THURSDAY, JULY 22, 1886

HAND-BOOK OF PLANT DISSECTION

Hand-Book of Plant Dissection. By J. C. Arthur, M.Sc., Charles R. Barnes, M.A., and John M. Coulter, Ph.D. (New York: Henry Holt and Co., 1886.)

THIS work will take the same place in the botanical teaching of the United States as will be occupied in this country by the "Practical Botany" of Messrs. Bower and Vines, when the latter is completed. Both are essentially guides to the laboratory instruction which now forms the most important part of every efficient course of botany.

The American hand-book differs from its English prototype in two important respects: first, in the fact that it begins with the lowest plants, while the English work begins with the highest; and secondly, in its more rigid adherence to the type system. Prof. Bower did not limit the work entirely to the main types, but frequently introduced other plants, which happened to be more favourable for the study of particular points of structure. The authors of "Plant Dissection," on the other hand, give us the type, and the type only. Their plan has the advantage of simplicity, but several points have to be passed lightly over which could have been studied efficiently in plants other than the selected types. On the whole, the more elastic method of the "Practical Botany" seems to us to be more satisfactory. Any teacher of botany would select Cucurbita for the study of the sieve-tubes, Caltha, or some allied plant, for the embryo-sac, and so on; and yet these are not plants which would be well suited for generally typical examples.

As regards the other point, whether it is better to begin at the upper or lower end of the vegetable kingdom, it may perhaps be said that the former is the course better adapted for beginners, while the latter has its advantages in the case of advanced students. If the learner has no previous knowledge of plants at all, it may be difficult to rouse his interest in such obscure forms as Oscillaria or Cystopus, while the study of some familiar plant, such as the sunflower or shepherd's purse, is much more likely to attract him. On the other hand, if some preliminary knowledge may be assumed, there will be no objection to following the strictly logical course of proceeding from the simpler to the more complex.

The "Hand-Book of Plant Dissection" begins with a short introduction on reagents, section-cutting, &c., and then come the types, occupying the bulk of the work. They are twelve in number, and have been selected as follows:—For the lower Chlorophyceæ, *Protococcus viridis;* for the Cyanophyceæ, *Oscillaria tenuis;* for the Conjugatæ, *Spirogyra quinina;* for the Phycomycetes, *Cystopus candidus;* for the Ascomycetes, *Microsphæra Friessi;* for the Liverworts, *Marchantia polymorpha;* for the Mosses, *Atrichum undulatum;* for the Ferns, *Adiantum pedatum;* for the Gymnosperms, *Pinus sylvestris;* for the Monocotyledons, *Avena sativa* and *Trillium recurvatum;* and lastly, for the Dicotyledons, *Capsella Bursa-pastoris.* It will be seen that while one or two of these plants are strictly American forms, most of the types are cosmopolitan.

It would be easy to criticise the selection in some of the cases: thus, "Protococcus" is not really entitled to the first place on the list, for its cells are more highly organised than those of the Oscillaria. Pythium shows the sexual organs much better than Cystopus, and Microsphæra is perhaps not so characteristic an Ascomycete as might have been found. On the whole, however, the types are good ones.

A few points may be mentioned where there appears to us to be room for serious criticism. It is evident from the remarks on p. 55 that Sachs's old classification of the Thallophytes is adhered to. Surely after the publication of De Bary's papers in the *Botanische Zeitung*, in 1881, and of Goebel's "Grundzüge der Systematik," in 1882, there is no excuse for retaining this manifestly artificial arrangement. Sachs's grouping of the Thallophytes by their sexual organs alone, without any regard to general structure, has been unkindly, but pointedly, compared to the sexual system of Linnæus, which is not usually reckoned as a natural arrangement. How inexpedient the classification in question is for the student is well shown in the work before us on the page referred to, where the reader is advised to study Nemalion or Batrachospermum in order to understand the fruit of Microsphæra. Can any one seriously believe that detailed homologies can be traced between so isolated a group as the red seaweeds and a highly specialised parasitic member of the Ascomycetous Fungi?

Going on to the chapter on the Liverwort, the footnote on p. 75 seems likely to confuse rather than to enlighten the student. The archegonia are *not* called sporogonia after fertilisation by any one who wishes to keep the distinction between the sexual and asexual generations clear in the mind of the learner. The sporogonium arises from the oosphere only; the archegonium, as distinguished from the oosphere, takes no part in its formation.

In the same chapter a statement on p. 82 that "the antheridia are modified hairs" demands notice. This is a bad example of old-fashioned morphology. The antheridia of the Liverworts are modified successors of the antheridia of the lower plants. The ancestors of highly organised plants like Marchantia must have long possessed sexual organs, probably at least as long as they have possessed "trichomes." The same mistake reappears on p. 120 in the description of the fern, when the "trichomes" are said to appear "in the form of sporangia." Either this is merely a roundabout way of stating that the sporangia are of epidermal origin, or else it means that these reproductive organs are actually due to the modification of hairs. The latter view will hardly commend itself to any one who realises that the spores of the fern are homologous with those of the Muscineæ.

