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THURSDAY, APRIL 28, 1870.

WHAT IS ENERGY?

IT is only of late years that the laws of motion have been fully comprehended. No doubt it has been known since the time of Newton that there can be no action without reaction; or, in other words, if we define momentum to be the product of the mass of a moving body into its velocity of motion, then whenever this is generated in one direction an equal amount is simultaneously generated in the opposite direction, and whenever it is destroyed in one direction an equal amount is simultaneously destroyed in the opposite direction. Thus the recoil of a gun is the appropriate reaction to the forward motion of the bullet, and the ascent of a rocket to the downrush of heated gas from its orifice; and in other cases where the action of the principle is not so apparent, its truth has notwithstanding been universally admitted.

It has, for instance, been perfectly well understood for the last 200 years that if a rock be detached from the top of a precipice 144 feet high it will reach the earth with the velocity of 96 feet in a second, while the earth will in return move up to meet it, if not with the same velocity yet with the same momentum. But inasmuch as the mass of the earth is very great compared with that of the rock, so the velocity of the former must be very small compared with that of the latter, in order that the momentum or product of mass into velocity may be the same for both. In fact, in this case, the velocity of the earth is quite insensible and may be disregarded.

The old conception of the laws of motion was thus sufficient to represent what takes place when the rock is in the act of traversing the air to meet the earth; but, on the othei hand, the true physical concomitants of the crash which takes place when the two bodies have come together were entirely ignored. They met, their momentum was cancelled—that was enough for the old hypothesis.

So, when a hammer descends upon an anvil, it was considered enough to believe that the blow was stopped by the anvil; or when a break was applied to a carriage-wheel it was enough to imagine that the momentum of the carriage was stopped by friction. We shall presently allude to the names of those distinguished men who have come prominently forward as the champions of a juster conception of things, but in the meantime let us consider some of those influences which served to prepare men's minds for the reception of a truer hypothesis.

We live in a world of work, of work from which we cannot possibly escape; and those of us who do not require to work in order to eat, must yet in some sense perform work in order to live. Gradually, and by very slow steps, the true nature of work came to be understood. It was seen, for instance, that it involved a much less expenditure of energy for a man to carry a pound weight along a level road than to carry it an equal distance up to the top of a mountain.

It is not improbable that considerations of this kind may have led the way to a numerical estimate of work.

Thus, if we raise a pound weight one foot high against the force of gravity we may call it one unit of work, in which case two pounds raised one foot high or one pound raised two feet high would represent two units, and so on. We have therefore only to multiply the number of pounds by the vertical height in feet to which they are raised, and the product will represent the work done against gravity. The force of gravity being very nearly constant at the earth's surface, and always in action, is a very convenient force for this purpose; but any other force, such as that of a spring, would do equally well to measure work by. Generalising, we may say, *the space moved over against a force multiplied into the intensity of that force will represent the quantity of work done.* So much for the definition of work, and it is necessary to know what *work* is before proceeding to define *Energy.*

Now what does the word Energy really mean? In the first place it does not mean force.

Two substances may have an intense mutual attraction, in virtue of which they form a very intimate union with one another; but when once this union has been consummated, although the force still continues to exist, the combination is singularly deficient in Energy. Nor does Energy mean motion, for although we cannot have motion without Energy, yet we may have Energy without motion.

By the word Energy is meant the power of doing work; and the energy which a labouring man possesses means, in the strictly physical sense, the number of units of work which he is capable of accomplishing.

This is a subject which at this stage we may attempt to illustrate by reference to a very different department of knowledge.*

The analogy which we shall venture to institute is between the social and the physical world, in the hope that those who are more familiar with the former than with the latter may be led to perceive clearly what is meant by the word Energy in a strictly physical sense. Energy in the social world is well understood. When a man pur sues his course, undaunted by opposition and unappalled by obstacles, he is said to be a very energetic man.

By his energy is meant the power which he possesses of overcoming obstacles; and the amount of this energy is measured (in the loose way in which we measure such things) by the amount of obstacles which he can overcome—the amount of work which he can do. Such a man may in truth be regarded as a social cannon-ball. By means of his energy of character he will scatter the ranks of his opponents and demolish their ramparts. Nevertheless, a man of this kind will sometimes be defeated by an opponent who does not possess a tithe of his personal energy. Now, why is this? A reply to this question will, if we do not mistake, exhibit in a striking manner the likeness that exists between the social and the physical world. The reason is that, although his opponent may be deficient in personal energy, yet he may possess more than an equivalent in the high position which he occupies, and it is simply this position that enables him to combat successfully with a man of much greater personal energy than himself. If two men throw stones at one another, one of whom stands at the top of a house and the other at the bottom, the man at the top of the house has evidently the advantage.

So, in like manner, if twc men of equal personal energy contend together, the one who has the highest social

* The subject has previously been discussed from this point of view by Messrs. Stewart and Lockyer in an article in *Macmillan's Magazine,* August 1868.

position has the best chance of succeeding. For this high position means energy under another form. It means that at some remote period a vast amount of personal energy was expended in raising the family into this high position. The founder of the family had, doubtless, greater energy than most of his fellows, and spent it in raising himself and his family into a position of advantage. The personal element may have long since disappeared from the family, but not before it had been transmuted into something else, in virtue of which the present representative is able to accomplish a great deal, owing solely to the high position which he has acquired through the efforts of another. We thus see that in the social world we have what may justly be termed two kinds of energy, namely :—

1. Actual or personal energy.
2. Energy derived from position.

Let us now again turn to the physical world. In this, as in the social world, it is difficult to ascend. The force of gravity may be compared to that force which keeps a man down in the world. If a stone be shot upwards with great velocity, it may be said to have in it a great deal of actual energy, because it has the power of doing useful work or of overcoming up to a great height the obstacle interposed by gravity to its ascent, just as a man of great energy has the power of overcoming obstacles. But this stone as it continues to mount upwards will do so with a gradually decreasing velocity, until at the summit of its flight all the actual energy with which it started will have been spent in raising it against the force of gravity to this elevated position. It is now moving with no velocity—just, in fact, beginning to turn—and we may suppose it to be caught and lodged upon the top of a house. Here, then, it remains at rest, without the slightest tendency to motion of any kind, and we are led to ask what has become of the energy with which it began its flight? Has this energy disappeared from the universe without leaving behind it any equivalent? Is it lost for ever, and utterly wasted? But the answer to this question must be reserved for another article.

BALFOUR STEWART

LEGISLATION AND NATURE

THE effect of Legislation upon Nature is one of those far-reaching subjects which men are only just beginning to investigate in a practical spirit. It is, of course, only a minor branch of the larger question of man's influence upon all external life and forms, but it has its special attractions, nevertheless, and may be pursued to advantage as an independent study. Incidentally, it illustrates many other problems. The diminutiveness of the Hindu cow, for example, may be due as much to the legislation which has made the domesticated animal sacred as to the nature of the climate of Hindustan. It is quite possible the oxen of this country would not have exhibited such a variety of forms and sizes had we selected one species and made it sacred some two or three thousand years ago. Take, again, the subject of maritime canals, which is now in its infancy. The Suez Canal has not existed long enough to have had any appreciable effect, either in modifying the coast-lines of the Mediterranean, or in creating any interchange of marine species; but it is likely enough to be one of a series, and we cannot predict what may be their effects. The diversion of the Nile may prove a serious matter, and now the Darien scheme has revived, a great impetus has been given to speculation, so that an ingenious projector has actually sketched a canal which should unite the Bristol Channel with the English Channel. Two more illustrations may suffice to make my meaning clear. There seems little apparent connection between woods and national greatness, but, nevertheless, the relation is a real one. When Spain lost the empire of the seas, she lost it from two causes—impoverished finances, due to a speculative trade in precious metals, and want of woods to build her ships. Her people had a foolish prejudice against trees, and an arid climate and reduced shipbuilding were the results. From Danzig to Pillau once stretched a thick pine forest. When King Frederic William I. was in want of money, one Herr Von Korff recommended its destruction. The experiment was a financial success, but the State was injured by it. As Willibald Alexis states, "the sea-winds rushed over the bared hills; the Frische Haff is half choked with sand; the channel between Elbing, the sea, and Königsberg is endangered; and the fisheries in the Haff injured. The operation of Herr Von Korff brought the King 200,000 thalers. The State would now willingly expend millions to restore the forests again."

Neither directly nor indirectly, in fact, can we touch nature by our laws, without beginning a new chain of causes, the end of which we cannot foresee. The consequences of human volition are always a little wonderful. When the treasures of Thorwaldsen were packed up in Rome, it was not dreamed that new plants would be conveyed to Copenhagen in the grasses of the Campagna, any more than Clusius, the first European writer who mentions the potato, could possibly foresee that half the miseries of Ireland would spring from its exclusive cultivation. What we owe to our game-laws, again, is a boundless subject which might be investigated by a naturalist with profit.

My immediate purpose, however, is—strange as it may seem—with Mr. Lowe and his Budget. He deserves to be styled a real friend to the farmer, though apparently he has only given him a restricted use of germinating barley. Readers of Darwin will remember how he traces the connection between the number of cats in a given locality, and the number of humble bees, and the abundance of red clover and heartsease. Well, Mr. Lowe's Budget starts a similar House-that-Jack-built. The freedom of firearms from taxation affects their number in any district, the number of guns determines the number of our small birds, and the number of our small birds affects the immunity of our fields from grasshoppers, cricket-moles, beetles, locusts, slugs, &c. Mr. Lowe was concerned for the security of life, for the prevention of early quasi-poaching habits, but his *1l.* tax may effect a revolution all the same. It is no longer a secret, that wherever a persistent warfare is carried on against small birds—against martins, blackbirds, sparrows, larks, &c.—vegetable life is sure to suffer. In the Isle of Bourbon, as M. Michelet tells us, the martin was exterminated, and a plague of grasshoppers followed; in Hungary, the sparrow was proscribed, until this valiant militia of the fields had to be recalled; in the neighbourhood of Rouen, the blackbird was shot down without mercy, and many a meadow's turf could be rolled up like a carpet; and in this country we had, until lately, our sparrow clubs, which paid for little victims at so many a dozen, just as two or three hundred years ago some of our pious churchwardens used to purchase hedgehogs of truant schoolboys in the rural districts, a lamentable increase of pestiferous insects being the consequence. The Rev. Charles Kingsley gives us a more recent example. In Trinidad, the free negro has been banging away at the small birds, partly for his own pleasure, and partly to supply the London markets and our ladies' hats. What has been the consequence? "Already the turf of the savannah, or public park, close by, is being destroyed by hordes of mole-crickets, almost exactly like (strange to say) those of our old English meadows; and unless something is done to save the birds, the canes and other crops will surely suffer in their turn. A gun-licence would be, it seems, both unpopular and easily evaded in a wild forest country. A heavy export tax on bird-skins has been preferred" (*Good Words*, April). A single pair of swallows, says M. Michelet, carry every week to the nest 4,300 caterpillars or *coleoptera*. The blackbird is a notorious insect-eater, and consumes hundreds of imperfect insects every day, to say nothing of worms and slugs. The common sparrow is a vivacious feeder, and somewhat dainty withal, but it makes great havoc with young worms and soft insects. All our field birds, in short, troublesome and non-melodious as many of them are, rid us of millions of fast breeding insects which would otherwise do incalculable injury to our vegetation, and could not well be destroyed by artificial means. Indeed, we disturb a natural arrangement when we step in and decimate a predatory class without also destroying their victims, and therefore it is gratifying to find Mr. Lowe putting a check upon amateur sportsmen, who bang away, reckless of consequences either to themselves or others. A little time ago we agreed to protect our sea-birds, because we found they showed us "schooling" fish, and warned our seamen from dangerous rocks in misty weather. This time our legislation is less direct. We have not had a select committee on the sparrow—there are plenty of chatterers in the House of Commons who might be "sat upon" to advantage; we have not even anticipated a Ministry of Agriculture by investigating the sources of injury to growing crops; but we have been moved by social advantages, and the bright-eyed broods of field and wood will profit by our sense of security and our desire to equalise taxation.

A word on another topic. The rating of woods and plantations is threatened. It is part of the very question I have so hastily touched upon. Wherever farms are very bare of trees, insects always abound. The locust and the grasshopper delight in the plain, whilst the smaller insects thrive in the young woods that give shelter to their enemies. If we do anything to diminish the planting of trees, we shall increase our insects and also dry our already impoverished soils. We are protecting salmon—why should we not protect our woods, and with them our birds and our crops? Dean Stanley notes that Jewish tradition ascribes to Joshua certain useful regulations as to woods—the grazing of cattle therein, the cutting of sticks, and the preserving of thinly-planted trees. There was wisdom in them all. Watch a bare and a wooded hill on a cloudy day, or a well-wooded farm in a dry summer, and you will see a difference which need not be described. Disafforesting threatens to become as common in the nineteenth as enclosuring was in the sixteenth century. Are we wise to hasten it?

E. GOADBY.

DR. JELINECK ON METEOROLOGICAL OBSERVATIONS

Anleitung zur Anstellung meteorologischer Beobachtungen und Sammlung von Hilfstafeln. Dr. Carl Jelineck. Royal 8vo. pp. 193, with 17 figures. (Vienna, 1869. London: Williams and Norgate, price 6*s*.)

A COMPARISON between the instructions of M. Carl Kreil, the late director of the Austrian Central Office for Meteorology and Terrestrial Magnetism, and those now issued by his successor, demonstrates steady and sound progress in practical meteorology. M. Kreil had to sow his seed on uncultivated soil, and was only partially supplied with the more modern implements of cultivation; Dr. Jelineck, on the contrary, has had before him the successive results of nearly a quarter of a century, and has profited by the vast experience gained from the correspondence carried on during that time between the central office and the numerous stations, distributed over the wide geographical area of the Austrian empire with its striking physical contrasts. No wonder then, that Dr. Jelineck's work, which the author modestly calls "a guide to meteorological observations, with particular reference to the stations in Austria and Hungary," has developed, under his hands, into an excellent manual of practical meteorology, which will prove, in many respects, most valuable to the observers of every country. In the instructions of his predecessor such important subjects as the employment of the aneroid and marine barometers, and of the maximum and minimum thermometers, are not discussed at all, and little attention is paid to a rigid reduction of the observations.

The introductory part of the present work treats on the following subjects: general organisation of the system of meteorological observations in Austria and Hungary; conditions for establishing new stations; regulations for the official correspondence through the post and telegraph offices; local requirements and instrumental equipment of stations, with a precise statement of the necessary expenditure; a list of the most recent and important works on meteorology published in Germany, England, and France; hours of observation and means for determining the true local mean time.

Then follows a concise and clear description illustrated by excellent figures, of the different kinds of barometers and aneroids, a discussion of their relative advantages and defects, and an exposition of the principal formulæ used in the reductions of the observations, with well-selected examples fully worked out, for those observers whose mathematical knowledge is deficient. It appears that the form of barometer mostly in use at the Austrian stations, is that in which there is no provision for adjusting the zero of the scale to the fluctuating surface of the mercury in the cistern. Hence, only one displacement of the index is made for every observation, viz. that at the upper surface of the mercurial column. This is undoubtedly an advantage, for the lower adjustment requires always great nicety in the observer, and is, in some kinds of light, really difficult ; but the advantage is, in our opinion, more than counterbalanced by the complexity of the reductions necessary for the instruments, which obviously require an additional correction for the change of level in the cistern.

The thermometers, maximum and minimum, dry and wet bulb, are described in the same exhaustive manner, and the best methods are discussed for obtaining trustworthy observations on the temperature of air, springs, rivers, and soils ; the tension of the vapour of the atmosphere, and hence the relative humidity of the latter. Dr. Jelineck erroneously states on page 41 (foot-note No. 4), that the mean temperatures in England and Scotland are solely derived from the readings of the maximum and minimum thermometers. It is quite possible that in former years such observations, for want of better ones, were made the basis for deducing the mean temperature of some localities ; but, as far as we are aware, these are exceptional cases, and the daily and annual mean temperatures are everywhere in this country derived from daily observations at fixed hours.

