but must be rather costly for transporting coal. Dr. Hector stated that all he had seen increased his confidence in the value of our West Coast coalfields, both as regards the quality and extent of the coal and the facilities for working it.

PARIS

Academy of Sciences, May 13.—M. Fizeau in the chair.—The following among other papers were read:—Observation of the transit of Mercury, on May 6, at Montsouris Observatory, by M. Mouchez. The observations were vague, owing to the bad weather, but so far confirmed the theory of Mercury. M. Picard got three photographic images, two of which seemed very good, but there was no trace of the planet. M. Mouchez was struck with the much more rapid succession of the phases in the transit of Mercury than in that of Venus; the times of contact should thus be obtainable with greater accuracy.—Researches on the law of Avogadro and Ampère, by M. Wurtz. Bioxalate of potassium becomes hydrated much in the same way in an atmosphere of hydrated chloral, and in one of moist air or chloroform, containing aqueous vapour with the same tension as the atmosphere of hydrated chloral. M. Wurtz infers that the latter is entirely dissociated.—M. Du Moncel read a paper on the Hughes microphone, from information communicated by Mr. Crookes.—Report on two memoirs of M. Dien, concerning (1) defective notes of instruments played with a bow, (2) resonance of the minor seventh in the grave chords of the piano. By placing small movable nuts on the short prolongations of the strings above the bridge, so as to tune those parts to the unison or octave of certain defective notes known in the violin, M. Dien gets rid of the disagreeable effect of the latter. In the second memoir he shows the resonance in question to be due to pressure of the damper on touching one of the nodes which produces the triple harmonic minor seventh. He employs a second damper acting simultaneously with the other.—On the refraction of organic substances in the gaseous state, by M. Mascart. It appears, generally, that no method based on the sole consideration of elementary composition enables one to calculate the refraction of a compound from those of its constituents. The notion of equivalents of refraction does not apply to gases any more than to solids or liquids. Each case has its special considerations, not easily determined.—On the production of sulphurised oils having insecticide properties, by MM. De La Loyère and Muntz. The considerable amount of combined sulphur found in fetid oils got by distillation of the bituminous limestone of Orbagnoux, the authors augment by introducing sulphate of lime or pyrites into the mineral before distillation.—On the telephone, by M. Izarn. A curious case of intelligible sounds being produced in one single-wire telephone system, by a derivation of current from other systems through wet ground and a system of pipes.—On a new electric lamp with incandescence, acting in free air, by M. Reznier. If a thin rod of carbon, pressed laterally by an elastic contact, and pushed in the direction of its axis, against a fixed contact, be traversed by a pretty strong current, it becomes incandescent at this part and burns, growing thinner towards the end. As the end gets used up, the rod, still pushed, slides in the elastic contact, always pressing against the other. The heat developed by passage of the current is greatly increased by the combustion of the carbon.—On a production of heat by chemical action, by M. Phipson. If a piece of chloride of lime be held in a rapid current of sulphuretted hydrogen from a narrow glass tube, the smell of sulphuretted hydrogen at once disappears, and is replaced by that of chlorine; a very light deposit of sulphur is formed on the piece, which becomes too hot to hold in the fingers. The reactions here are notable.—Action of aqueous vapour on hydrocarbons raised to red temperature, by M. Coquillion. It facilitates their dissociation while producing a fall of temperature, which in blast furnaces is added to that caused by transformation of carbonic acid into carbonic oxide.—On investigation of ozone in atmospheric air, by M. Daremberg. He finds ozonoscopic researches useless. An ozonograph should be used which should expose the paper only during a few minutes.—Observations of the moon, made with meridian instruments of Paris Observatory during 1876, by M. Villarceau.

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