A repetition of the same confusion of ideas on p. 125 need not be further noticed.

In the account of the anatomy of the leaf of Pinus there is an error as to a simple matter of fact which ought to be corrected. On p. 154, *d* and *e*, the thin-walled cells of the mesophyll, are said to be empty, while those with bordered pits are described as having "more or less conspicuous contents." This is just the reverse of the truth. The thin-walled cells have protoplasmic contents throughout life, while the tracheides with bordered pits (transfusion tissue) contain, in the mature condition, nothing but water.

On p. 164 the statement that there is finally "free communication" between the contiguous tracheides of the wood of Pinus is erroneous. The pits are closed, at any rate as long as the wood serves its main function of conveying the sap.

At p. 171, in the same chapter, there is a repetition of Hofmeister's old mistake as to the deliquescence of the original cell-walls of the endosperm in the Conifers. Strasburger showed in his "Angiospermen und Gymnospermen," that this idea was due to Hofmeister having confused the disorganised cells of the nucellus with those of the endosperm. The Conifers have one and the same endosperm throughout the development of the ovule: there is no distinction of "primary and secondary" endosperm.

Judging from the footnote on p. 209, there seems to be some confusion between the xylem and the bundle-sheath in Trillium.

It is to be regretted that the student is not shown how to investigate the minute structure of the angiospermous embryo-sac when ready for fertilisation.

In spite of the rather serious faults noticed, the book on the whole is a good and useful one. D. H. S.

MR. MERRIFIELD'S "TREATISE ON NAUTICAL ASTRONOMY"

A Treatise on Nautical Astronomy for the Use of Students. By John Merrifield, LL.D., F.R.A.S. (London: Sampson Low, Marston, Searle, and Rivington, 1886.)

THIS is an excellent work for the student, evidently compiled with considerable care, which may also be consulted with advantage by the seaman. Of course the author does not claim originality, excepting in one particular, viz. a method of his own for "clearing the lunar distance," as, in point of fact, nearly everything the work contains has been published in previous treatises. Mr. Merrifield deserves, however, the credit of placing clearly before the student many points which are only touched on by other writers—notably the account of the correction for refraction, and the explanation of the fact that the maximum altitude is not invariably the meridian altitude, a point which is only touched on by a footnote in Raper, and is usually ignored entirely; yet which is of considerable importance in the case of the moon. The examples, also, which are given at the end of each chapter are of great use to the student, as from them a knowledge is obtained of the subjects he is likely to be examined in; and as these questions have been selected from many examination papers, they are an excellent guide. In the theoretical part of nautical astronomy the book is nearly all that can be desired, and this part can always be learnt better on shore than in a ship, where the constant noise and interruption, together with perpetual motion at sea, renders study all but impracticable: in one or two cases, however, Mr. Merrifield also touches on the practical use of instruments, &c., and on these subjects he is naturally not so good an authority. It may perhaps, therefore, be advisable to point out the usual course of proceedings in Her Majesty's surveying-vessels, both in correcting instruments and also in ascertaining positions at sea.

First, with regard to the sextant, the error of collimation is not readily obtained, as stars only are available, and there are no means of illuminating the wires in the telescope, so that a bright moonlight night is requisite. Secondly, with respect to the errors of centering and graduation, Mr. Merrifield suggests that the combined error should be ascertained by means of measuring the distance between several pairs of stars by the instruments, the correct distances having been previously calculated. But here the varying nature of the refraction prevents good results, and a better method is to measure the distances both by the sextant and by the repeating circle, as in the latter instrument all errors are eliminated.

In the account of the artificial horizon Mr. Merrifield says that "it is used for taking altitudes when the sea horizon is obscured," being apparently under the impression that it can be used on board a vessel. Were such the case, it would often relieve the mind of many an anxious navigator, but, unfortunately, the constant motion of a ship altogether precludes its use at sea; it is true that the late Capt. Becher, R.N., invented a method of observing altitudes at sea, in foggy weather, by attaching a small pendulum, suspended in oil, outside the horizon-glass of a sextant; to this a horizontal arm was fastened which carried at its inner end a slip of metal showing the true horizon when seen in a certain position; but this did not prove a success, and is now almost forgotten; and there is nothing to trust to but the compass and log when the horizon is obscured. The true use of the artificial horizon is to obtain observations on shore, and the sea horizon should never be used then. The best artificial horizon is a trough filled with mercury, covered with a glass roof, but this cannot be used in the extreme cold of the Arctic regions, and consequently there a plate of dark glass is substituted, which is adjusted by spirit levels. The error of the artificial horizon is due to two causes, first the imperfections in the glass roof, which, as Mr. Merrifield remarks, may be guarded against by reversing the roof; and secondly, owing to the attraction of mountain masses causing the mercury to depart from the true level. Could some means be found which would enable the seaman to take observations, in a vessel, independently of the sea horizon, it would be the most useful nautical discovery of the age, but this is not to be effected, as Mr. Merrifield suggests, by mounting the artificial horizon on gimbals, for even if the ship were in herself rigid, the motion at sea would preclude the possibility of obtaining observations, as the position of the observers could not be changed with sufficient rapidity to suit the ever-varying angle of reflection from the horizon, with respect to the observer on the deck; and Mr. Merrifield's own experiences of the difficulties of obtaining observations from the roof of a quiet house must have taught him that it would be much more difficult in a vessel which is constantly vibrating from the motion of the engines or other disturbing causes. The idea of placing a piece of glass on the mercury to still its vibrations, was some years ago promulgated by the late Staff-Commander George, attached to the Geographical Society, who invented a very useful little artificial horizon for the benefit of travellers, in which the floating glass was part of the plan.