The remainder of the work comprises chapters on rain-gauges, the direction and force of wind, anemometers, the amount and form of clouds, the direction of upper currents, thunderstorms, optical phenomena of the atmosphere, ozone observations, and finally, the best methods for deducing from the observations the most probable annual mean results. Although the author shows himself, on the whole, well acquainted with what has been done in this branch of physical science beyond Germany, some of the chapters alluded to appear defective. A great deal of scientific knowledge and mechanical ingenuity have been brought to bear in this country on many of the subjects just mentioned, and our observatories, both public and private, are now supplied with instruments for different purposes, with which those described by Dr. Jelineck will bear no comparison ; indeed, his instructions with reference to them, show that very little advance has been made in this respect from an almost primitive state : and if we consider what use is being made in this country of photography for obtaining continuous records of the principal atmospheric phenomena, and how well founded our hopes are thus, at last, to obtain an insight into the great laws which must regulate these phenomena,—we cannot but regret that the wide experience and profound knowledge of continental meteorologists should remain unsupported by the invaluable assistance of our modern appliances in their scientific investigations. The attentive reader will nevertheless find treasures even in those parts which fall short of our expectations, for every page is replete with most valuable hints, instructions, and suggestions, derived from long and extended experience.

The second part consists of very numerous and highly-valuable auxiliary tables, some of which, especially those referring to hypsometrical observations, we do not recollect to have met before in such a compact form.

No allusion whatever is made to solar radiation and atmospheric electricity, two meteorological elements the importance of which is rising more and more in the estimation of all thoughtful meteorologists.

We learn with satisfaction that the metrical system will shortly be introduced in Austria and Hungary, and that in future the Centigrade scale will be made use of in the meteorological observations. B. L..

OUR BOOK-SHELF

The Home Life of Sir David Brewster. By his Daughter, Mrs. Gordon.

We like this book. It is notoriously difficult for a near relation to write a truthful biography, but Mrs. Gordon has done her work with great ability, taste and judgment. To most readers, the family details at the beginning will be of little interest, but as the life advances the interest grows. The book is essentially what its title imports, it pictures Sir David as a man rather than as a philosopher ; yet his daughter tells us much of when and how his literary and scientific work was accomplished, and gives us lively anecdotes both of himself and of many of his contemporaries. In one chapter she analyzes his mental characteristics, and while acknowledging his imperfections, she shows that much which appeared inconsistent in his actions arose from an uusually dual nature, the continuation of a peculiarly impulsive temperament, with a scientific habit of thought. In another, she traces his religious history, and we see his advance from a somewhat cold and rigid orthodoxy to a living and happy faith, when without materially changing his own opinions he was ready to sympathise with good men who differed from him. Those who are well acquainted with the multitudinous optical researches of Brewster, will enjoy a glimpse of him at work among apparatus, often extemporised from corks and bits of metal, and glass, meanwhile indulging in a low purring whistle of satisfaction, and those who remember him only as a Nestor in science with furrowed features and snowy hair, describing his discoveries, or declaring his convictions in clear vehement language, will like to know him also as the head of a family, and the principal of a university, a politician, and a writer of reviews, gaining high distinctions, and promoting valuable institutions. But we can only just indicate these things, and must refer to his daughter's book for details about the dawn full of promise, the brillant noonday, and the beautiful sunset of his life.

J. H. Gladstone

On the Rotation of the Embryoes of the Frog within the Egg. By Dr. S. L. Schenk. Pflüger's Archiv. 1870, iii. Jahr., Heft 2 and 3.

It is well known that the embryo of the frog exhibits remarkable movements of rotation, the direction being in opposition to that of the movements of the hands of a watch, supposing the observer to be looking vertically down upon the instrument, and that the head of the animal is directed away from him. These movements continue without interruption, and may be watched for hours together. They vary considerably in rapidity, but a series of observations made by Dr. Schenk showed that the rotation was effected in from five minutes and thirteen seconds to twelve minutes and two seconds. It has not been accurately ascertained when these movements commence, since in the earliest stages of development the surface of the egg is in close contact with the capsule, and it is only after some water has been imbibed that the two are separated, but Dr. Schenk shows that they result from the presence of ciliated cells on the surface ; first, because these can be demonstrated with the microscope ; secondly, because they can be accelerated by the application of moderate heat, which is well known to render the movements of cilia more rapid, and thirdly, because they can be arrested almost instantaneously by the action of weak acids, which are known to operate in the same way on ciliary movements.

Des Races Humaines ou Eléments D'Ethnographie. Par J. J. D'Omalius D'Halloy. Pp. 157. 1869. (Williams and Norgate.)

THE author of this treatise divides mankind into five races, distinguished by the colour of the skin—the white, yellow, black, brown, and red races—which he holds to be more reliable than either craniological character or linguistic affinities; adducing against the former, or Retzius' classification, the observation of Brandt that in examining the crania of a large number of beavers he found great variations to exist; whilst in regard to the classification founded on language, admitting that the consideration of language may prove of great service to ethnology, there is yet no identity between the two sciences. He estimates the members belonging to the several great religions of the world as follows: Christianity 380,000,000, Mahommedanism 100,000,000, Buddhism 500,000,000, Brahmanism 100,000,000, other religions 120,000,000, making a total population for the world of 1,200,000,000. M. D'Halloy is unusually orthodox in his opinions, and defends Scriptural authority with more energy than of late years has been customary with anthropological *savants*.

Studien aus dem Institute für experimentelle Pathologie in Wien aus dem Jahre 1869. Herausgegeben von S. Stricker. (Wien: Braunmüller.)

THIS is another of those German local periodical publications which disturb the minds and pockets of English readers. The time is evidently not far distant when a sumptuary law of publications will become a necessity in Germany. This, the first number of an intended series, is devoted to the histology and physiology of inflammation, and contains papers entitled, "Experiments on Corneal Inflammation," "On Cell Division in Inflamed Tissues," "On Endogenous Formation of Pus Corpuscles in the Conjunctiva of the Rabbit," and others, in all nine in number, contributed by Stricker and his pupils, with a prologue "On the Present State of the Inflammation Controversy," and an epilogue "On the Effect on that Controversy of the Preceding Memoirs," both by Stricker. One paper by Oellacher, "On the Cleavage and Stratification of the Hen's Egg," has only a general and indirect reference to inflammation.

Sketches of Life and Sport in South-Eastern Africa. By Charles Hamilton, F.A.S.L. (London: Chapman and Hall. 1870.)

WE do not understand with what object this book has been published. Of sketches of sport there are few, and none that can compare in interest with the many exciting records of South African adventure in earlier books with which we are familiar. The author's ideas on all subjects connected with natural history are of the vaguest, as where he says, "The Struthionidæ may comprise, *for what I know*, other species besides those of the ostrich; a geologist would give the reader information on the possibility of these birds existing in some analogous form centuries before the present formation of the globe!" Of sketches of life there are some, but with not much greater claim to novelty. That Mr. Hamilton succeeded in so far divesting himself of European prejudices as to submit to be carried to his bath by twenty buxom Kaffir girls, and after having been ducked by them in the water (an operation which he found "rather agreeable than otherwise"), to be painted over with red earth, may be interesting to himself and his friends, but hardly to the general public. What becomes of the old crinolines appears from the fact that the ordinary costume of a Kaffir schoolgirl is a necklace and an outrageously large skeleton crinoline without any covering over it. The woodcuts are on a par with the letter-press, and would be a hideous disfigurement to any work of higher literary pretensions.

LETTERS TO THE EDITOR

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

Analogy of Colour and Music*

I HAVE read with interest the letters in NATURE of 31st March, on the relation between the harmonies of sound and colour, and I wish to point out that the most important principle of harmonising in colour is one which has no parallel or analogue in sound, except only that, like the harmony of sound, it has a mathematical basis. I mean the law that complementary colours harmonise with each other. The definition of complementary colours is, that any two colours which are complementary and of equal intensity, produce white when combined. In sound, on the contrary, there is nothing analogous to white, and consequently no relation analogous to that of complementaries.

All possible colours except white are colours of the spectrum. Black is only the negation of light, and grey is a subdued or lowered white. Brown tints, which to the eye appear unlike any of the colours of the spectrum, are "merely red, orange, or yellow, of feeble intensity, more or less diluted with white." (Clerk Maxwell, *Philosophical Transactions*, 1860.) "One circumstance, however, must not be left unnoticed here: namely, the difficulty of obtaining [that homogeneous red light which forms the transition between the violet and red of the ordinary spectrum, and which can only be produced by the prism under remarkably favourable circumstances (on a bright summer's noon). This outermost colour of the spectrum, which may be equally well regarded as extreme red or extreme violet, I will call purple . . . . In point of fact, the transition from violet to red is just as continuous to the eye as that between any two other colours, though the limit has not yet been fixed by observation at which the same impression of colour is produced by a different duration of vibration." (Prof. Grassmann, *Philosophical Magazine*, April 1864.)

The duration of vibration at the extreme of the violet end of the visible spectrum is about twice what it is at the extreme of the red end. According to Sir John Herschel (*Good Words*, August 1865), the vibrations at the extreme ends of the spectrum, number respectively 399,401,000,000,000 and 831,479,000,000,000 to the second; so that those of the extreme violet are a little more than twice as numerous as those of the extreme red, and the power of vision extends through a little more than a large octave.

With these facts before us it is scarcely possible to doubt that the principle of the octave is as true of light as of sound. Any two notes, whereof the vibrations producing the one are exactly twice as numerous in the same time as those producing the other, are in a manner recognised as the same note, the one being the octave of the other. It is in the highest degree probable that the same is true of light, and that "the limit at which the same impression of colour is produced by a different duration of vibration" is at the point where the vibrations of the one are exactly twice as numerous in the same time as those of the other.

Independently of this speculation (which is not a new one), it is a fact of observation, and is indeed only a statement in other words of the fact quoted above from Prof. Grassmann, that the order of the tints in the spectrum is recurrent. According to Prof. Grassmann, the order of the tints is the following:—

1. Red.
2. Orange.
3. Yellow.
4. Yellowish green.
5. Green.
6. Bluish green.
7. Azure.
8. Indigo.
9. Violet.
10. Purple.

Red again.

And he maintains, reviving Newton's theory, that every colour has its complementary in the spectrum;—the series of complementaries being this:—

1. Red + bluish green = white.
2. Orange + Azure = white.
3. Yellow + indigo = white.
4. Yellowish green + violet = white.
5. Green + purple = white.

*The importance of the accompanying letter from Mr. Murphy induces us to reopen a subject which we had considered closed; we append also two others previously received.—ED.

If the order of the tints is recurrent, it is only using another word for the same fact to say that it is circular; and it is possible so to arrange the colours of the spectrum in a circle that any two tints which are opposite to each other shall be complementaries.

Grassmann's results are purely theoretical, but they coincide in a great degree with the experimental determinations of Helmholtz, and of Clerk Maxwell. In such experiments the method is to mix two or more coloured lights by letting them fall on the same spot of white paper. Mixture of colouring stuffs will not give the same result.

I now come to some remarks of my own on the theory of complementaries.

If colours are so arranged on the circumference of a circle that every tint has its complementary opposite to it, as has been done by Newton and by Grassmann after him, any two tints which are 180° apart are complementaries, and any two tints which are 360° apart coincide. If then the theory of the octave is true, of two tints which are 360° apart, the number of vibrations in a second (or the frequency of vibrations) of one is twice that of the other. It might be expected that the ratio of the frequency of vibrations between any two tints which are 180° apart, would be the square root of this; or, in other words, that when the frequency of the vibrations of any colour is known, that of its complementary might be found by multiplying or dividing, as the case may be, by the square root of two.

To put this in another form: If we so arrange the tints, from red to its octave, where purple turns red again, round the 360° of a circle, that any two tints separated by equal areas shall have their frequencies of vibration in equal ratios; then, as the frequencies of vibration of the two reds which are separated by 360° stand to each other in the ratio of 2 to 1, the frequencies of vibration of any two tints which are separated by 180° will be to each other in the ratio of the square root of 2 to 1. Now if the theory of a chromatic octave be true, the pair of tints which are 360° apart are exactly alike, and we might expect those which are 180° apart to be complementary to each other.

But this is not the case.

The ratios of the wave-lengths and of the frequencies of vibration (which, of course, are in the ratios of the reciprocals of the wave-lengths), corresponding to various tints, have been determined with great accuracy by Prof. Clerk Maxwell (*Philosophical Transactions*, 1860), by means of an interference-spectrum. The numbers in the following table, which are given on his authority, are the numbers of wave-lengths in the retardations; each colour is written in the same line with its complementary. In the case of bluish-green, blue, and indigo, I take the middle one of three places in the same colour.

Red	36·40	Bluish green	48·30
Orange	39·80	Blue	51·80
Yellow	41·40	Indigo	54·70

If the frequency of vibration of the colours in the second column were to that of their complementaries in the first, in the ratio of the square root of 2 to 1, the numbers would be—

Bluish green	51·47
Blue	56·28
Indigo	58·54

Thus the frequencies as observed were considerably less than as calculated from the hypothesis. The differences are all on the one side, and are much too great to be the result of any accidental error. The complementary tints in the foregoing table are not precisely opposite, but approach each other by the green side of the circle; and if from the portions of the circle from red to yellow, and from bluish green to indigo, any two tints are taken which stand exactly opposite, so that their frequencies of vibration are in the ratio of 1 and the square root of 2, their unison will not give pure white, but white with a blue tinge.

But does this disprove the hypothesis that the true complementaries are those tints whereof the frequencies of vibration are in the ratio of 1 and the square root of 2? I think not.

Complementaries are usually understood to be tints, which by combination form a colour sensibly identical with that of sunshine. But is this correct? The solar spectrum is not pure, in consequence of the great number of absorption lines towards the violet end. That of the electric light, on the contrary, is free from absorption lines, and, in consequence of their absence, the electric light is sensibly bluer than that of the sun. If now the colour of the electric light, instead of that of sunshine, were taken as the true white, it appears probable that experiment would show the frequencies of vibration in any colour and its complementary to be in the ratio of 1 and the square root of 2.

There are some remarks on this subject in the 2nd vol. of my work on "Habit and Intelligence," of which book you inserted a notice by Mr. Wallace on 15th Nov. and 2nd Dec., 1869, but it is more thoroughly thought out in this letter.

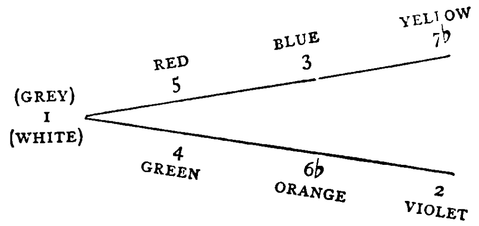
JOSEPH JOHN MURPHY

Old Forge, Dunmurry, Co. Antrim, April 16

M. RADAU, in his "Acoustique," says:—"The disdain with which most musicians repel the invasion of their domain by the exact sciences is to a certain extent justified." I venture to think it is very much justified, since little has been accomplished in aid of a technical theory of music by scientific men from Pythagoras down to Helmholtz. The highest service the mathematicians have rendered was to assist in destroying the application of their own theories by establishing the universally received system of "equal temperament." Now that the "effects" of colours are falling under the manipulation of mathematicians, could not the learned who are occupying your columns with the old discussion on "ratios" condescend to receive some warning from the history of "speculative music"?

One of your correspondents asks for a "white sound"! Seeing that a complementary colour completes the numerical value of the white rays more or less as the inversion of any musical interval completes the octave, is it unscientific to assume that the white ray must be the analogue of the monochord? Allow me to assume that it is so, and that white and black are complementaries, as M. Chevreul admits. Let me also assume that they are the two extremes of *light and shade*, including many gradations —*many octaves*—of intermediate shades of grey.

Taking any normal gradation of light and shade, and calling it grey or white, as the generator, the primary colours and their complementaries correspond to the harmonics, thus:—



The following series of figures

1	2	3♭	3	4	4♭	5	6♭	6	7♭	7	1
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
1	7♭	6	6♭	5	5♭	4	3	3♭	2	2♭	1

represent what musicians call a table of inversions in the octave. It must be understood that in the system of inversions of numbers I employ, what is meant by a number and its inversion are the distinct notes in the scale the two numbers represent. For instance, 1 to 5 is C to G in ascending, and the inversion is 1 to 4, C to F—always in ascending, and counting from the generator No. 1.

Hence the following table of abstract intervals and their inversions, produced in regular order from the generator:—

Unison 1 White or Grey.	5th Red.	Minor 3rd Indigo.	Major 3rd Blue.	Minor 7th Yellow.	Major 7th Lemon.	5th Red+Green (brown). (tritone).
⋮	⋮	⋮	⋮	⋮	⋮	
1 White Octave	4th Green.	Major 6th Chrome.	Minor 6th Orange.	Major 2nd Violet.	Minor 2nd Lavender.	Sharp 4th Green+Red (brown

Musically speaking, the generator No. 1, as the root of a natural dissonant chord 1, 5, 3, 7♭, becomes No. 5 of the scale, or dominant of the key, the tonic of which is four degrees higher.