In obtaining the position of a ship at sea the difficulty is to get observations both for latitude and longitude at the same time, as all other observations depend on the distance covered by the vessel in the time which has elapsed between the observations. Now, as this distance depends not only on the direction and rate of the vessel through the water, but also on the direction and rate at which the water itself is moving, and as this latter element in the calculations cannot be ascertained with precision, it follows that all observations at sea which depend on the ship's run in the interval have an element of uncertainty. The best time to obtain simultaneous observations for latitude and longitude is at twilight, morning and evening, as then the horizon is clear, and, unless the weather is very cloudy, some stars can be seen. Here Sumner's method is invaluable, as three or more stars can be utilised and the correctness of the result guaranteed, provided, of course, that the chronometer is correct. In the day-time the only chance to obtain simultaneous observations is when the sun and moon are both visible, or when Jupiter, or Venus, happen to pass the meridian at an interval of over 2½ hours from noon, as then, in bright weather, their meridian altitudes can be obtained by a practised observer with a good sextant.

One of the difficulties in obtaining good results at sea is owing to the varying nature of the refraction, more especially close to the horizon. This may be guarded against in the case of the meridian altitude of the sun by observing, when practicable, its altitude with the north and south horizons. To show the closeness of the results ascertained in this manner, it is only necessary to observe that H.M.S. *Triton*, when fixing the position of the Ower and Lemon light-vessel on the east coast of England in 1884, obtained the latitude on four different days, the results being as follows :—

		°	'	"	
June 25	Lat.	53	7	56	N.
July 9	,,	53	8	0	N.
July 11	,,	53	7	54	N.
July 12	,,	53	7	57	N.

an extreme range of 6″, or 600 feet, in the latitude. Such a close accordance shows the value of this method, which is recommended by Raper.

As regards obtaining the longitude by lunar distances, this has been gradually falling into desuetude owing to the quicker passages made by vessels and to the cheapness of chronometers. There can, however, be no doubt of its utility, as it is the only good way of obtaining the position of the ship at sea should any accident happen to the chronometers, and it is to be regretted that it is so seldom practised, particularly when we remember the excellent results obtained by the older navigators, especially by Cook. For the actual observation the repeating circle is a far better instrument than the sextant, as by it the distance between the sun and moon is observed with much greater accuracy, a matter of the utmost importance when we remember that an error of one minute in the distance makes an error of twenty-five miles of longitude under the most favourable circumstances. It is therefore evident that this observation requires to be made with the utmost care and that constant practice is necessary to obtain good results.

In the problem of obtaining the true bearing of a terrestrial object from a ship at sea, Mr. Merrifield has omitted the correction of the angular distance due to the height of the object: this is probably an accidental omission, but although it does not usually amount to much, it is desirable the student should be acquainted with it.

LETTERS TO THE EDITOR

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

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

Laws of Solution

In my paper on "Chemical Affinity and Solution," published in NATURE, vol. xxxiii. p. 615, I gave some general proofs (taken from Thomsen's researches on thermo-chemistry) of the truth of my theory of solution. I shall now show that there are certain well-marked and definite laws of solution which are in complete accord with that theory, and seem to me to place it beyond doubt. In all chlorides, bromides, iodides, sulphates, and nitrates, for which data are available, the heats of solution in water *vary directly*—

(1) As the affinity (measured by heat of combination) of the positive element of the salt for O varies ;

(2) As the affinity (measured by heat of combination) of the negative element or radicle of the salt for H varies ;

And *inversely*—

As the affinity (measured as above) between the positive and negative elements of the salt varies.

The following examples will make this plain :—

Compound	Heat of combination	Difference	Heat of solution of chloride	Difference
[Mg,Cl_2	151010	—	35920	—
[Mg,O,Aq]	148960	2050	—	—
[Ca,Cl_2]	169820	—	17410	+18510
[Ca,O,Aq]	149260	20560	—	—
		−18510	—	+18510
[Ca,Cl_2]	169820	—	17410	—
[Ca,O,Aq]	149260	20560	—	—
[Sr,Cl_2]	184550	—	11140	+6270
[Sr,O,Aq]	157780	26770	—	—
		−6210	—	+6270
[SrCl_2]	184550	—	11140	—
[Sr,O,Aq]	157780	26770	—	—
[Ba,Cl_2]	194740	—	2070	+9070
[Ba,O,Aq]	158760	35980	—	—
		−9210	—	+9070

Similar results are obtained if we substitute the alkali metals for above, but there is a variation in the case of metals which form insoluble oxides or hydrates. In the latter case the heats of solution are not so great as they should be if compared with above compounds. Among themselves, however, they follow the laws pretty closely, and seem arranged in groups. Thus, $ZnCl_2$ and $CdCl_2$, $FeCl_2$, $CoCl_2$, and $NiCl_2$ form two such groups.

The foregoing examples illustrate the effect of the change of the positive element of the salt on the heat of solution. Now let us change the negative element and we shall see the same result.

Compound	Heat of combination	Difference	Heat of solution	Difference
[K,Cl]	105610	—	−4440	—
[H,Cl,Aq]	39315	66295	—	—
[K,Br]	95310	—	−5080	+640
[H,Br,Aq]	28380	66930	—	—
		−635		+640
[K,Br]	95310	—	−5080	—
[H,Br,Aq]	28380	66930	—	—
[K,I]	80130	—	−5110	+30
[H,I,Aq]	13170	66960	—	—
		−30		+30

These relations obtain for the haloid salts of all the metals for which data were available for comparison. The only exception is $AuCl_3$ and $AuBr_3$, the difference of heats of solution of these salts being too great according to the foregoing laws. They are apparently proportional, however.

There is another way of showing these laws and also of showing the conditions which determine the absolute amount of heat of solution, whether positive or negative. If we take the sum of the heats of formation of any salt and of water on the one hand, and on the other, instead of measuring the heat of solution directly, take the sum of the heats of formation of the oxide, of the acid and of neutralisation, we shall find that the heat of solution is the difference of these sums—positive when the latter sum is the greater, and negative when it is the less. This exhibits in a striking manner the relations of the various affinities to solution, and is very suggestive when we consider that the heat of solution regularly increases with the heat of formation of [M,O,Aq], and when the heat of $[MO] > [M,Cl_2]$, decomposition of water takes place. Consider the following examples :—

Compound	Heat of combination	Compound	Heat of combination
[Mg,OAq]	148960	$[Mg,Cl_2]$	151010
[2H,Cl,Aq]	78630	$[H_2O]$	68360
Neutr.	27690		
	255280		219370
	219370		
Difference	35910 = Heat of solution.		

Compound	Heat of combination	Compound	Heat of combination
[Sr,O,Aq]	157780	$[Sr,S,O_4]$	330900
$[H_2,S,O_4,Aq]$	210770	$[H_2,O]$	68360
Neutr.	30710		
	399260		399260
	399260		
Difference	0 = Heat of solution. Salt insoluble.		

Compound	Heat of combination	Compound	Heat of combination
$[K_2,O,Aq]$	164560	$[K_2,N_2O_6]$	242970
$[H_2,N_2,O_6,Aq]$	102190	$[H_2,O]$	68360
Neutr.	27540		
	294290		311330
	311330		
Difference	− 17040 = Heat of solution.		

The above illustrate the cases of positive, negative, and zero heats of solution. These relations obtain with all salts, whether the oxide is soluble or not. The only discrepancy I found was in the case of silver chloride, which showed a slight negative heat of solution ; but as its affinity for O is excessively small, it is not surprising it should be an abnormal case.

These laws of solution explain and are illustrated by many cases of constant differences in the heats of formation of similar compounds in water. Thus it has been pointed out in Muir and Wilson's "Thermo-Chemistry" that between the heats of formation of soluble chlorides, bromides, and iodides in water, there is a constant difference, no matter what the positive element is. For example, consider the following cases :—

Compound	Heat of formation	Compound	Heat of formation
[H,Cl,Aq]	39315	[H,Cl,Aq]	39315
[H,Br,Aq]	28380	[H,I,Aq]	13170
Difference	10935	Difference	26245
[K],Cl,Aq]	101170	[K,Cl,Aq]	101170
[K,Br,Aq]	90230	[K,I,Aq]	75040
Difference	10940	Difference	26130

Now the reason of this is perfectly obvious in the light of the laws of solution. Any variation from the above differences in the heat of formation of the undissolved salt is at once counterbalanced by the heat of solution, which varies inversely. Thus :—