Consequently, if there be any analogy at all between sound and light, or between musical intervals and colours, the key-note of the spectrum would be *green*—the ray of medium refrangibility—and four degrees higher than the dominant or generator *white*. In modern views of harmony, I may remark it is not the concord or triad, but the dissonance, which is the basis of the technical theory.

Collecting, then, the abstract intervals given above, and considering them as representing separate notes, and arranging them in regular order, counting the original generator as No. 5, we get the following scale—major, minor, and chromatic—of F♮, or *green*:—

					(Tonic)						
5	6♭	6	7♭	7	1	2	3♭	3	4	4♯	5
C	D♭	D	E♭	E	F	G	A♭	A	B♭	B	C
Grey.	Lavender.	Violet.	Indigo.*	Blue.	Green.	Red.	Orange.	Chrome.	Yellow.	Lemon.	White.

* Indigo is, I think, a misnomer: it should be purple between blue and violet.

On the same system it is easy to construct an enharmonic scale on the principle employed by M. Chevreul. The double flats and sharps sometimes give ternary compounds. For example, 4♯♯ equals green + red + red, and its inversion 5♭♭ would give red + green + green. Some of the neutral greys, olives, slates, browns, &c., which would not appear in a table so constructed and calculated at a normal pitch, are produced by lowering the diapason.

From the above very brief explanation of the system of inversions, the following results may be suggested:—

1. That a table of colours of all gradations, with their complementaries, may be musically expressed in numerical notation with the greatest exactitude.

2. That, contrary to scientific opinion, it does not follow that because the red ray has the lowest degree of refrangibility, &c. &c., or perhaps because it happens to be at the bottom of the series of prismatic colours, it should necessarily be the initial note on the tonic of a scale.

3. Even if the red ray be the tonic, it does not follow that the scale of the spectrum should be *major*, as is too frequently given in elementary works on optics. By the system of inversions of numbers here presented, the scale of the spectrum appears, by disjoining the conjunct tetrachords, to consist of one tetrachord major and one minor, corresponding to the descending minor scale in use, of F♮ minor, supposing C♮ to represent the normal pitch of the dominant No. 5 corresponding to any given intensity of white light. Moreover, one conjunct tetrachord of the spectrum appears in *ascending* and one in *descending*, both tetrachords *converging* on the tonic.

4. If the analogy be true so far, there is only one colorific key. Modulation through a series of colorific keys, as in *modern* music, is impracticable. The reasons I have not space to explain. J. G.

MR. SEDLEY TAYLOR has, it seems to me, written his criticism on my letter published in NATURE, Feb. 10th, far too hastily. I do *not* compare the diameter of the rings with one another, but *their cubes*, otherwise we should be led in establishing the musical analogy to the absurd equation $\frac{1}{\sqrt[3]{2}} = \frac{1}{2}$. It would perhaps have been better to have said, that the ratios of the spheres described on the diameters of the rings, taken successively from red to violet, two and two together, the 1st to the 2nd and the 2nd to the 3rd, &c., give a series of fractions identical with those expressing the relative lengths of the musical chords from D to C, ascending and taken in like manner. As Mr. Taylor doubts Prof. Zannotti's accuracy, I will quote the following passage from Biot's "Precis Elémentaire de Physique," 3rd Ed., Vol. ii. Paris, 1824, p. 400, *et seq.* Speaking of Newton, "Il mesura les diamètres des anneaux simples *de même ordre*, dans la partie intérieure et dans la partie extérieure de leur périmètre, et en les considérant successivement aux limites des diverses couleurs du spectre a commencé par le violet extrême. Suivant sa méthode constante, il prit soin de lier ces resultats par une loi mathématique qui les représentât avec une suffisante exactitude. Il trouva ainsi que les diamêtres, soit intérieurs, soit extérieurs, étaient sensiblement entre eux comme les racines cubiques des nombres $\frac{1}{2}$, $\frac{9}{16}$, $\frac{3}{5}$, $\frac{2}{3}$, $\frac{3}{4}$, $\frac{5}{6}$, $\frac{8}{9}$, 1, lesquels représentent les longueurs que doit avoir une corde de musique pour produire toutes les notes d'une gamme mineure; c'est-à-dire, que si l'on représente par 1 le diamètre intérieur d'un certain anneau, lors qu'il est formé par les rayons rouges qui composent la partie la plus extrême du spectre, $\sqrt[3]{\frac{8}{9}}$ exprimera le diamètre intérieur du même anneau, quand il sera formé par les rayons qui sont la limite du rouge et de l'orange, et ainsi de suite jusqu' à $\sqrt[3]{\frac{1}{2}}$ qui représentera le diamètre intérieur du même anneau quand il sera formé par les derniers rayons violets pris à l'autre extrémité du spectre."

I can only add, that if Mr. Taylor doubts also the accuracy of M. Biot, he can easily refer to Newton's own treatise on colour.

Rome, March 16 W. S. OKELY

The Barlow Lens

I HAVE found the addition of a double concave lens to my telescope and microscope of so much service that I am anxious to call the attention of your readers to this simple application for increasing and improving the working power both of telescopes and microscopes. The application consists in the introduction of a biconcave lens in the adapter, which holds the eye-piece of the telescope, at a distance of two or three inches from the field-lens; as the focal length of the instrument is thereby increased, it is necessary to adjust the distance of the lens from the eye-piece according to the length of the adapter, so that the latter still admits of being drawn out sufficiently for focussing. A friend procured me several lenses of different powers at the ridiculous price of a shilling a-piece from an optician and spectacle-maker at Brighton, which answer admirably.

The chief advantage obtained by the use of this lens is the great increase of magnifying power without a corresponding loss of light. This is a great desideratum in looking at a planet, but it is equally important in separating double stars. With a low eye-piece of 60, my refractor (one of Cook's with a 3½in. object glass, and the addition of the Barlow lens) shows the Companion of Rigel beautifully.

I first became aware of this useful application many years ago, in reading Admiral W. H. Smyth's "Cycle of Celestial Objects." In page 343, vol. i., he states: "On receiving it, I directed the telescope upon a watch-plate fixed on a distant chimney, which quickly proved the power of the lens in enlargement, with scarcely any obscuration of light. While the image expanded under each progressive eye-piece, I was surprised at the additional advantage of its simultaneously flattening the whole field of view; and though the magnifying power became double on distant objects, the apparent magnitude of the spider-lines diminished in an equal ratio: a property which, with all powers above three hundred, is of considerable benefit to operations upon close double stars, and the finer micrometric desiderata. I afterwards raised the discs of the Satellites of Jupiter, and examined several double stars, with equal facility and advantage, the definition being quite distinct, and the stray light rather subdued than increased. After a little practice, I came to the conclusion that the achromatic concave lens will render the instrument to which it shall be applied equal to two telescopes for particular cases; for if a set of observations be made *with* it and another set *without* it, the errors of vision will be in some degree neutralised, or even done away with."

In spite of this strong recommendation I never gave it a trial until a few weeks ago, when a paper in the Polish language by Prof. Piotrowsky passed through my hands. It remains to this day a sealed book to me, but the two annexed figures taken from it leave no doubt in my mind that the paper treats on the same subject of which Admiral Smyth speaks so favourably. The result of my own trial made me regret having foregone for many years an advantage which I have every reason to congratulate myself on now possessing; but this circumstance it is also which induced me to ask for a small corner in NATURE for these remarks, when other more interesting subjects are less pressing than usual.

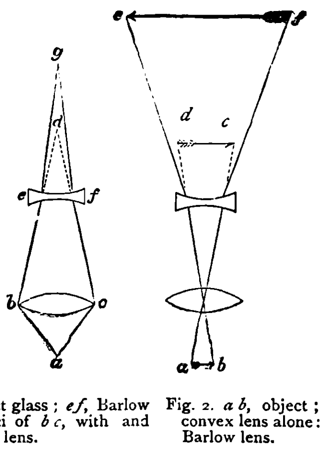


Fig. 1. *b c*, object glass; *e f*, Barlow lens; *d g*, foci of *b c*, with and without Barlow lens.

Fig. 2. *a b*, object; *c d*, image, with convex lens alone: *e f*, image, with Barlow lens.

Walham Grove F. d'A.

A Word in Defence of Physicists.

Two passages in NATURE of April 14th show that the supposed opposition between geologists and physicists is not forgotten. This feud can only impede the advancement of truth.

Prof. Duncan, in his instructive paper on Dr. Carpenter's Report, writes thus :—" Physicists have propounded theories which have been accepted by some geologists, but they are looked upon as doubtful hypotheses by others. Palæontologists and such theories have been constantly at issue. The theories involving pressure, and the hardness of deep-sea deposits, will suffer from the researches ; but many difficulties in the way of palæontologists will be removed."

I cannot think that either of the "theories," to which allusion appears to be made, can ever have been accepted by any one who understood the nature of fluid pressure. The tissues of a living being inhabiting the depths must necessarily be permeated by liquids at the same pressure as that of the water without. Hence no crushing effect can be produced. So, too, the particles of mud or sand at the bottom of the ocean are buoyed up by water at the same pressure as that by which they are forced down, and they sink only by the difference of weight between themselves and the dense water ; so that the ooze at a profound depth ought actually to lie lighter than beneath shallower water. These considerations have always occurred to me when reading about the misconceptions to which Prof. Duncan alludes. But what I wish to point out is, that it is not the deductions of physicists which are overthrown, but the fancies of those who are not physicists, which were always opposed to physical principles.

Mr. Wilson's letter about "geological time" may possibly elicit a reply from Professor Pritchard. But why is Sir W. Thomson's name introduced into the heading? And does Mr. Wilson intend to tell us that Mr. Darwin considers natural selection incompetent to produce the human eye? For unless Mr. Darwin admits direct *design* in the arrangement of the human eye, it does not appear how Mr. Pritchard's *lapsus* in seeming to include man among the *Articulata*, can vitiate his argument as against Darwin. O. FISHER

Heat Units

IN No. 24 of NATURE (April 14) Mr. Thomas Muir calls atention to the inconvenience arising from the want of some uniform and generally recognised mode of expressing qualities of heat. As there can be no question that the inconvenience is a real one, I venture to suggest as one remedy for it, the employment of the following terms, namely—

grain-degree,
pound-degree,
gramme-degree
kilogramme-degree,

to denote respectively the quantities of heat required to raise the temperature of one grain, pound, gramme, or kilogramme of water from 0° to 1° Centigrade. These expressions are used in the article HEAT, in Watts's "Dictionary of Chemistry"; and having been for several years in the habit of using them in my lectures, I am able to say from experience that the employment of them greatly facilitates statements relating to quantities of heat.

It appears to me to be in favour of these terms, as compared with Mr. Muir's "therm," "kilotherm," &c., that they enable us to do without the formation of any new word, that they are self-interpreting, and that by means of them quantities of heat can be expressed with reference to the British or to the metrical standards of mass, with equal facility.

University College, London, April 25. G. C. FOSTER

The Sun's Chromosphere

Is there any way, by means of an ordinary telescope with coloured glasses, of seeing the red prominences on the sun's edge —that is, without a spectroscope? If so, what coloured glasses ought to be used? In one of the former numbers of NATURE, an observer saw, with only a telescope, what he believed to be these prominences ; the sun was near the horizon, a series of rose-coloured undulations became visible, unconnected, as supposed, with atmospheric disturbance, and which it was suggested might be due to the red flames of the chromosphere.

A.

Lefthandedness

IN a letter on this subject by J. S., in this week's number of NATURE, the hypothesis is mentioned that left-handed persons may owe their peculiarity to a transposition of the viscera, or at least of the great arteries of the upper limbs. This supposition, which has been more than once advanced, is certainly not true. Several cases of transposition of viscera are on record in which the persons affected were right-handed. One was recorded by M. Géry (quoted in Cruveillier's *Anatomie*, tome 1, p. 65, note), another by M. Gachet (*Gazette des Hopitaux*, Aug. 31, 1861), and a third in the *Pathological Transactions*, vol. xix., p. 447.

Your correspondent's opinion seems probable that righthandedness is the result partly of hereditary, partly of individual education, and is intimately associated with the more complex functions of the hand. P. S.

April 18, 1870

THE ABRADING AND TRANSPORTING POWER OF WATER

II.—FRICTION OF WATER

ON a former occasion the abrading and transporting power of water (which is supposed to increase as the velocity increases, but to decrease as the depth increases) was considered from a mechanical point of view, and arguments were brought forward to show that water rolls rather than slides. The question then arises—

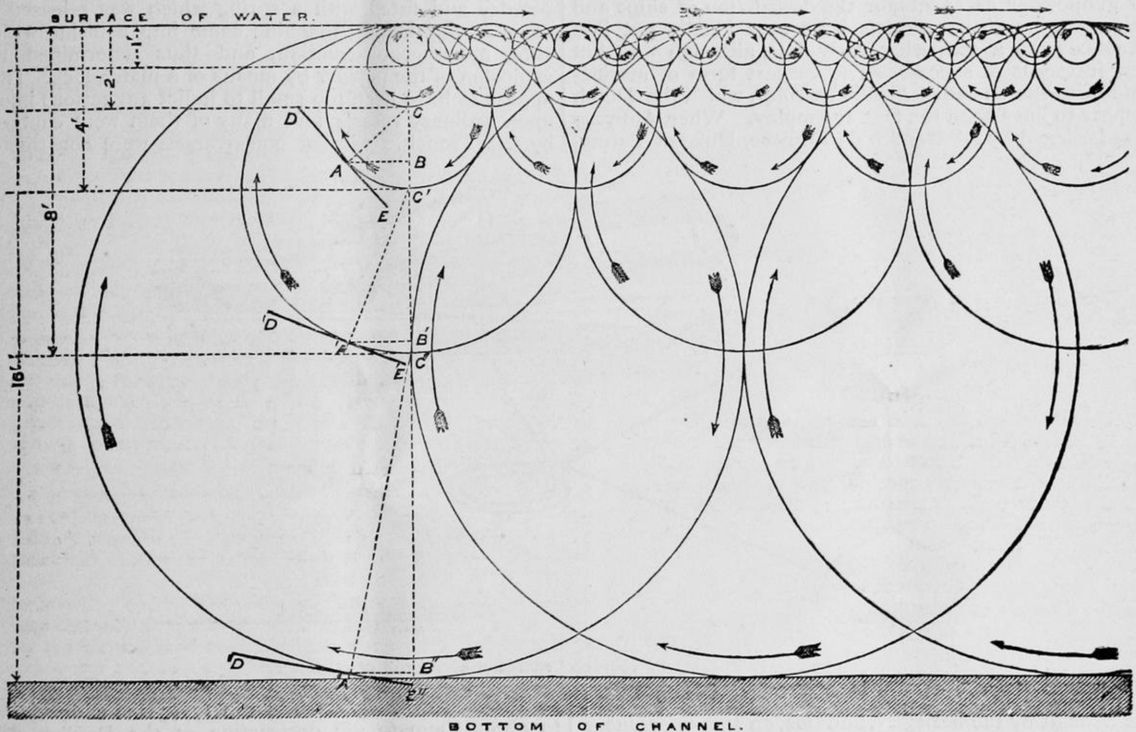
III. How does flowing water obtain this rolling motion? The reply to this is, By *friction*.

Take, for example, the rifling of a gun ; we all know that it is owing to the spiral grooves or prominences in the chamber that the shot gets its spinning motion; but supposing the shot be a sphere, and fired from a smooth bore, it has not this rotatory motion at right angles to the line of flight, and no great dependence can be placed on its accuracy, but it may rise or fall, pass to the right or left, all depending on which side of the gun's mouth the shot touched when passing out, for so will it revolve. Should it ricochet, it will, when nearly spent, be observed to roll over the ground, and this is all caused by the friction offered by the resistance of the ground with which it came in contact. And what reason can there be assigned against water adopting this most simple of all laws for bodies in motion; and is it not owing to this that water in a cistern takes a circular motion when escaping through an orifice in its bottom, or presents a cork-screw appearance when poured out of a small vessel? Again, on the large scale, with rapid currents such as in the Pentland Frith, what but this circular motion of the stream can cause that boiling ap-appearance given to the water, which everyone must have observed who has navigated waters where there is a strong tideway? And cannot this explain why there should be an enormous breaking sea at the point where the heavy swell of the Atlantic meets the ebb tide; and does not this rolling motion given to the tide, acting in an opposite direction, check the oscillations of the Atlantic swell, causing those huge breakers so well known to the Orcadian boatmen?