Compound	Heat of formation	Heat of solution	Total
[H,Cl]	22000	17315	39315
[H,Br]	8440	19940	28380
Difference	13560	− 2625	10935
[Na,Cl]	97690	− 1180	96510
[Na,Br]	85770	− 190	85580
Difference	11920	− 990	10930

and so on in other cases. WM. DURHAM

Ice on the Moon's Surface

IN May 1884 Mr. Peal, of Sibsagar, in Assam, who has studied the moon's surface with great attention, sent me a paper in which he maintained views closely resembling those of Capt. Ericsson (NATURE, p. 248) on the glacial origin of the lunar craters. In my answer I suggested that it was difficult to admit the existence of ice on the moon's surface, without a layer of water vapour over it, and that the telescope proves that if such vapour exists it is only in extraordinarily small quantities. It seems due to Mr. Peal, who was undoubtedly ignorant of Capt. Ericsson's paper of 1869, to draw attention to the correspondence. I am not sure whether the paper has been yet published.

Cambridge, July 17 G. H. DARWIN

Luminous Clouds

I AM not sure of the date, but believe it was in June 1885 that I called attention in your journal to a strange effect of bright silvery lighted clouds, which remained visible in the north-west sky after sunset until nearly 11 p.m. Several times this summer I have noted repetitions of these same curiously lighted cloud-forms, but have never seen such a wonderful display of this "after-sheen" as that of this evening, July 12.

The day from 11 a.m. until 6 p.m. had been wet, followed by a clear-up toward sundown, with a warm orange-coloured sunset near the horizon ; above this, and extending nearly to the zenith, lay masses of brilliant and, one would almost say, self-illuminated cloud-ripples looking like an inverted sea of frosted silver or mother-of-pearl.

There was a strongly-marked focus in the light above the place of the sun, but it extended far beyond that both north and west. The vapour forming these cloud-waves, and which received this intense white light, must, I think, have been at a great elevation, for though all the lower vapour near the horizon retained its usual orange glow long after sunset, there was never any indication of colour upon these clouds from the beginning of the effect, about 7.30 p.m., until it disappeared soon after 10 p.m. The moon, which was in the southern part of the sky, looked quite warm in colour when contrasted with the almost bluish-white glare upon this vapour. ROBT. C. LESLIE

Moira Place, Southampton, July 12

THE luminous night clouds seen here on the 22nd ult. (NATURE, July 1, p. 192) have recurred, with a very remarkable development on the night of the 8th inst.

The sketches illustrate phases one hour apart from midnight to 2 a.m. ; the last made solely by "cloud-light" in a window with northern aspect ! The long luminous belt began to form at 11.30 p.m., fading out at 2.30 a.m. It extended obliquely from N. 10° W. to N. 30° E. in the wind's direction, which was light from N.W. Temperature subsequently fell.

Last night (9th inst.) the upper northern sky was obscured with cumulous cloud, but in a clear space above the horizon, from N. to N.E., a belt of cloud resembling that of the previous night extended obliquely. In this case the belt was dark; but beneath, and apparently descending from it, bright luminous patches formed of a golden lustre at midnight, and faded out at 1.30 a.m. Wind again from N.W., light. Temperature cool for season.

Examined with a good field-glass, these cloudlets present the usual cirrous type in all but singular luminosity, and little (if any) of the aurora. D. J. ROWAN

Dundrum, co. Dublin, July 10

Animal Intelligence

A REMARKABLE instance of animal intelligence has lately come under my notice, which I venture to relate as being possibly of interest to the readers of NATURE. In a neighbour's bungalow in this district two of our common house-swallows (*Hirundo javanica*) built their nest, selecting as their site for the purpose the top of a hanging lamp that hangs in the dining-room. As the lamp is either raised or depressed by chains fixed to a central counter-weight, these chains pass over pulleys fixed to a metal disk above, on which the nest was placed. The swallows evidently saw that, if the pulleys were covered with mud, moving the lamp either up or down would destroy the nest; so to avoid this natural result they built over each pulley a little dome, allowing sufficient space, both for wheel and chain to pass in the hollow so constructed, without danger to the nest, which was not only fully constructed, but the young birds were reared without further danger. This is, in my opinion, a wonderful example of adaptation to environment, and showing a step far beyond what may be contended as instinct only.

I may here add another curious case which seems to point to another branch of reasoning. During the dry weather I have been constantly annoyed by wasps building up with mud key-holes, sometimes keys, blank cartridge cases, and even in one case a *pen-holder*. As I did not care to have my gun charged with young wasps, I used to empty out any cartridge case which I found closed up with mud, but one cartridge-case in particular I noticed had been selected. This one I had left on my office table, and each time the wasp closed it up I drew the charge of mud and "grubs," &c.; but as frequently the wasp closed it up again. I may here mention that the wasp used to deposit the egg, and several small grubs in a cell, close over the top, and repeat the operation again till the cartridge was full, when the mouth would be pasted over with a lid of mud. As I repeatedly knocked out the grub and mud, it appears the wasp started a fresh plan. I noticed somewhat to my surprise that the mouth of a cartridge I had but a few hours before emptied was pasted over, so I thought it would be interesting to see how many grubs the wasp had secured in so short a time. I therefore removed the fresh lid, that was still damp, and discovered nothing inside! I am unable to say if this was done to direct my attention to one particular cartridge case or not, while another spot was being used, but I am inclined to believe such to have been the case, for later I noticed a gap made between two bundles of letters in one of my pigeon-holes, well built up with mud, and, of course, as well packed with grubs.

Ballangoda, Ceylon, June 14 FREDERICK LEWIS

Deafness and Signs

IN my studies with regard to the sign-languages I have, like others, turned some attention to cases of deafness. In such cases the use of signs, not the finger alphabet, but natural or conventional signs, such as are used by Indians or by deaf-mutes of themselves, have appeared to me to give particular satisfaction to the sufferer. The nervousness attendant upon attempting to make out what is said being avoided, the relief is very great, and more attention is given to what is spoken. Of course such aid to those untrained is but partial, and English people accustomed solely to the use of speech are rather unapt, but nevertheless signs are valuable auxiliaries, and will be found worth trying. Individuals vary in their capability, but inasmuch as many children pass through a period of sign-language, there will be many cases of adaptability. Whoever has watched deaf-mutes conversing, without the finger alphabet or without lip-reading, will recognise the satisfaction they receive from their intercourse by signs. My only object is to call attention to what has been found by experience to be an acceptable help, and which may be extended in its application.

HYDE CLARKE

The Duration of Germ-Life in Water

A RECENT announcement by Messrs. Crookes, Odling, and Tidy, that *Bacillus anthracis* in water approximately devoid of nutrient material after "a few hours" loses its power to multiply in suitable culture-media, induces me to send you a note of my own results in the same domain.

My observations were commenced in 1877, but were shortly afterwards suspended and not resumed in earnest until May 1885.

So far I have worked only with the various forms of organisms which chanced to be present in the water—usually distilled—employed. For a *preliminary* investigation I regard this as preferable to operating on pure cultures; one is more likely to be concerned with organisms of aqueous habitat naturally, and one sees which kinds predominate from time to time, and which survive.

In dealing with an indefinite variety of micro organisms it is necessary, of course, to be extremely rigid in one's precautions to guard against intrusion of foreign germs, an intrusion which cannot be detected as in the case of pure cultures. On this account I abandoned my original *modus operandi*—it was almost identical with that of Mr. Crookes and his colleagues—and adopted the arrangement of tubes described and figured in a paper by Mr. Blunt and myself in *Proc. Roy. Soc.*, vol. xxviii. p. 202.

Of a series of such tubes containing distilled water, originally rich in germ-life, kept at a temperature varying from 18° C. to 21° C., and examined at intervals from May 2, 1885, down to now, I find that in every one micro-organisms have sooner or later developed on the addition of the nutrient material.

Each tube is a microcosm, and it has been most interesting to observe how, as elsewhere, as time went on, the first dominant form has grown more and more feeble, until it seems to have become extinct, and is now succeeded by races of quite different kind. Whether the new order will yet give place to others remains to be seen. I can at any rate say confidently that micro-organisms vary greatly in the duration of their life in distilled water, and that some forms may survive for at least fourteen months in that medium at an ordinary temperature.

Chelmsford, July 19 ARTHUR DOWNES

The Bagshot Beds

IN reply to the letter from Mr. Irving in NATURE of July 8 (p. 217), I beg to state that a mere abstract of the paper on the Bagshot Beds by Mr. Herries and myself was read at the meeting of the Geological Society on June 9, on which occasion Mr. Irving was not present; that the report of our remarks in NATURE of July 1 (p. 210) only purports to give the conclusions at which we arrive, and not the evidence by which they are supported. We trust therefore that your readers will reserve their judgment until the entire paper is published.

HORACE W. MONCKTON

1, Hare Court, Temple, July 17

A Lubricant for Brass Work

MANY besides myself have probably been inconvenienced by the corrosive action of ordinary lubricants—lard, grease, &c.—upon brass and copper, which causes the plugs of stop-cocks to leak or get fixed in their places, and does much damage to air-pump plates.

Melted india-rubber answers fairly, but it has too little "body," and too much glutinosity; moreover, it does, undoubtedly, in course of time, harden into a brittle, resinous substance. Vaseline is quite without action on brass, and never hardens; but it has not sufficient tenacity and adhesiveness.

A mixture of two parts by weight of vaseline (the common thick brown kind) and one part of melted india-rubber seems to combine the good qualities of both without the drawbacks of either.

The india-rubber should, of course, be pure (not vulcanised), and should be cut up into shreds and melted at the lowest possible temperature in an iron cup, being constantly pressed down against the hot surface and stirred until a uniform glutinous mass is obtained. Then the proper weight of vaseline should be added, and the whole thoroughly stirred together.