Supposing every particle of water to be a sphere in itself that can roll independently, and that a number of them being collected together form a larger sphere, which also rolls, and so on, then the diameter of the spheres increases with the depth, be it ever so great. Consequently, the facility for rolling will also increase, so that the deeper and broader a stream is—that is, the farther the centre of a stream is from the retarding medium (the bed and banks of a river)—the less is this rotatory motion obstructed ; and does not this explain how the velocity increases with the hydraulic mean depth? The air also has a retarding effect even in a perfect calm; for where the Mississippi was very deep, it has been observed that the greatest velocity was not at the surface, but at some distance below it.

Supposing that water moves in an innumerable number of circles, varying from a single particle in diameter to that of hundreds of feet, and that every obstruction sets these circles revolving at right angles to their surfaces, we can at once begin to understand how, by increasing the areas exposed to friction, an innumerable set of wheels of various sizes are set spinning in all directions, but are retarded in this action by the attraction of the several particles to each other. Thus wheels within wheels will be set in motion, some revolving in opposite directions; and the quicker the revolutions—that is, the smaller the diameter of the wheels, in other words the shallower the stream—the greater will be the power expendend, which power Nature exerts in holding solid matter in suspension; therefore, if the foregoing arguments be correct, it is evident that the transporting and abrading power of

The various angles with the horizon are represented by the lines D E, D′ E′, and D″ E″, which show the necessary slopes, in order that the centre of gravity of each circle should be equally beyond the point of support A′, and that consequently A B, A′ B′, A″ B″, should be all equal; they indicate that where the slope of the surface of the water remains in each case the same (say, for example, one foot in a mile), the velocity probably increases proportionally to the increased hydraulic mean depth, or that where the velocities are the same, and the depths differ, the slope requires also to vary. Let, for example, the velocity be in each case about 5 miles an hour, or some $7\frac{1}{2}$ ft. a second, while the depths are 5ft., 8ft., 10ft., and 90ft. respectively, the slopes vary from 25 feet in the mile to only some 4 inches, while the load of solid matter held in suspension is about 7 per cent., 5 per cent., 3 per cent., and only $\frac{1}{1700}$ of the weight of water in each of the above cases respectively. With the assistance of the diagram, therefore, it will



water must increase in some ratio inversely as the depth, and that the retarding of a ship's sailing on a flowing river must depend on the increased area of surface exposed, thus explaining why a ship with a foul bottom, a rough, rocky bed to a river, or weeds in a stream, all retard velocity, because they one and all set so many more wheels spinning. This leads us to the important questions where abrasion and the power of flowing water to hold solid matter in suspension have to be investigated, with the view of showing how this rotatory motion acts in nature. To do so the following diagram will perhaps give a slight idea of the complicated nature of this rotation, the circles being supposed to increase in diameter with the depth. This diagram is only intended to show the relative motion of one set of particles with respect to its neighbouring set of particles, each for its own depth of 1, 2, 4, 8, or 16 feet deep. Thus where the depth is 16 feet, there would be a series of circles 16 feet in diameter rolling within each other, where the depth was 8 feet, there would be circles of 8 feet in diameter, and so on. That is, with the same velocity, the rotation would decrease as the diameters became greater.

at once be seen how the whirling motion given to a stream must increase as the depth decreases, and how, by the increased agitation, the water is able to hold proportionally more solid matter in suspension, while the action on the bed of the channel must at the same time be increased.

To carry this action to extreme cases it appears evident that where the velocities are considerable, and the depths only a foot or two, the slopes must become almost precipitous, while the stream must become semi-fluid mud, or transport a large proportion of boulders, and even rocks; in doing which a certain amount of power must be expended, and in transporting this solid matter this loss of power cannot but retard the flow of the stream. On the other hand, it may be assumed that, even with considerable velocities, which at small depths would tear up and hurl forward rocks, boulders, sand, and mud, with excessive depths the water may flow on in almost a comparatively pure state, and instead of holding in suspension stones and coarse sand, can only transport fine particles of mud.

T. Login.

THE SCIENCE OF EXPLOSIVES AS APPLIED TO WARLIKE PURPOSES

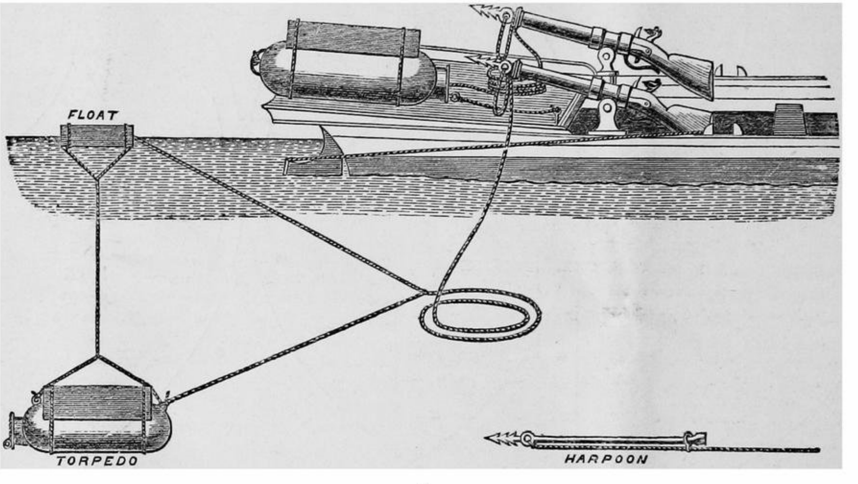
I.—EARLY STUDY AND APPLICATION OF EXPLOSIVES

THE protracted and disastrous war between the Northern and Southern States of America was fruitful in the development of expedients to serve as auxiliaries to the hitherto well-recognised materials of defence and attack. No subject connected with the details of that war has, however, received more general attention on the part of European Powers, great and small, than the extensive and successful applications of a somewhat ancient class of war-engine, the value of which up to that time had received no practical demonstration, but which is now on every hand regarded as destined to play a most important part in future wars.

The idea of employing floating or submerged charges of gunpowder as agents for the destruction of ships and other marine structures, has been occasionally put into practice from a somewhat early date, although with but few instances of success. The earliest form of marine-mine was the so-called *Explosion Ship*, which the Dutch appear to have been the first to employ. When Antwerp was besieged by Alessandro de Farnese, Duke of Parma, in 1585, a boom or boat-bridge was constructed across the Scheldt by the besiegers, and this, an Italian engineer, Jambelli, undertook to destroy for the Dutch. Four large flat-bottomed vessels were each of them loaded with several thousand pounds of powder, over which were placed fireworks and large masses of stone; two of the boats were provided with slow matches, the burning of which had been timed, and the others fitted with clock-work contrivances by whose agency the powder was to be exploded at a pre-determined period. The vessels, thus equipped, together with a number of fire-ships, were allowed to drift towards the boom, and, on its centre being reached, one of them immediately exploded with such violence as to destroy several of the ships composing the structure, and likewise to kill 800 men and wound many more, among whom was the Prince Farnese himself.

Vessels of this kind were repeatedly used by the English in the seventeenth century; thus an attempt was made in 1693 to destroy St. Malo by the explosion of a vessel of 300 tons laden with a large quantity of gun-powder, besides various other combustibles; and similar attacks were likewise directed with little or no success two years later against St. Malo, Dieppe, and Dunkirk. For some time after these operations explosion-vessels seem to have fallen into disuse, there being no instance of their employment on record until 1809, when Lord Cochrane destroyed a boom in the Basque Roads by exploding in contact with it a vessel laden with very closely packed gunpowder. Some unsuccessful attempts at the destruction of English ships by means of explosion-vessels were also made by the Americans during the War of Independence; but this very wasteful and uncertain mode of applying gunpowder in marine operations appears to have been since then altogether abandoned, until the late American War, when Admiral Porter, of the United States Navy, added one more to the list of unsuccessful operations of this kind, by endeavouring to destroy or disable Fort Fisher by the above means.

The earliest form of submerged self-acting mine was the so-called *floating petard* used by the English during the operations in Rochelle, in 1628. These implements of warfare consisted of small cases of sheet-iron filled with powder and fitted with a spring which was released as soon as the drifting machine came into collision with a ship, or other obstruction, and thus determined the explosion of the powder by means of a match-lock. They appear to have been too small to inflict any serious injury upon ordinary vessels, and many of them were captured by the French. Similar contrivances were constructed by an American, Mr. Bushnell, in 1777, who endeavoured to apply them to the destruction of the English fleet anchored near Philadelphia in that year; but the machines were started at too great a distance from the ships, and drifted away in wrong directions, the damage inflicted by them being limited to the destruction of a ship's boat and her crew, who were engaged in capturing one of the dangerous shoal. In 1800 another American, Robert Fulton, submitted to the French Government several projects for the destruction of ships by means of submarine mines, or as they were called at the time, infernal machines. This gentleman appears to have spent three or four years in perfecting his system of warfare, but received such scant assistance and encouragement from his own Government, that in 1805 he determined to offer his invention to the English, who about that time had been creating a considerable panic in the French fleet off Boulogne, by sending among the vessels a number of fire-ships and small drifting mines of a self-acting nature, termed *catamorons*.



THE FIRST SO-CALLED "TORPEDO" PROPOSED BY FULTON IN 1800

The first of Fulton's torpedoes, of which trial was made by the English naval authorities, consisted of a metal vessel holding about 100lb. of gunpowder, and fitted with a clockwork instrument which could be regulated to release a flint-lock at a determined period after it was set in motion. The machine was partly encased in cork, so that when charged with powder it was a little heavier than sea-water, and it was attached by a line to a box float, whereby it could be kept suspended at any particular depth. These torpedoes were carried in harpoon-boats, and connected by long lines with harpoons fired from small guns at the ship to be attacked. If the harpoon was successfully planted in the ship's side, the torpedo was drawn into the water by the line, and this, as it ran out, released a pin from the torpedo, setting the clock-work in motion. The submerged torpedo was then supposed to drift into close proximity with the ship by the time the flint-lock caused ignition. Several French ships were attacked by means of these explosive machines—which, by the way, Fulton was the first to term *torpedoes*—but although they were in some instances successfully exploded, the enemy's vessels sustained no material injury, from the fact that the charges were immersed in too great a depth of water. Fulton's drifting torpedoes were employed in a more simple form in an experiment made in October 1805, in the presence of the principal officers of the fleet commanded by Lord Keith, on which occasion a 200-ton brig, the *Dorothea*, anchored for the experiment off Walmer Castle, was destroyed at one operation. The torpedo employed contained 180lb. of powder, and was suspended at a depth of fifteen feet; it was simply allowed to drift with the tide against the hulk, the clockwork which regulated the explosion being timed to run eighteen minutes before the machine was cast adrift.

The torpedoes made use of by the Russians in the Baltic in 1855, were mechanical self-acting machines, containing charges of from 8lb. to 10lb. of powder; they were constructed with some care and ingenuity, and if they had been but of larger size, their existence would have greatly jeopardised the safety of our ships. The machines were conical in form, and were so arranged as to explode on being struck by a passing vessel, the blow causing the fracture of a glass tube containing sulphuric acid, which, falling upon a tuft of cotton wool saturated with chlorate of potash, sulphur, and sugar, at once ignited the charge.

But it was not, as previously stated, until the subject of torpedoes was seriously taken in hand by the Americans during the recent war, that torpedo-warfare assumed a grave and wide-spread importance. In the hands of the Confederates especially, the applications of submarine mines to warlike purposes were very carefully studied, and with such marked success, that, according even to the official despatches of the Federals themselves, twenty-five ships are admitted to have been destroyed. In the first instance *mechanical* torpedoes only were used, such, viz., as exploded by means of percussion arrangements fitted on the outside, or by a drifting line attached to a trigger, but these were afterwards succeeded to some extent by machines ignited at will from the shore by electricity. The latter were, in the opinion of Admiral Porter, of inferior value, from the fact of their ignition not being effected at the proper time; and the gallant officer reports, that on one occasion he safely ran the gauntlet through a channel bristling with these machines, by simply sending forward as pioneer a sham *Monitor* built of logs, and furnished with an imitation turret, which passed without damage over several torpedoes exploded at her, and was afterwards followed by the fleet unharmed.

Consequent upon the successful employment of torpedoes by the Confederates, the Federals turned their attention more closely to the matter, building a torpedo-boat especially for this kind of warfare, and reconstructing six *Monitors* for the same purpose.

The perfection to which submarine mines have been brought up to the present time, and the various methods adopted for applying electricity to their ignition, will form the subject of the second part of this paper.

THE DEEP-SEA SOUNDINGS AND GEOLOGY

SOME little time ago an eminent geologist, Professor Gümbel of Munich, applied to Sir Roderick Murchison for specimens of the Deep-sea Soundings which have lately been the subject of so much discussion. Sir Roderick mentioned Dr. Gümbel's wish to me, and I immediately sent him a small quantity of North Atlantic mud from 2,350 fathoms, which had been preserved in spirit. The following translation of a letter, dated April 18th, 1870, with which Dr. Gümbel has favoured me, and which embodies the result of his researches hitherto, will, I am sure, be read with the greatest interest by geologists and biologists. I may mention that I long since found coccoliths in the nummulitic limestone of Egypt. T. H. HUXLEY

Many thanks for sending me the specimen of mud obtained by the deep-sea dredge. I have already subjected it to searching investigation, and have obtained results, which have the most important bearing upon my other work. Although my inquiries are, at present, only commenced, it will possibly interest you to receive some information respecting them. I call the new kind of investigations which I have begun to carry out, "Deep-sea investigations on the dry land;" *i.e.*, examinations of the different calcareous rocks, with reference to the share which the smallest organic forms, similar to those at present existing in the deep sea, have had in their formation. When limestone is soft and earthy, traces of the smallest marine animals can be detected by triturating it in water. In chalk, for instance, from Palestine, I have convinced myself, in the most unequivocal manner, of the formation of the calcareous mass, for the greater part from your so-called coccoliths, besides *Foraminifera*, &c., which have long been known. Similar soft calcareous rocks are unfortunately rare in older formations. With these another process must be adopted. I started from the fact that in many of these calcareous rocks, the original calcareous portion of the organic beings is replaced by silica, and that hence in such rocks, by the separation of chert or flint, at least a part of the calcareous portion of the coccoliths and coccospheres might be replaced by silica. It was to be expected that the exterior form might suffer by this replacement, as, in fact, the chalk coccoliths have become materially different in their form from those of the existing deep-sea ooze.

I found, in fact, by treating such a siliceous limestone with very dilute acetic or hydrochloric acid, in the fine mud which is left, an organic residuum corresponding to the coccoliths of the present day. Even in the Trenton limestone, and in a yellow limestone of the Potsdam series, corresponding minute bodies were to be recognised, although sparingly, presenting themselves amongst an incredible multitude of other minute particles of organic origin. The microscope discloses, like the telescope, in the vault of heaven, a new world of the smallest organic beings, respecting which, however, I must say nothing at present, but confine myself to the coccoliths. These casts of coccoliths are found very sparingly. I explain this from the circumstance that the silica is chiefly the result of the decomposition of large masses of organic material, especially of the larger testacea. I obtained, however, important results by subjecting the deep-sea ooze, for which I am indebted to your kindness, to the action of the acids. These with violent development of carbonic acid, dissolve the minute bodies of the coccoliths, of the coccospheres, and perhaps also those of *Bathybius* (although of this I am not quite sure), and there remain only certain peculiarly formed but very much changed portions of the coccoliths as roundish discoidal flakes, the organic portion of the original coccoliths. In single isolated coccoliths this change of form is difficult to follow, but this can easily be done in those which appear to be firmly bound up (enveloped?) with a mass of the granular flakes (*Bathybius?*); and after the operation of the acid, can be again easily recognised in their exact position. Accompanying these coccoliths transformed by the action of acids, are countless little bodies extremely similar to those which can be obtained, in most cases, by dissolving siliceous limestone in acids.

This is the first commencement of researches which I propose following up, with, I hope, important results; since thin sections are of no good in studying these minute forms. I cannot close these notes of the researches with which I am at present engaged, without adding a further contribution, and I hope not an unimportant one, to what is known respecting the nature of the deep-sea mud.