This may be left on an air-pump plate for at any rate a couple of years without perceptible alteration either in itself or the brass. H. G. MADAN

Eton College

Butterflies' Wings

CAN you inform me of any method of relaxing the wings of butterflies allowed to stiffen in the closed state?

Stretford, Manchester, July 1 J. M. B.

[If the butterflies are laid on damp sand under cover of a bell-glass or other air-tight covering they will soon relax so as to be fit for setting-out. A drop or two of carbolic acid on a sponge should be placed with them in order to prevent mouldiness. —ED.]

NOTE ON THE ABSORPTION SPECTRUM OF DIDYMIUM

IN a paper on "Radiant Matter Spectroscopy" (Part 2, Samarium),[1] I said that in fractionation of the didymium earths with ammonia—"After a time a balance seemed to be established between the affinities at work, when the earths would appear in the same proportion in the precipitate and in the solution. At this stage they were thrown down by ammonia, and the precipitated earths set aside to be worked up by the fusion of their anhydrous nitrates so as to alter the ratio between them, when fractionation by ammonia could be again employed."

That in most methods of fractionation a rough sort of balance of affinities beyond which further separation by the same method is difficult, appears to be a general rule. I have long noticed this action when fractionating with ammonia, with oxalic and nitric acids, and with formic acid. The valuable point which renders this fact noteworthy is that the balance of affinities revealed by fractionation is not the same with each method. It was in consequence of the experience gained in these different methods of fractionation that I wrote in my paper read before the Royal Society, June 10 last (*Chemical News*, vol. liv. p. 13), after saying that I had not been able to separate didymium into Dr. Auer's two earths, "probably didymium will be found to split up in more than one direction according to the method adopted."

In illustration of this I may mention that, although I have not split up didymium into the two earths, or groups of earths, which are described by Dr. Auer, other processes of fractionation give me, so to speak, other cleavage planes or lines of scission through the compound molecule didymium.

According to Dr. Auer, a line in the well-known yellow band, close to the soda line, but less refrangible (w.l. about 579), is a component of the absorption-spectrum of neodymium, and therefore, under all conditions, its intensity should follow the same variations as the other bands of neodymium in the blue (wave-lengths 482, 469, 444). Some of my didymium fractions, however, show that the line 579 does not follow the same law as the other bands I have named. Thus, in a rather low fraction (+6) of the didymium earths from gadolinite and samarskite I found that the neodymium line 579 was of the same degree of blackness as the adjacent praseodymium line in the yellow (wave-length about 571), but the bands in the blue of neodymium had almost disappeared. In the adjacent fractions of didymium I was enabled, by appropriate dilution, to keep this set of bands in the yellow as a standard, of exactly the same intensity; it was now seen that in successive fractions the intensities of the other more refrangible lines belonging both to neodymium and praseodymium varied greatly from strong to almost obliteration, the bands in the yellow always being kept of the same intensity.

Didymium prepared from a specimen of fluocerite differed somewhat from the other didymiums. Here the band 579 (ascribed to neodymium) was very strong, the band in the yellow of praseodymium (571) slightly weaker, and the bands in the blue of neodymium (482, 469, and 444) easily visible. On diluting the solution the bands in the blue of neodymium and the one component of praseodymium in the yellow (571) appeared to follow the same law in becoming fainter and fainter with dilution, whilst the other component band in the yellow of neodymium (579) remained unaffected.

It seems to me that a possible explanation of this variation might be founded on the great strength of the bands in the yellow, and that the two fractions of didymium then under examination might differ only in the fact that one was slightly stronger than the other. To test this hypothesis I took the two fractions first experimented on, and putting each into a wedge-shaped cell of glass viewed them together in the spectroscope. (1) I adjusted the wedges so that the group in the yellow appeared to be of the same intensity in each spectrum. On examining other parts of the spectrum it was seen that in one solution the bands in the green were tolerably strong, and the bands in the blue scarcely visible, whilst in the other solution the bands in the green were very faint, and those in the blue quite absent. (2) The position of the wedges was adjusted so that the bands in the green in each case should be of equal intensities. It was now seen that the alteration had greatly upset the balance of the bands in the yellow, the solution in which the bands in the green were faintest before, now having much stronger yellow bands than the other. The explanation mentioned above therefore falls through, and I see no other way of accounting for the facts except in the supposition that by the mode of fractionation then adopted, didymium had split up in a different manner to what it would have done if the method of Dr. Auer had been followed.

The colour of the different fractions of didymium nitrate varies from a dark rose-red at the more basic end (+17) to amber at the less basic end (+4). These variations in colour do not necessarily accompany a difference in the absorption-bands, for in one instance an amber and a rose-coloured salt were found to have almost identical spectra.