You speak of the chemical behaviour of these masses. The question whether these minute organisms represent animals or plants is still open. I have exposed the ooze to the action successively of a solution of iodine, of iodine and sulphuric acid, and of zinc chloride with potassium iodide, and have each time obtained in a remarkable manner a distinct blue colour, different shades from violet to green, in the substance of the coccoliths. There must therfore exist in the organism of the coccoliths, besides the calcareous skeleton, a kind of cellulose. Their organic nature is thus established beyond all doubt; but the conclusion might after all be drawn that we are dealing with plants, were it not that in the animal kingdom cellulose has been found in the Ascidians. But it is at all events interesting here on the boundary of organic life, to meet with cellulose. As a confirmatory test, I treated the substance with Millons' test which, as is well known, colours conchiolin red, but leaves the chitin of the *Orthropoda* on the other hand unchanged.

I obtained by this means no red colour in the flakes belonging to the coccoliths after the limestone had been dissolved by the excess of acid. A red colour showed itself, on the other hand, in many other particles, for instance, in the *Polycistineæ* whose siliceous coat was coloured red at the margins; and in irregular patches, which appeared to be derived from broken and crushed mussel-shells. I also noticed much deep brown and yellow colour. Especially by treatment with different chemical reagents, differentiated minute particles make their appearance which can scarcely be recognised by my microscope, and which, before the treatment with the chemical reagents, cannot be by any means detected. I expect that by this method an important extension of our knowledge of the most minute forms of organic life will be effected. I will only mention further that the red of the conchiolin shows itself of a bright red in the smallest particles which are found in such great numbers in the agglomerated flakes (*Bathybius*), and which are smaller than the little elevations on the epidermal structures, which probably belong to *Holothuridæ*, and which frequently occur in the field of the microscope.

I should like to pursue further the chemical side of these investigations; but, unfortunately, the supply sent over to me is almost exhausted. If you consider these researches of sufficient importance to be worth continuing, and could obtain further material for me for this purpose, I should be greatly indebted to you. If you can make any use of this communication, it is at your service.

NOTES

PROBABLY few are aware of the magnitude or special aim of the Cornell University. While our own rulers can scarcely grapple with the Education question because of the unsettled state of Ireland, the Government of the United States laid the foundation, during the height of the most terrible struggle for existence of modern times, of one of the most important educational movements the world has ever seen. On the 2nd of July, 1862, Congress passed an Act granting public lands to the several States and Territories which might provide colleges for the benefit of agriculture and the mechanical arts; the share of the State of New York amounting to 990,000 acres. In 1865, this grant was conferred on a University about to be established, on the condition that the Hon. Ezra Cornell should give to the institution 500,000 dollars, with a few other conditions. This munificient grant was afterwards supplemented by another of 200,000 dollars; and the University was established at the village of Ithaca. It is needless to say that the Act of Inauguration provides that the education shall be given to all comers irrespective of creed, colour, or race; the motto of the founder being, "I would found an institution where any person can find instruction in any study." Besides the original grants, the University has since been enriched by private liberality, with gifts of public buildings, laboratories, libraries, museums, a herbarium, printing-press, &c. A simple, but, as far as it goes, a strict entrance examination in geography, English grammar, and arithmetic and algebra, admits intending pupils as undergraduates, and they can then take their choice of pursuing their studies in either of several departments in which degrees are conferred, in Science, Philosophy, Arts, or in some other special subjects, the full course extending over four years. The special feature of the University, however, is what is called the voluntary labour scheme, by which students are enabled to work out a portion or the whole of the expenses of their education, either by unskilled labour on the farm, or by skilled labour at the printing-press or workshops. The University Register just published states that the scheme has thus far been worked with a degree of success hardly to be expected at so early a stage. We shall look with great interest on the progress of the University.

WE are in a whirl of soirées. Last Saturday the second Royal Society's soirée of the season drew together a brilliant gathering, and we shall next week give an account of the scientific novelties exhibited. On Wednesday the President of the Linnean Society's conversazione came off, and to-morrow Sir R. Murchison, the president of the Geographical Society, receives his friends at Willis's Rooms.

THE question of admitting lady students of medicine to classes in the Edinburgh University on the same footing as other students was discussed at the half-yearly meeting of the University Court on the 19th inst. Professor Masson moved a resolution in favour of so admitting them, and quoted Miss Pechey's case in support of his motion. Mr. Balfour, Professor of Botany, seconded the resolution. Mr. Laycock, Professor of Physic, moved a negative resolution. Professor Christison seconded the amendment, which was carried by 58 votes against 47 in favour of the motion.

A PROPOSITION was some time ago made to telegraphists by Mr. Robert B. Hoover, of Alleghany, Pennsylvania, to present Professor Morse, the "father of the telegraph," with a testimonial upon his eightieth birthday. The response was general, and the nucleus of a fund was immediately raised. It has since been found that this fund will warrant the casting of a bust, or perhaps a full-length figure, of the professor; so the original idea of making Professor Morse a birthday testimonial has been abandoned, and a really national one is to take its place.

THE corner-stone of a new college for Melbourne, which is to be affiliated with the Melbourne University, under the title of Trinity College, was laid on the 10th February, by the Right Rev. the Bishop of Melbourne. The building stands near the south-west corner of the reserve, to the north of the University, and considerable progress in the erection of it has already been made by the builder. Only a small portion of the whole design, namely, the Provost's lodge, &c., has been undertaken, and it is to cost 7,500*l*. The funds in hand amount to 4,000*l*., and the buildings will be carried out as far as the money will allow.

THE schooner yacht *Norna*, Mr. Marshall Hall, owner and master, is fitting out to dredge off the west coast of Spain and Portugal. Mr. W. S. Kent, of the British Museum, and Mr. Edward Fielding accompany the expedition.

EVENING Technical Schools are to be established in the chief towns of Massachusetts. A museum of mechanical inventions and models of machinery are to be formed in connection with each, and there is to be one instructor for every twenty-five pupils.

WE regret to have to announce the death, in his 82nd year, of Mr. Jonathan Couch, of Polperro, Cornwall, a well-known naturalist. His name is especially associated with ichthyology, the standard works of Bewick and Yarrell owing much to his assistance; his own work on the subject being also a very valuable one. Hs was also a frequent contributor on various branches of Natural History to the scientific journals. A correspondent of the *British Medical Journal* states that he was a good linguist, and devoted a considerable time to antiquities. He was a man in whom simple tastes were combined with persistent industry and very accurate powers of observation, and was one of few in whom these qualities were not spoiled by easy circumstances.

THE photographic journals announce the sudden death, in his 72nd year, of a distinguished photographer, M. Niepce de St. Victor, one of the most skilful and indefatigable of experimentalists, and unquestionably the practical originator of photography on glass plates. His name will, however, be associated chiefly with the process of photo-engraving.

THE conversazione of the Society of Arts is fixed to take place at the South Kensington Museum on Wednesday evening, the 4th of May. Cards of invitation have been issued.

IT will be remembered that on the 13th of July last a deputation from the Council and India Committee of the Society of Arts waited on the Duke of Argyll for the purpose of urging the Government of India to take steps for providing a Department of Agriculture for India. The Council have great pleasure in announcing that a Department of Agriculture and Commerce for India has now been established, and that Mr. Rivett Carnac has been appointed the secretary.

AT the last meeting of the Society of Arts, a valuable paper was read by Mr. Alexander J. Ellis on a practical method of meeting the spelling difficulty in school and in life, which was followed by an interesting discussion.

A SERIES of ladies' classes has been arranged at Blackheath, and a large number will attend lectures by the Rev. Stopford Brooke, and Professors Seeley, Miller, and Duncan.

Mr. W. RALSTON will deliver a lecture at St. George's Hall, Langham-place, at 4 p.m. on Wednesday, May 4, on "Russian Folk-lore," which will be illustrated by a number of stories taken from the "Skazki" (or prose tales answering to Dasent's "Tales from the Norse," or Grimm's "Mährchen"), with a few notes on their historical, mythological, and social bearings.

DR. HOOKER'S "Student's Flora of the British Isles" is announced as nearly ready. It will contain fuller descriptions of the orders, genera, and species of British plants than the existing manuals aim at giving, together with the distribution of the species in area and altitude, and their hitherto recognized sub-species and varieties. The method adopted will differ from those of the author's predecessors in many points, and the whole will be contained in a pocket volume suited for the class-room and the field.

A PECULIAR variety of *Chamælio Vulgaris*, found near Bughodeer, on the Grand Trunk Road, was presented by Mr. H. Hexter to the Asiatic Society of Bengal, Calcutta, on January 5. Dr. Stoliczka, the palæontologist of the Indian Survey, said that the specimen was very interesting, and of a kind not often found in India so far north. It was fully 12 inches long, the tail measuring slightly more than half. Dr. Günther remarks in his "Reptiles of India," p. 162, that most of the Indian specimens are of a green colour. The present specimen was a distinct greyish olive, having throughout a slight green tinge, which Mr. Hexter stated appeared to have been more prevalent and variable during the life of the animal; but faded quickly after its death. Each side was marked with eight irregular orange brown cross bands. The head, the greater part of the feet, and part of the tail were bright yellow. The animal is more fully described in the the Society's *Proceedings*, 1870. No. 1.

FROM Thorell's Essays on European Spiders ("Nova Acta regiæ Societatis Scientiarum Upsaliensis," ser. III. vol. vii. fasc. 1, 1869), we extract the following observations, first suggested by M. Westring, a Swedish naturalist, on the best mode of preserving spiders in Natural History collections. The essential feature of the method is that the spider's *abdomen*, and that part only of its body, is *hardened by heat*. The spider is first killed, either by the vapour of ether or by heat, and is impaled by an insect pin, which is passed through the right side of the cephalo-thorax; the abdomen is then cut off close to the cephalo-thorax, and the cut surface dried with blotting-paper. The head of another insect pin is cut off, and the blunt extremity introduced through the incision into the abdomen, up to the spinners. The abdomen thus spitted is inserted into a large test-tube held over the flame of a candle, the preparation being constantly rotated till dry, avoiding the extremes of too much or too little heat—the firmness of the abdomen being tested every now and then with a fine needle, till it is so firm as not to yield to pressure; the front extremity of the pin is now cut off obliquely, and the point thus made inserted into the cephalo-thorax, the two halves of the body being thus again brought into apposition. The animal may then be mounted as usual. This method is stated by Mr. Thorell to preserve the appearance of the animals almost entirely unchanged.

AN attempt is being made to cultivate the Japanese tea-plant in California. 27,000 trees have been imported.

THE third course of Cantor Lectures of the Society of Arts for the present session is being given by Professor A. W. Williamson, The course consists of four lectures, "On Fermentation," on Monday evenings, the 25th of April, and the 2nd, 9th, and 16th of May, at 8 o'clock, and will include an account of important investigations of M. Pasteur. The subjects treated of will be as follows:—Chief varieties of fermentation; chemical processes which take place in the best known processes of fermentation; other chemical processes analogous to them; how these cyclical processes are distinguished from ordinary processes of chemical action; cyclical action analysed; 1. in known cases; 2. in less known cases; theory of "contagiousness" of chemical action; composition of yeast, and changes which it undergoes; assimilation of food by yeast plants during life; decomposition of yeast plants during life; propagation of ferments; prevention of fermentation; germs in air: how removed: how destroyed; processes for arresting fermentation; wine-making and wine-keeping; chemical changes which improve the quality of wine; chemical changes which deteriorate the quality of wine.—These lectures are open to members, each of whom has the privilege of introducing two friends to each lecture.

A TELEGRAPHIC despatch from Marseilles announces the discovery there, by M. Borelly, of a new planet. Its position on the 19th at 10h. 33m., 13s. was—Right ascension, 13h. 2m. 39s. North declination, 6° 50′ 39″.

THE Italian Parliament is engaged in discussing a vast financial plan of the new Ministry, one feature of which is the suppression of a number of the smaller Italian universities. Irrespective of considerations of economy, it is thought that the cause of education will gain by the concentration of the teaching power of the nation in a few towns where a great educational movement exists. A portion of the scheme which meets with less favour is the suppression of the Superior Institute of Florence, an establishment which, the capital having no University, somewhat supplies the place of a national college and musuem, and which numbers among its staff the distinguished names of Donati in Astronomy, Maurice Schiff in Physiology, Ugo Schiff in Chemistry, Targioni-Tozzetti in Zoology, and Parlatore in Botany.

THE South Kensington authorities have printed syllabuses of the courses of lectures already delivered at the Museum, under the title of "Instruction in Science and Art for Women." We have before us "Notes of fifteen lectures on Physics, by Professor Guthrie," and "Notes of ten lectures on Botany, by Professor Oliver." We commend both these programmes to lecturers on natural science, as models of what scientific lectures ought to be—thorough, exact, and yet popularly intelligible.

WE have received a German edition, by Dr. Oppenheim, of Wurtz's History of Chemical Theory, from the time of Lavoisier to our own day.

THE *Paisley and Renfrewshire Standard* prints an unpublished letter of Wilson the ornithologist. It is dated Nashville, Tennessee, May 1st, 1810, and deals more with the manners and customs of the people than with his favourite science of Ornithology.

MR. KEITH JOHNSTON, jun., publishes a map of the Lake Region of Eastern Africa, showing the sources of the Nile, recently discovered by Dr. Livingstone. To it is appended an interesting account of the progress of discovery in the Lake Region, with notes on its physical features, climate, and population.

DR. J. LEON SOUBEIRAN has reprinted from the Annals of the Linnean Society of Maine-et-Loire an article on the herring fishery, which gives an account of the fishery from the earliest times in the different countries of Europe, and of the various modes of curing the fish.

THE *Architect*, for April 9, describes the projected new buildings for Owens College, Manchester. The designs for the first portion being now complete, the works will shortly be commenced on a site about a mile to the south of the centre of Manchester, on the west side of Oxford Road. The style of the building is Gothic, of a collegiate and early type.

C. G. EHRENBERG's "Gedächtnissrede auf Alexander von Humboldt," presented to the Academy of Sciences at Berlin, is a graceful centenary tribute to the memory of the great *savant*.

THE Commissioners for the Annual International Exhibitions of selected works of fine and industrial art and scientific inventions have issued a code of rules for educational works and appliances produced in the United Kingdom, or produced abroad, but submitted to the British judges. We suspect that exhibitors will find it somewhat difficult to determine under which of the denominations named in the commissioners' list they should range themselves; thus we find "philosophical instrument makers," and "optical instrument makers," with separate headings for "microscope makers," "telescope makers," "stereoscope makers," &c. We should hardly have thought that it would have been necessary to make arrangements for the special exhibition of objects under the heads of "coloured saucer makers," "pink saucer makers," "preparers of botanical specimens," "Ward's case makers," &c. Everything intended for exhibition must be sent in by Wednesday, the 8th of February, 1871.

M. CLOEZ has detected in the leaves of *Eucalyptus globulus*, a tree which has been recently largely introduced into France for purposes of ornamentation, a substance extremely analogous to camphor. Ten kilogrammes of fresh leaves give 275 grammes of this new substance, the formula for which is $C_{24}H_{20}O_2$, and its boiling point 175° C.

A MONTHLY journal has been started in Jena devoted to the interest of Sericiculture. We have before us the first number of the *Seiden-bau Zeitung für Nord-deutschland*; bearing the names of Dr. E. Hallier, H. Maurer, and J. Zorn, as Editors.

MADREPORARIA OF THE RED SEA

THE following table is required to complete Prof. Duncan's account in NATURE, No. 24, p. 612, of the Madreporaria dredged up in the *Porcupine* Expedition. The specific names given in the table are those finally adopted by Prof. Duncan :—

Name.	No.	Latitude.	Longitude.	Depth.	Temp.	Remarks.
				fathoms.		
1. Caryophyllia borealis, *Fleming*	2	51° 57 N.	10° 23 W.	30-40	52°·00	Specimens very numerous.
Syn. C. clavus	...	....	....	......	....	The species is found in the coralliferous British seas and Mediterranean. Fossils in Miocene and Pliocene of Sicily. At great depths in Mediterranean (recent).
C. Smithii	88	59 26 N.	8 23 W.	705	42·65	
C. cyathus and many varieties.						
2. Ceratocyathus ornatus, *Seguenza*	88	....	....	705	42.65	One specimen. Not known elsewhere; the genus is, with this exception, extinct. The species is fossil in the Sicilian Miocene.
3. Flabellum laciniatum, *Ed. & H.*	3	51 51 N.	11 50 W.	370	....	Specimens numerous.
Syn. Ulocyathus arcticus, *Sars*	25	56 41 N.	13 39 W.	164	46·5	This is a well-known Norwegian recent form.
4. Lophohelia prolifera, *Pallas*, sp.	5	52 4 N.	12 8 W.	364	48·8	Specimens numerous.
Syn. All the species hitherto published, viz :—						The variability of this species at different depths is so great that all the known species must in consequence be considered varieties of one form. Recent in Norwegian seas, Mediterranean, and off the Shetlands. Fossil in Miocene and Pliocene deposits of Sicily. A variety is found off the American coast. A considerable number of specimens was found in the "cold area" at depths from 500-600 fathoms.
L. anthophyllites, *Ed. & H.*	13	53 42 N.	13 55 W.	208	49·6	
L. subcostata, *Ed. & H.*	14	53 49 N.	13 15 W.	173	49·6	
L. affinis, *Pourtales*	15	54 5 N.	12 7 W.	422	47·0	
L. Defrancei, *Defrance.*	25	56 41 N.	13 39 W.	164	46·5	
L. gracilis, *Seguenza*	54	59 56 N.	6 27 W.	363	31·5	
and several varieties.						
5. Amphihelia profunda, *Pourtales*, sp.	54	59 56 N.	6 27 W.	363	31·5	Many specimens.
6. —— oculata *Linnæus*, sp.	54	....	....	......	....	The necessity for absorbing *Diplohelia* is stated in the following pages.
7. —— miocenica, *Seguenza*	54	....	....	......	....	The species of *Amphihelia* range from the Miocene to the present day; but only *A. oculata* has hitherto been found in recent fauna.
8. —— atlantica, *nobis*	54					
9. —— ornata, *nobis*	54					
10. Allopora oculina, *Ehrenberg*	54	....	....	......	....	A few specimens.
		59 40 N.	7 10 W.	530	47·0	Dredged in *Lightning* Expedition. A recent form.
11. Balanophyllia (Thecopsammia) socialis, *Pourtales*, sp.	54	59 56 N.	6 27 W.	363	31·5	These are West Indian forms, and are included in *Thecopsammia*, a subgenus, by Pourtales.
var costata						
britannica						
Jeffreysia	65	61 10 N.	2 21 W.	345	29.9	
12. Pliobothrus symmetricus, *Pourtales*	...	....	....	500-600	Cold area.	It is a West Indian form.

Total species, 12; species absorbed, 9. Good varieties numerous. Greatest depth from which species were dredged, 705 fathoms. Lowes temperature of sea at bottom whence corals were dredged, 29°·9.

*ON THE CHARACTER AND INFLUENCE OF THE ANGLO-SAXON CONQUEST OF ENGLAND, AS ILLUSTRATED BY ARCHÆOLOGICAL RESEARCH**

THERE are numerous points of general and living interest relating to the Anglo-Saxon conquest of this country which are very largely dependent upon archæological research for their elucidation. Amongst these may be mentioned the question of the extent to which the Romano-British population previously in occupation was extirpated; the question of the relative position, in the scale of civilization, held by victors and vanquished; and the question of the extent of our indebtedness as to language and laws to one or other of the two nationalities. Light is thrown even upon points apparently of the most purely archæological character from such literary sources as histories of the nomenclature of localities; as the records of monasteries; as illustrations in manuscripts; and as laws. But the graves of the Anglo-Saxons and their contents have been for the present investigator the primary; and such literary works as those alluded to, and such as many of those published under the direction of the Master of the Rolls and by the Early English Society, have been only a secondary source of information. They have however, been by no means neglected by him.

It may be well to begin by stating how an Anglo-Saxon is to be distinguished from a Romano British interment. Anglo Saxons, during the period of their heathendom, which may be spoken of roughly as corresponding in England to a period of some 200 or 230 years onwards from their first invasion of the country in force, were interred in the way of cremation, and in urns of the pattern so common in the parts of North Germany and of Denmark whence they are supposed on all hands to have come. A reference to any manual of archæology, or an inspection of any such series as that figured by Mr. Kemble in the *Horæ Ferales* from the Museum in Hanover, will show the unmistakable identity of the pattern, fashion, and moulding of such urns as these, and these which I have had figured after digging them up in Berkshire. The Romans and Romano-Britons had given up the practice of burning the dead long before the time of Hengist and Horsa. When they practised it in England, their urns were of a very different kind, being well burnt and lathe-turned. All the Romano-Britons I have exhumed in the particular cemetery which has furnished me with the tolerably wide basis of something approaching to 200 interments of all kinds, were interred much as we inter our dead now. They were oriented, though by the aid of the sun and not by that of a compass; and, dying in greater numbers in the winter quarters of the years, had the bearings of their graves, as has been observed by the Abbé Cochet, pointing a little south of east. Now a Romano-British interment in this way of burial has to be distinguished from an Anglo-Saxon one in the same way of non-cremation; and this may be done thus. The Romano-Britons never buried arms nor any other implements which could be of use in this, and might be supposed to be of similar use in the next world, together with a corpse. Funeral ware, such as lacrymatories, I have not found in company with coins of the Christian Emperors; but such articles stand in relation to quite a different idea from that which caused the Teuton to inter the dead with spear, shield, and knife; to say nothing of the less common *situla* and sword.

The Anglo-Saxons are supposed by Kemble to have relinquished cremation only when they assumed Christianity; it is a little difficult to be quite sure of this; at any rate, when we find, as we often do, an Anglo-Saxon in a very shallow grave, which may point to any one point of the compass, and in the arms or other insignia which it contains, gives us such clear proof that its tenant thought that whatever he may *not* have brought with him into the world, at all events he could take *something* out, we are tempted to differ even from such authority as Mr. Kemble's. But I am inclined to think that in some cases it is possible to identify the tenant of a properly oriented grave as having been an Anglo-Saxon. In many such graves Anglo-Saxons are to be recognised by virtue of their insignia; and mixed up with their bones may be found the bones of the Romano-Briton who occupied the grave before them. But further, in some such cases it is possible to be nearly sure that we have to deal with an Anglo-Saxon, even though there be no arms or insignia in the grave. These cases are those in which we have evidence from the presence of stones under the skull that no coffin was employed in the burial; and in which stones are set alongside of the grave as if vicariously. In many such cases the craniological character of the occupant of such a grave lends some colour to this supposition. But upon such identifications as had been come to in the absence of arms and insignia I have based no statistics. The results of the statistics of the cemetery which I have explored, as stated above, when brought to bear upon the large questions alluded to at the beginning of the paper, would lead us to think that the Anglo-Saxons were in a considerably lower grade of civilisation than the people they conquered, firstly and most forcibly on account of the shorter lives they led. An old Anglo-Saxon male skeleton was a rarity, an old Romano-British one a very common "find" in my excavations. Nothing however in this life is from the natural history point of view more characteristic of real civilisation or real savagery than this matter of the duration of life. The Merovingian Franks had, like the followers of Cerdic, been observed to have led short lives, merry, as the Capitularies of Charlemagne teach us of their kinsmen, with those kinds of mirth the end of which is heaviness. The next question which suggests itself upon the mastery of these facts and figures is, were not these men merely soldiers encamped? are not these statistics just such as a cemetery similarly explored now-a-days, say at Peshawur or Samarcand, would yield? Not altogether such; for, however improbable it may seem, it is nevertheless true that the Anglo-Saxons, at all events in Berkshire, appear to have brought their own wives with them, and not to have provided themselves with wives from the families of the conquered previous inhabitants. The figures of the crania of females interred with Anglo-Saxon insignia, when compared with figures of the crania of Romano-British women, show a very great difference, to the disadvantage of the former of the two sets of females. The soldiers of Cerdic, who conquered this part of Berkshire about half-a-century or so after the time of the first invasion, resembled the soldiers of Gustavus Adolphus in very little else, but they appear to have resembled them in being accompanied by their wives. Whether this was the case elsewhere in England, I do not know; I am inclined to think that savagery was no great recommendation, nor heathendom either, to a Christianised female population in those days; and that the reluctance which would on these grounds interpose itself to prevent inter-marriage between Romano-Britons and Saxons, sets up as great an *a priori* improbability against the theory which assumes that such inter-marriages did take place, as the difficulty of bringing wives over in the ships in those days sets up in its favour.

Indeed, on the hypothesis of much inter-marriage the actuality of our Anglo-Saxon language is a very great difficulty. We do speak a language which, though containing much Celtic and a good deal of Norman-French, is nevertheless "English." Now we know, from finding cremation urns of the Anglo-Saxon type all over England nearly, that the whole of the country was overrun by a heathen population; to thus overrun it, this population must have been (relatively at least) numerous: add to the two conditions of heathendom and multitude which may be considered as proved, the third condition of isolation which may be considered as matter for dispute; and then the fourth of this heathendom and isolation lasting from the time of Hengist to that of Augustine; and the present fact of our language being what it is is explained.

For proving anything as to the period of which I have been speaking, a period which is rendered Pre-historic, not so much by conditions of time as by conditions of space, the absence of contemporary historians having been entailed by geographical and political isolation, arguments of two kinds, literary arguments and natural history arguments, must be employed. Neither the one kind nor the other is sufficient by itself. The empires of the natural sciences and of literature touch at many isolated points, and here and there they lie alongside of each other along lengthy boundary lines. But empires need not be hostile though they be conterminous; and that the empires of which we have just spoken may be united happily and in a most efficient alliance for work in common, may be seen from the title-page of that most excellent German periodical, the 'Archiv für Anthropologie,' where we have the name of the Physiologist Ecker coupled in editorship with that of the Antiquarian Lindenschmit. The necessity for a combination of the two lines of evidence and argument is as obvious when we have to controvert, as when we have to establish a conclusion. If you have to attack or resist a force comprising both cavalry and infantry, you must have both

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cavalry and infantry of your own; otherwise, some day or other, either in a country intersected with woods, or in some open plain furrowed into deep undulations, one of the two arms in which you are deficient will take you in one or both flanks, and you will be surprised, broken, and routed.

GEORGE ROLLESTON

SOCIETIES AND ACADEMIES

LONDON

Chemical Society, April 21.—Prof. Williamson, F.R.S., president, in the chair. T. Patchett was elected a Fellow. Prof. Roscoe, F.R.S., delivered a lecture on "Vanadium." This metal was discovered in 1830 by Sefström, who also ascertained some of the most peculiar characters of the substance, and prepared some of its compounds in the pure state. Sefström not having leisure to proscecute the full examination of the new metal, handed over his preparations to Berzelius; and it is to the investigations of the great Swede that we owe almost all our acquaintance with the chemistry of vanadium. He found the atomic weight of the metal = 68·5, and wrote its oxides:—VO, VO_2, VO_3, and its chloride VCl_3. Some years afterwards Rammelsberg observed that the mineral vanadinite, a double salt of lead vanadate and lead chloride, is isomorphous, with apatite and with mimetesite, the former containing phosphoric, the latter arsenic acid. This crystallographic analogy would have led to the conclusion that the oxide of vanadium in the vanadinite has the formula V_2O_5, agreeing with the corresponding oxides of phosphorus and arsenic, P_2O_5, and As_2O_5. But the unyielding facts Berzelius had obtained in his analysis, and according to which the oxide in question was represented by the formula VO_3, compelled to regard vanadinite as an exception to the law of isomorphism. Prof. Roscoe, having come into the possession of a plentiful source of vanadium, determined to ascertain whether there really was such an exception, or whether Berzelius's formula may not perhaps be erroneous. He soon found the latter to be the case. He proved that the substance supposed by Berzelius to be vanadium, is not the metal, but an oxide, and that the true atomic weight of the metal is 51·3. Thus the VO_3 of Berzelius becomes V_2O_5, corresponding to P_2O_5 and As_2O_5. The lecturer went on to demonstrate that the characters of the vanadates bear out the analogy of V_2O_5, with P_2O_5 and As_2O_5, and vanadium, hitherto standing in no definite relation to other elements, must therefore be regarded as a member of the well-known Triad class of elementary substances, comprising nitrogen, phosphorus, boron, arsenic, antimony, and bismuth. The above-mentioned source of vanadium is a by-product obtained in the preparation of cobalt from the copper-bearing beds of the lower Keuper sandstone of the Trias at Alderley Edge, in Cheshire.

The President, in proposing a vote of thanks to the lecturer, called attention to the great service Prof. Roscoe had rendered chemical science by his successful investigation of vanadium. The President's remarks were fully endorsed by Profs. Frankland and Odling, and the meeting expressed its appreciation of Prof. Roscoe's lecture by prolonged applause. Prof. Hofmann, from Berlin, who was present at the meeting, favoured the Society with some observations on a compound ($C H_2 N_2$), which he had obtained when treating sulpho-urea with silver oxide. The body is distinguished by its great tendency to polimerise. Dr. Hofmann further communicated that a compound isomeric with chloral (the new anæsthetic) had recently been discovered by two Berlin chemists. It differs from the ordinary chloral by possessing a much higher boiling point.

Geological Society, April 13.—Sir P. de Malpas Grey Egerton, Bart., M.P., F.R.S., vice-president, in the chair. Mr. S. W. North, of Castlegate, York, was elected a Fellow of the Society. The following communications were read:—

1. A letter from Dr. Gerard Krefft, dated Sydney, 29th January, 1869, accompanying a model of the left lower incisor of *Thylacoleo carnifex*, Owen, and the original fragment from which the model was made. Dr. Krefft also referred to the fossil remains of herbivorous marsupials in the museum at Sydney, which included, according to him, besides a great number of Wombats (*Phascolomys*), many wombat-like Kangaroos or Wallabies (*Halmaturus*). He proposed to divide the Kangaroos into the following groups:—

1. *Macropus*, dentition as in *Macropus major.*
2. *Halmaturus*, with the premolar permanent, divided into two sub-groups:—
   a. True Wallabies, with the premolars long, narrow, and compressed, and the rami of the lower jaw but slightly anchylosed.
   b. Wombat-like Wallabies, with the premolars compact, rounded, and molar-like, and the rami of the lower jaw firmly anchylosed.

Illustrative sketches and photographs accompanied this paper. Prof. Owen remarked upon the importance of the researches made by Dr. Krefft and Prof. Thompson. No traces of man had been found. The numerous remains of mammals, especially the herbivorous species, had doubtless been carried into the caves by *Thylacoleo.* Prof. Busk inquired on what evidence Prof. Owen decided that the tooth of *Thylacoleo* was that of a Carnivore. Prof. Owen indicated the remarkable compression of the tooth and the absence of the spatulate form proper to the Kangaroos as characteristic of *Thylacoleo* and indicative of carnivorous habits. Mr. W. Boyd Dawkins stated that *Thylacoleo* was most closely allied to *Plagiaulax*, which was probably a true Herbivore. He indicated the importance of the question, as if *Thylacoleo* were a Carnivore, *Plagiaulax* would be one also. Prof. Owen remarked that *Plagiaulax* was also a Carnivore. The premolars resembled the small tubercular molars of the Hyenas, Felidæ, &c. The anterior tooth, associated with the small tubercular tooth, was compressed and sharp pointed. The low condyle forming part of the angle of the jaw, was such as occurs in *Thylacinus.* Dr. Dnncan remarked that it was by no means necessary that all carnivorous mammals should be formed upon the same type, and that he did not see why there should not be a carnivorous form of the kangaroo type. The chairman said that the settlement of these questions must now be postponed until we obtain further materials. He mentioned the discovery by Dr. Krefft, in the interior of Australia, of a species of fish resembling *Lepidosiren*, and possessing singular affinities to some of the Devonian fishes.

2. "On the Fossil Remains of Mammals found in China." By Prof. Owen, LL.D., F.R.S., F.G.S. The specimens of teeth described by the author were obtained by Robert Swinhoe, Esq., late H. M. Consul at Formosa, chiefly by purchase in the apothecaries' shops at Shanghai. They included two new species of Stegodon (named *S. sinensis* and *S. orientalis*), a new Hyena (*H. sinensis*), a new Tapir (*Tapirus sinensis*), a new Rhinoceros (*R. sinensis*), and a species of Kaup's genus Chalicotherium (*C. sinense*). The author remarked that the whole of these teeth presented an agreement in colour, chemical condition, and matrix, which led to the conclusion that all belonged to the same period. But for the presence of the Chalicotherium, they would have been referred either to the Upper Pliocene or the Post Pliocene period. The author did not consider that the occurrence of the Anoplotherioid species need affect the determination of the age of the fossils, especially as Chalicotherium departs in some respects from the type genus Anopoltherium, and is not known from deposits older than the Miocene. The Chairman called attention to the remarkable association of forms among the fossils described by Prof. Owen. Prof. Busk remarked that the materials at command seemed to him insufficient for the establishment of new species. He observed that the distinctive characters of *Stegodon sinensis* appeared to be very slight, and that the Hyena was probably *H. spelæa.* The tooth of Rhinoceros might be a milk-molar of *R. sumatranus.* Mr. W. Boyd Dawkins suggested that, as the specimens were obtained from apothecaries, there was no evidence of the contemporaneity of the fossils. Mr. H. Woodward stated that Mr. Swinhoe had himself obtained a series of these fossils from a cave many miles inland, he believed on the course of the Yang-tse-kiang. Mr. Woodward also called attention to Mr. Hanbury's paper on Chinese Materia Medica, in which many fossil teeth of mammalia are noticed. Prof. Owen, in reply, stated that great quantities of the fossils had passed through his hands, and that he had selected for description those which, from their minute agreement in chemical and other characters, might justly be inferred to be derived from caves of the same age.

3. "Further discovery of the Fossil Elephants of Malta." By Dr. A. A. Caruana. Communicated by Dr. A. Leith Adams, F.G.S. The author described a new locality in Malta in which the remains of elephants had been found recently—the Is-Shantin fissure at the entrance of Micabbiba. It was filled with a compact deposit of red earth containing fragments of limestone, many teeth and fragments of bones of elephants, associated with bones of large birds. The author found three small

shark's teeth, and a small tooth which he regarded as belonging to a Hippopotamus. He indicated the nature of the teeth and bones of elephants found by him in the newly-discovered fissure. The whole of the five localities in which ossiferous fissures have been discovered are in the same part of the island; and the author concluded with some remarks upon the geological conditions under which the remains of mammalia must have been accumulated, and upon the probability that a connection then existed between Malta and Africa. In a note appended to the paper, Dr. A. Leith Adams stated that the supposed tooth of Hippopotamus was a germ true molar of one of the pigmy elephants, and that the shark's teeth had probably been derived from the Miocene deposits. Prof. Busk remarked that there was no doubt that three species of elephants had lived in Malta. Capt. Spratt said that it appeared to him that the chief interest of the communication lay in the greater comparative abnndance of the larger species of elephant in the new locality.

Royal Geographical Society, April 11.—Sir R. I. Murchison, President, in the Chair. The first paper was on a Pundit's explorations in Western and Central Thibet in 1868, by Major T. G. Montgomerie, R.E. The previous exploration having furnished some information as to the districts between Rudok and the Thok Jalung gold-field, it was decided to send the third Pundit to Rudok, and through Rawung and Tingche, north of the Aling Gangri Peaks. A reported trade route from Thok Jalung to Tengri-noor lake, and thence to Lhasaon, was to be attempted; failing this, the route by Majin and Shellifuk to Tadum Monastery. The result has been to give definite information as to the character of the great elevated plain of Thibet, 15 to 16,000ft. above sea level, extending probably to Sew Choo, nearly to the great wall of China. The Pundit, as one of a party of Bisahiris, went from Spiti to Demchok, on the upper Indus; the river was 270ft. broad, and 5ft. deep in July—velocity of stream $2\frac{3}{10}$ miles per hour; Rudok had not been visited; officers had penetrated to within 12 miles of the Fort, where the Jong-pon or Governor resides. The Pundit determined the position; the Fort is on a hill of 250ft., with 4 monasteries and 150 houses round it. July 22nd.—The party proceeded eastward through Rawung and Tingche to Dak-korkor, a standing camp and annual fair. Large and small salt lakes were passed, and three days' march of a waterless country, the soil of a dazzling white. Five days north he heard of a district called Tung Phaiyu-Pooyu, of the same character, very lofty, named from high snowy-peaks, probably E. Kiun-kuenlun. A large river is said to flow N. and E. to China; the population is numerous, consists of Dokpas under Lhasa: The snow-white plains have been noticed east of Changchenmo Pass; no high peaks were seen to north and east. All accounts and observations confirm the existence of great plains from the Chang Thang of Rudok to China; the Pundit identified "Jiling," with Sining, N. lat. 37, E. long. 102. The party reached Dak-korkor, 20 miles N. of Aling Gangri, during the annual fair. Robbers attacked the camp. The Jong-pon levied a black mail from the traders to avoid pillage, probably sharing the plunder. The Pundit proceeded eastward by the Aling Chu river, which falls into lake Hagongcho. He passed lake Chakchaka, whence Nepal, &c., is supplied with salt. These lakes are nearly connected. A salt field of 20 miles by 10 is nearly on a level with the lakes. The Pundit heard of seven gold-fields besides those visited, Thok Sailung and Thok Jalung, and those of the northern district. South of Thok Jalung the gold bearing rocks were left. The supply in the gold districts is inexhaustible.

From Thok Jalung they passed through Majin—the country drained eastwards, partly undulating and partly level; all about 16,000ft. above the sea. They reached Kinglo on the large river Chu Sangpo, unfordable in summer, flowing east into a large lake Cho Sildu, which receives three large streams but has no exit. Shellifuk Monastery lies south of this lake from Kinglo. They were obliged to turn off the Tengri-noor route, and go south-west to Lake Mansarowae. Crossing the Nagchail and Riego ranges, offshoots of Kailas Peak, numerous borax fields were passed, furnishing a sufficient supply for the potteries of Europe. A tax of 10 annas or 1s. for above 240 lb. only is imposed. Large herds of black wild yaks, wild asses, numbers of Hodgsonian antelope, wild goats and sheep, including Ovis Ammon wolves, reddish hares, marmots, and a kind of fox were observed. The lakes were tenanted by quantities of geese, ducks, and storks; eagles and vultures were seen everywhere. Robbers abounded, but went off at the sight of guns. The Pundit surveyed the Mansarowae Lake; the water was sweet; no exit. He failed to join the Ladak caravan to Lhasa, but proceeded to Shigatse, where he was stopped, and obliged to return. His servant reached the Tadum Monastery, but was sent back. He crossed into Nepal by the Muktinath, pass of only 13,000 feet.

Mr. Shaw described the white plains which he had traversed for 10 or 12 miles as resembling ice covered with snow, one being soda; under it lay crystallised salt. The thieves were encouraged by the authorities, but were so afraid of guns, that a quantity of stolen sheep were voluntarily restored on the approach of European shooting party. Sir Henry Rawlinson considered there were no mountains north of Rudok, but that the plain descended by a gentle slope, affording facilities for a greatroad to be connected with the road from India. He referred to a Persian work, Tarik-i-Ras-chidi, written by a cousin and general of the great Baber, giving full topography of Thibet and Kashmir. Mr. Saunders exhibited a map of Thibet, he believed Central Asia proper was encircled by mountains with an escarpment descending rapidly on the north as well as the south, and argued against the hypothesis of a gentle slope. He pointed out the remarkable depth of the Himalayan gorges. The Pundit's servant who had penetrated behind Mr. Everest, found the base of the peaks to be only on a level of 6,000ft., the gorges 20,000ft. deep. Dr. Campbell stated that a Chinese army had invaded Nepaul by the Muktinath Pass.

The President remarked that our knowledge of the country had till now been derived from the Jesuits and Thibetan survey. The discussion made him realise our ignorance of it.

A second paper was read by Captain I. Gregory on an attempt made to communicate from Assam with Catholic missionaries now residing at Sakka and on the Mekong and Salween rivers. The envoy was turned back. A letter received from the missionaries was read, mentioning that Europeans were casting cannon for the Mahommedan king. They expressed their desire to aid English travellers, and mentioned that last year they had received "a nice young gentleman from Bathang named Cooper." The bishop is at Ta-Tsien. Col. Yule mentioned that 10 years ago a letter from the Vicar Apostolic at Bonga to Bishop Des Mesures at Rangoon first disclosed the presence of Catholic missionaries in Thibet. Information was sent by them concerning the rivers flowing from the plateau of Thibet, between the Bramapootra and the Upper Yang-tze-kiang. The upper waters of these and the Mekong Salween and Irrawaddy, issue from a higher latitude than supposed and can be traced to 35°. The determination of the disputed questions connected with these rivers is proposed as an object of future exploration. A paper on the Upper Irrawaddy is shortly to be read before the Society.

Royal Astronomical Society, April 8.—William Lassell, F.R.S., president, in the chair. The minutes of the last meeting were read and confirmed, and 37 presents announced. A paper by Mr. Plummer on the Orbit of the Comet of 1683 was read. From the observations of Flamsteed, a parabolic orbit was decided by Halley, but recently Clausen of Dorpat has computed an elliptical orbit. The author, at Mr. Hind's suggestion, re-examined the matter, making all possible corrections, and using the latest star places, and finds as the result that the orbit is parabolic, so that the return of the comet in a few years hence is not to be expected.—Mr. Tebbutt, junr., sent some observations from Australia, of the Lunar Eclipse on January 17, 1870. During the totality, the details of the surface of the moon were distinctly seen through the copper-coloured tint pervading the disc, which was given at the edges. A number of telescopic stars became visible in the path of the moon, and several occultations of these during the eclipse were noted. The times of contact were likewise given. Mr. Bird read a paper on "The Floor of Plato." There are now 35 spots known on this space, 8 of them having been discovered since November 1869. The result of 771 observations was given in a tabular form, showing the degree of visibility in the first 6 lunations of a year, in the last 6 lunations, the increase and decrease of visibility, and the amount of the variation. The observations were made with telescopes of 6 to 9 inches aperture, the greater number coming from Mr. Crossby's Reporter of the latter size. The President announced that there was a possibility of the Government providing the means of transit to and from Mediterranean ports, for observers of the eclipse in December next, and he invited the Fellows willing to take part in an organised scheme to send in their names, as nothing could be done until the probable number was known. The Astronomer Royal opened a discussion on the subject by tracing the course of the eclipse from Portugal to the Black

Sea, and stated that the only points which were especially available would be Xeres near Cadiz, or Gibraltar; Oran in Algeria, and a station in Sicily, near Syracuse or Catania. [This subject has already been fully discussed in our columns.] The remainder of the evening was occupied by Mr. Watson, who brought forward his hypothesis, the result of ten years' study of the moon, that both water and air exist on the side invisible to us. His argument was, that from his telescopic views of the moon he was convinced water and volcanoes had left traces of their action; that chemically and geologically air and water were necessary for such action; that the air and water could not get away from the moon, and that as they were not present on the side visible—which he admitted to the fullest extent—they must be existing on the other side—although he could give no other proof in support of his assertion. Mr. Watson's views were severely criticised in a jocular tone by Capt. Noble, and more seriously by Col. Strange, who said that Mr. Watson having wished to extract an opinion whether he was right from the society, could not have it, as that body as such never gave an opinion on any communication, and that if distinguished astronomers did not rise to confute him he must not take silence for consent. Even assuming all that Mr. Watson said to be correct, which Col. Strange by no means admitted, there was even another explanation than that offered, viz., that the water had been absorbed into the interior of the moon. Mr. Watson's remarks were a striking example of the danger of bringing forward opinions formed without a foundation of facts.—After electing seven new Fellows, the long and interesting meeting came to an end.

Anthropological Society of London, April 19.—Dr. Berthold Seemann, V. P., in the chair. Mr. John Colam, 105, Jermyn Street, St. James's; and Mr. David Mitchell Henderson, 1, Carden Place, Aberdeen, and Old Calabar, West Africa, were elected Fellows. Dr. D. Lubach, of Kampen, Holland, was elected a corresponding Member.

A paper, by Mr. Alfred Sanders, was read "On Mr. Darwin's Hypothesis of Pangenesis as applied to the Faculty of Memory." The first question to be asked was—"Is thought a function of the brain?" The author answered it in the affirmative, and cited facts and appearances in physiology, anatomy, pathology, and physics in support of his opinion. Thought could not be considered as a product of the brain-cells any more than light could be produced by the cells of the retina, yet the brain-cells were necessary for the communication between the mind and the external and internal world, and were exhausted in the process of thinking and willing, in the same manner as the cells of the retina were exhausted and required renewal in the process of seeing. Passing to the consideration of the faculty of memory, the author combated the theory of Mr. John Stuart Mill, that the mind is a series of feelings and nothing more, and that memory is an ultimate fact incapable of explanation. The remainder of the paper was devoted to the application of Mr. Darwin's hypothesis of Pangenesis, which the author maintained was capable of explaining the difficulty raised by Mr. Mill; it being granted that the mental faculties depend upon the brain, and that the brain-cells give off self-propagating gemmules indefinitely, everything becomes plain. After describing in detail the action of external impressions on the brain at different times in the life of an individual, some of the many conditions favourable or the reverse to the retention of such impressions, and the dormant and active states of the brain-cells, the author entered into a consideration of the growth of the supposed gemmules, their action at maturity, and their power of self-propagation. Mr. W. B. Kesteven supplemented the paper by a speech of some length in general support of Mr. Darwin's hypothesis, but not of its treatment by Mr. Sanders, and by the exhibition of a series of microscopic anathomical preparations in illustration of his remarks. The discussion was further sustained by Dr. Langdon Down, Rev. Dunbar Heath, Mr. Dendy, Dr. Ellis, M. Robert Des Ruffières, Mr. George St. Clair, the Chairman, and others.

Mr. George C. Thompson contributed a note on "Consanguineous Marriages," urging upon the Society an investigation into the following questions:—1. When the defects commonly attributed to relationship of the parents are exhibited, are the germs of these defects traceable in the parents or their families? 2. When the medical pedigree of the parents is faultless are the children sound and healthy? 3. When any particular excellence occurs in the parents' family, is it transmitted to the children in increased force? Dr. Langdon Down said that after an examination of some five thousand cases of interbreeding he had arrived at the conclusion that the practice was not only not necessarily injurious, but that a methodical and judicious selection in the marriage of close relations would be of enormous value to the community in the improved race of men that would by that means be obtained. Captain Blair cited in support of that view the case of a people on the Ganges, while other speakers adduced conflicting evidence.

London Mathematical Society, April 14.—Prof. H. J. S. Smith, V.P., in the chair. The Chairman made some remarks on a problem in kinematics; Mr. Cotterill communicated some propositions bearing on residuals and former papers of his own read before the society; Mr. Crofton drew attention to a locus in Cartesian ovals; Mr. Jenkins gave a geometrical construction for showing the spherical excess of a triangle; and the chairman mentioned some focal properties of skew surfaces to which he had been led.

Palæontographical Society, April 8.—Annual general meeting; Dr. J. S. Bowerbank, F.R.S., in the chair.—The Council reported that the Society was in a most prosperous condition; that the volume for the present year was in progress, and would be published in the autumn; that new monographs by Mr. Carruthers, on the Fossil Cycades, by Dr. Lycett on the Fossil Tregoniæ, and by Prof. Owen on the Purbeck Mammalia, were in preparation. It was added that Mr. H. Woodward would continue the Monograph on the Trilobites, left unfinished through the death of Mr. Salter, and that Mr. Wood would issue a supplement to the Crag Mollusca. The ballot for the council and officers was taken, and the following gentlemen were elected. President, Dr. S. J. Bowerbank. Vice-Presidents: Prof. Bell, C. Darwin, T. Davidson, and Prof. Owen. Council: Prof. Ansted, Dr. J. J. Bigsby, W. Boyd Dawkins, Prof. Duncan, Sir P. Egerton, Bart., J. W. Flower, R. Hudson, J. W. Ilott, J. Gwyn Jeffreys, H. Lee, Sir C. Lyell, Bart., J. Pickering, J. Prestwich (Pres. Geol. Soc.), Prof. Tennant, C. Tyler, H. Woodward. Treasurer, Searles Wood; Honorary Secretary, Rev. T. Wiltshire.

Edinburgh

Royal Society, April 18.—"On Change of Apparent Colour by Obliquity of Vision." By Robert H. Bow, C.E., Edinburgh. Mr. Bow observed the peculiarity of chromatic vision in the month of January, when experimenting upon the perfection of definition at different parts of the retina. Coloured objects seen obliquely undergo two changes: first, they become less obviously coloured,—this is particularly the case with greens, yellows, and oranges; and secondly, the colour becomes altered in character, most strikingly so in the cases of pinks, purples, and scarlets; pinks and purples become blue, and a brilliant scarlet (such as given by biniodide of mercury fixed with gum arabic) becomes successively orange and yellow, according to the degree of obliquity. The phenomena are most satisfactorily produced when the coloured objects are held on the nasal side of the observing eye. The author speculates on the influence this discovery may have upon the theories of colour sensation, and upon our knowledge of the nature of colour-blindness and the anatomy of the retina.

Paris

Academy of Sciences, April 18.—A memoir by M. Moutard, entitled "Researches upon the Equations with partial derivatives of the second order, with two independent variables," was communicated by M. Bertrand.—M. Boileau presented a memoir on the determination of the latent work in systems, with uniform or uniformly periodical movements.—M. G. A. Hirn communicated a second note on the specific heat of water towards its maximum of density.—A note by M. Croullebois on the variations of the index of refraction of water with temperature, was presented by M. Balard. Upon this subject the author had come to a conclusion directly opposite to those of Arago and M. Jamin, and maintained that the index of refraction attains its maximum at the maximum density of water (4° C=39° 1 F.) and decreases both above and below that temperature. He described the apparatus employed by him.—M. L. Sonrel communicated a note on the Aurora Borealis of the 5th April, of which he described the appearance and the various phenomena accompanying it. The Aurora only became visible in the evening, but it was then decreasing in intensity; it was visible over the greater part of Europe, and everywhere presented the same characters. It was accompanied by a strong and disagreeable odour, which was noticed both in France and Germany. Magnetic perturbations were observed both on the 4th and 5th of April.—M.

Delaunay presented some remarks upon M. Flammarion's note on the law of the rotatory movement of the planets, by M. G. Quesneville. The author maintained that M. Flammarion's numbers were incorrect.—A note on the spectrum-analysis of a solar spot, by M. G. Rayet, was also communicated by M. Delaunay. The author stated that while observing the spectrum of an immense spot in the south-west region of the solar disc, he saw the line C become luminous in the portion answering to the nucleus.—The greater number of the papers presented to the meeting were on chemical subjects. M. Descloiseaux presented a note on the clinorhombic form of the red oxide of mercury.—M. H. Sainte-Claire Deville indicated some experiments which he is now completing, upon the decomposition of aqueous vapour by iron. The phenomena, according to him, resemble in some important points, the mechanical phenomena of vaporisation and condensation; that is to say, they favour hygrometric laws.—M. J. P. Prat presented some experimental researches upon gold and its compounds. The author described the formation of a spongy gold by the addition of bicarbonate of potash to a solution of sesquichloride or gold, adding oxalic acid to the filtrate, and boiling it for two minutes. The spongy gold, heated with a combination of sulphuric and iodic acids, is entirely oxydised; the product dissolves in forming nitric acid. The solution, when diluted and heated, gives a precipitate of protosulphate of gold. The author noticed further the chlorides, iodides, and oxides of gold, two of the latter being new compounds (Au^2 O^2 and $Au\,O^2$). A current of chlorine passed over a heated chloride of gold may produce a volatile chlorine superior to the sesquichloride.—M. H. Debray communicated a note on the assay of silver containing mercury. After noticing and explaining the process of Levol for effecting this assay in the humid way, the author described the method adopted by him, which consisted in heating a small portion of the silver, known to contain mercury, in a small crucible of gas charcoal for about a quarter of an hour, when the mercury is driven off and the silver remains as a button.—M. Balard presented a note by M. E. Reboul, on the hydriodates and hydrochlorates of monobrominated æthylene and propylene.—In a note on black phosphorus, M. Blondlot stated that after many unsuccessful trials by Thenard's method, he had prepared this substance by distilling phosphorus, or heating it to 212° F. under water in contact with mercury. Its colour is due to a multitude of black points, which disappear when the substance is fused and reappear on its cooling. At first the black phosphorus thus prepared, contained a trace of mercury, but after several distillations this disappeared, although the coloration was retained. The black material is more volatile than ordinary phosphorus, of which the author believed it to be an allotropic form.—M. Boussingault communicated a note by M. Musculus, on a dextrine insoluble in cold water, prepared by treating starch with crystallisable acetic acid. The author considered their insolubility of this dextrine to be due to its retaining the organisation of the starch grains. He described its characters and behaviour under various circumstances.—M. L. Henry presented two important memoirs, one on the chloronitric and bromonitric æthers of glycerine; the other, on the direct combination of allylic compounds with chloride of iodine and hypochlorous acid. In the former paper he described the action of nitric acid upon the halogenated æthers of glycerine, and especially the compounds *dichloromononitrine* (C^3H^5), Cl^2 (NO^3), and *monochlorodinitrine* (C^3H^5), Cl $(NO^3)^2$,.—M. A. Béchamp communicated a note on the formation of urea by the action of hypermanganate of potash upon albuminous matters, in which he maintained the correctness of his assertion that this reaction takes place, and described his mode of experimentation and the results of the analysis of his products.—M. P. Guyot communicated the results of his investigations into the toxical properties of some products of the phenic group—azuline and lydine.—M. J. Cloquet presented a note by M. L. Van Backer, containing a list of earthquake shocks and volcanic eruptions recorded as having taken place in the Dutch East Indies since the commencement of the sixteenth century. This list is derived from Junghuhn's "History of volcanoes."—M. H. Baillon made some observations on the crests of ice which have been noticed on the stems of plants, and stated that this phenomenon was a purely physical one, and had nothing to do with the life of the plant.—According to M. Guérin-Méneville, the parasitic insect, called *uji* or *oudji*, which attacks the silkworms in Japan, is a Dipterous fly, like the Chinese one noticed by M. Castellani, and the French fly which has transferred its attentions to the *Cynthia*-silkworm. M. Guérin names the parasite *Tachina oudji*.—M. N. Joly, in a letter to M. Dumas, noticed the occurrence of a distinct rotation of the embryos in the eggs of the axolot.—Dr. Pettigrew, presented some observations on the flight of Insects, with reference to M. Marey's communications on this subject. Dr. Pettigrew claims the priority in determining that the wings of insects in movement describe a figure of 8.—M. Andral, presented a note on the temperature of new-born infants; M. Moyret proposed the employment of perchloride of iron for the purification of the air evacuated from hospitals; and M. Namias forwarded some remarks upon the employment of bromide of potassium as a medicine, in reply to which M. Balard, made some observations, reccommending the use of bromide of sodium. Of the following communications the titles only are given:—A note on cholera by M. Levery; a note on the movement of liquids by M. d'Estoquois; and a note on vapour in a state of saturation, by M. Leloup.

VIENNA

Imperial Academy of Sciences, March 17.—A memoir was communicated by Professor V. Graber "On the resemblance of the structure of the female external sexual organs in the Locustidæ and Acrydii from the point of view of their developmental history." The author stated that in these two families of saltatorial orthopterous insects the external sexual organs of the females are exactly similar in number, form, and position in their original condition when the young animals leave the egg, and that it is only by changes taking place during development that the great differences observable in the mature insects are brought about. These developmental changes were described by the author in detail.

March 24.—Professor J. Stefan presented a preliminary communication "On a new experimental method of analysing the movement of sounding columns of air," by Professors A. Toepler and L. Boltzmann; and also a paper by himself "On the excitation of longitudinal vibrations by transverse ones."—Dr. S. Stern communicated a memoir "On the resonance of air in free space, as a contribution to the theory of sound."—Dr. A. Boué spoke upon the accumulation of erratic blocks in the sedimentary rocks, and in tertiary sandstones or conglomerates. He discussed the various hypotheses which have been put forward to account for these phenomena, which occur in various formations from the older carboniferous sandstones to the most recent beds. For the Eocene and Miocene rocks the author adopted the theory of their having been floated by ice; he also opposed the notions of those geologists who ascribe the excavation of lake-basins to the action of glaciers and assume the existence of glaciers at all geological periods.—A memoir was communicated by Professor Brücke "On the physiological significance of the partial decomposition of fat in the small intestine."

PHILADELPHIA

American Philosophical Society, March 4.—"On the Periods of Certain Meteoric Rings." By Daniel Kirkwood.

I. The Meteors of April 20. In the *Astronomische Nachrichten*, No. 1632, Dr. Weiss called attention to the fact that the orbit of the first comet of 1861 very nearly intersects that of the earth, in longitude 210°; the point passed by the latter at the epoch of the April meteoric shower. A relation between the meteors and the comet, similar to that recently detected between the November meteors and the comet of 1866, was thus suggested as probable. Is this hypothesis in harmony with facts? and if not, are our present data sufficient for determining with any reasonable probability the true period of the April meteors?

Dates of the April Shower.—Prof. Newton selects the following from Quetelet's catalogue as belonging to this period:*

1.	B. C. 687,	4.	A. D.	1093,	'4 '5, and '6
2.	,, 15,	5.	,,	1122,	'3
3.	A. D. 582,	6.	,,	1803,	

Period of the first Comet of 1861.—The elements of this body were computed by Oppolzer, who assigned it a period of 415 y. 4. Now, while it is true that the interval from B. C. 687 to A. D. 1803, is very nearly equal to six periods of 415 years, the slightest examination will show that this period does not harmonise with *any of the intermediate dates*. This fact, then, without further discussion, seems fatal to the hypothesis that the period of the meteors is nearly equal to that of the comet.

* Silliman's Journal for July, 1863.

What is the probable period of the ring?—The showers of 1093-6 and 1122-3 at once suggest a period of from 26 to 30 years. The nodal passage of the densest portion of the ring at the former epoch may be placed anywhere between 1093 and 1096, and that of the latter, in either 1122 or 1123. The entire interval from B. C. 687 to A. D. 1803 is 2490 years, or 88 periods of 28 y. 295 each; and the known dates are all satisfied by the following scheme:—

B.C. 687 to B.C. 15	672.000 yrs.	=24 periods of	28.000 each.
15 to A.D. 582	597.000 ,,	=21 ,,	28.429 ,,
A.D 582 to 1093.714	511.714 ,,	=18 ,,	28.429 ,,
1093.714 to 1122.143	28.429 ,,	= 1 ,,	28.429 ,,
1122.143 to 1803	680.857 ,,	=24 ,,	28.369 ,,

These coincidences indicate a period of about 28⅓* years, corresponding to an ellipse whose major axis is 18.59. Hence the distance of the aphelion is very nearly equal to the mean distance of Uranus. It will also be observed that the time of revolution, which seems to have been somewhat lengthened about the Christian era, was previously one-third of the period of Uranus.

II. The Meteors of December 11-13.

In the catalogue of Quetelet we find the four following extraordinary displays which belong undoubtedly to this period. Observations made in England, 1862, indicate also a more than ordinary number of meteors at the December epoch in that year.

1. A.D. 901. "The whole hemisphere was filled with those meteors called falling stars, the ninth of Dhu'lhajja (288th year of the Hegira) from midnight till morning, to the great surprise of the beholders, in Egypt."—*Modern part of the Universal History*, 8vo. vol. 2, p. 81. Lond. 1780. The date of this phenomenon corresponds to the December epoch, A.D. 901.

2. 930. "Averse remarquable d'ètoiles filantes en Chine."

3. 1571. "On vit à Zurich 'du feu tomber du ciel.'"

4. 1830, 1833, and 1836. The maximum seems to have occurred in 1833, when as many as ten meteors were seen simultaneously. "Dans la nuit du 14 au 12 décembre, on vit, à Parme une grande quantité d'étoiles filantes de différentes grandeurs, qui se dirigeaient presque toutes avec une grande vitesse vers le SSE. A 10 heures et ¼, entre les seules constellations du Bélier et du Taureau, on en compta environ une dizaine."

5. (Doubtful.) 1861, 1862, and 1863. Maximum probably in 1862. The meteors at this return were far from being comparable in numbers with the ancient displays. The shower, however, was distinctly observed. R. P. Grey, Esq., of Manchester, England, says the period for December 10-12 was, in 1862, "exceedingly well defined."†

These dates indicate a period of about 29⅙ years. Thus:—

901 to 930	1	period of 29.000 years.
930 to 1571	22	periods of 29.136 years.
1571 to 1833	9	periods of 29.111 years.
1833 to 1862	1	period of 29.000 years.

III. The Meteors of October 15-21.

The showers of the following years (see Quetelet's Catalogue) belong to this epoch:—

1. 288. "Apparition en Chine."

2. 1436 and 1439. In each year a remarkable apparition was observed in China.

3. 1743. (Quoted from Herrick, in Silliman's Journal for April 1841.) "A clear night, great shooting of stars between 9 and 10 o'clock, all shot from S.W. to N.E. [*Qu.* N.E. to S.W. ?] One like a comet in the meridian very large, and like fire, with a long broad train after it, which lasted several minutes; after that was a train like a row of thick small stars for twenty minutes together, which dipt N."

4. 1798. "Brandès marque, à Goettingue, un grand nombre d'étoiles filantes dans les observations simultanèes qu' il fait avec Benzenberg."

These dates indicate a period of about 27½ years:—

288 to 1439	42 periods of	27.405 years each.
1439 to 1743	11 ,,	27.636 ,,
1743 to 1798	2 ,,	27.500 ,,

If these periods are correct, it is a remarkable coincidence that the aphelion distances of the meteoric rings of April 18th—20th, October 15th—21st, November 14th, and December 11th—13th, as well as those of the comets 1866 I, and 1867 I, are all nearly equal to the mean distance of Uranus.

* Herrick assigned a value of 27 years. See Silliman's Journal for April 1841, p. 365.

† Silliman's Journal for May, 1863, p. 461.

DIARY

THURSDAY, April 28.

Royal Society, at 8.30.—On the organs of Vision in the Common Mole: Dr. R. J. Lee.—On an Aplanatic Searcher applied to Microscopes: Dr. Royston Pigott.—On a cause of error in Electroscopic Experiments: Sir Chas. Wheatstone.

Zoological Society, at 8.30.—Notes on a North-American Batrachian (*Spelerpes rubra*): Mr. St. George Mivart.—Notes on some points in the anatomy of certain Kingfishers: Dr. Cunningham.—On a new gigantic Amphibian, allied to *Lepidosiren* from Queensland:—Mr. G. Krefft.

Royal Institution, at 3.—Electricity: Prof. Tyndall.

FRIDAY, April 29.

Royal Institution, at 8.—Popular Myths: Prof. Blackie.
Zoological Society, at 1.—Anniversary Meeting.

SATURDAY, April 30.

Royal Institution, at 3.—Comets: Prof. Grant.

MONDAY May 2.

Entomological Society, at 7.
Society of Arts, at 8.—Cantor Lecture on Fermentation: Prof. A. W. Williamson.
Royal Asiatic, at 3.
Royal Institution, at 2.—Annual Meeting.

TUESDAY, May 3.

Anthropological Society, at 8.—The Aboriginal Tribes of the Nilgiri Hills: Major Ross-King.—The Armenians of Southern India: Dr. John Shortt.—The Kajahs of Southern India: Dr. John Shortt.
Royal Institution, at 3.—Moral Philosophy:—Prof. Blackie.

THURSDAY, May 5.

Royal Society, at 8.30.
Society of Antiquaries, at 8.30.
Chemical Society, at 8.—Vapour Densities: J. T. Brown.—New Cornish Minerals, No. 7: Prof. Church.
Royal Institution, at 3.—Electricity; Prof. Tyndall.
Linnean Society, at 8.

BOOKS RECEIVED.

English.—On Natural Selection: A. R. Wallace (Macmillan and Co.).—Sketches of Creation, illustrated by Prof. Winchell: (S. Low, Son, and Co.)—The Population of an Old Pear Tree, translated from the French of E. Van Bruyssel (Macmillan and Co.).—Records of the Geological Survey of India. Vol. I., parts 1, 2, 3; vol. II., part 1.—Contributions to Botany: J. Miers; vol. 2 (Williams and Norgate).—Symons's Monthly Meteorological Magazine; vol. for 1869.—Trees and Shrubs for English Plantations: A. Mongredien (Murray).

Foreign (through Williams and Norgate).—Die Schule der Chimie: Dr. J. A. Stöckardt.—Der Elektromagnetische Telegraph: Dr. H. Schellen.—Le Darwinisme et les générations spontanées: D. C. Rossi.—Catalogus Musei Botanici Lugduno-Batavi: Prof. Miguel.—Verzeichniss von 4793 teleskopischen Sternen: Dr. J. V. Lamont—Annalen der königlichen Sternwarte; vol. 17.—Der rationelle Wiesenbau: L. Vincent.—Die fünf Sinne des Menschen: W. Preyer.—Zeitschrift für die gesammten Naturwissenchaften; vols. 33, 34: Drs. Giebert und Siewert.—Handbuch der Mathematik: Physik, Geodäsie und Astronomie: Dr. A. Wolf.—Die Erfindung des Fernrohrs und ihre Folgen für die Astronomie.—De la Reforme de l'enseignement supérieur et des libertés Universitaires: C. Schützenberger.—Mémoires de la société royale des Sciences de Liége; vols. 1, 2.

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Errata.—In No. 24, page 630, second column, line 10: for "Acalephic" read "Acalephæ."—Page 635, column 1, line 5 from bottom, for "Von Martins," read "Von Martius; and column 2, line 4: for "Martins," read "Martius."