It would almost appear from these experiments, coupled with the facts I brought forward in last week's *Chemical News* (p. 14), that the "one band, one element" theory I lately advanced in connection with the phosphorescent spectrum of yttrium, may probably hold good in the case of the group of elements forming absorption spectra. According to this hypothesis, therefore, neodymium and praseodymium must not be considered as actual chemical elements, but only the names given to two groups of molecules into which the complex molecule didymium splits up by one particular method of fractionation.

WILLIAM CROOKES

[1] *Phil. Trans.*, Part 2, 1885, p. 706. A reprint of this paper is also commenced in No. 1390 of the *Chemical News*, p. 28.

HEATING AND COOKING BY GAS

A FEW years ago the public was led to believe that the use of coal-gas for lighting purposes was on its trial, and must shortly give way to the electric light. Threatened institutions live long, and even if coal-gas is destined to be eventually superseded by electricity for lighting purposes, a useful future is now opening out for it as a fuel offering many advantages over coal for domestic heating and cooking. In these fields it may possibly occur in the future that coal-gas—unless the price is everywhere considerably reduced—will have to encounter rivals such as the petroleum oils on the score of their cheapness, but at present, coal-gas, for cooking and heating purposes, offers many facilities and advantages over any other kind of fuel.

Gas Cooking Stoves.—Those who remember the gas cooking stoves which were offered to the public even a few years ago, will acknowledge that the modern stoves now manufactured have reached a very high degree of perfection. In nearly all the larger kinds of stove intended for a family of six or more persons, the sides and top of the oven are constructed of double walls, and packed with a non-conducting fire-proof material—generally slag wool—so that but little heat escapes from the exterior of the stove to be lost by radiation; the internal surfaces of the stoves are usually enamelled, and are thus preserved from rust and decay, and easily kept clean, and in addition in some ovens, the racks for suspending the grids from which the meat is hung, slide out or turn out on a hinge, and are thus more easily cleaned than when fixed in the oven. On the tops of the stoves are placed burners for boiling kettles and saucepans, and for stewing, and an invertible burner is sometimes added, which can be rotated so as to bring the flame underneath when it is intended to grill. The following points may be enumerated as those in which cooking by gas possesses decided advantages over the ordinary kitchen range:—(1) There are no dust or cinders, and the whole process is more cleanly; (2) in some of the best stoves the oven can be heated up to a high temperature—sufficient for making pastry—in a few minutes only after the gas is lighted; (3) the different degrees of heat necessary for cooking various articles can be easily attained by limiting or increasing the supply of gas to the oven burners, or by increasing or diminishing the ventilation of the oven by opening or closing the flue-valve; and this is a point which good cooks will especially appreciate.

The principal arguments adduced by the opponents of gas cooking may be stated to be:—(1) That the cost is greater; (2) that joints of meat baked in gas ovens smell or taste of gas; (3) that the fumes and smell of cooking are more perceptible from gas ovens than from ordinary kitchen ranges; (4) that there is no supply of hot water with a gas oven; (5) that the gas stove does not warm the kitchen. We will now proceed to consider these objections *seriatim*.

(1) Although there can be no doubt that more heat is obtained from coal by burning the same value than from gas, still if attention is paid to the stove, and the gas is turned off as soon as the cooking is finished, for ordinary sized households the difference in cost between cooking by gas and cooking by coal is hardly appreciable.

(2) We may class gas ovens as of two kinds, A and B. In A, rings or rows of burners are placed at the bottom of the oven, and the air of the oven is heated up, this heated air and the products of combustion of the gas passing over and baking the meat. The burners used are usually those which give a luminous flame, for the reason that the luminous flame, although not itself of so high a temperature as the non-luminous flame from the atmospheric burner, yet radiates more heat. This greater radiation of heat is, like the luminosity, due to the separation of solid particles of carbon in the flame which become incandescent. Thus we see that the luminous flame radiates more heat to the air of the oven than the non-luminous. But it is in this class of oven especially that the baked meat smells or tastes of gas, as it is liable to become sodden with the steam and other products of combustion of the gas jets which pass over it, and no amount of ventilation of the oven will entirely cure this defect. In the other class of ovens, B, the burners are placed in rows at the bottom and along the sides of the oven walls. The oven walls are heated by the flames, and when hot radiate the heat to the joint of meat, which is thus baked by radiant heat as well as by hot air. The products of combustion of the gas jets pass up the sides of the oven and escape by the flue at the back without contaminating the meat. Atmospheric burners are almost invariably used in this class of oven, because the non-luminous flame is hotter than the luminous, and more quickly heats the oven wall, although less heat is radiated from the flame itself. The atmospheric burners have also this advantage, that the gas being mixed with twice its volume of air, the hydrogen and carbon are burnt at the same time, and no solid particles of carbon are formed, and thus there can be no soot from imperfect combustion, as so often happens in the luminous flame, in which the hydrogen of the hydrocarbons burns before the carbon, which is separated into small solid particles and strongly heated up before being finally burnt to carbonic acid. Consequently meat baked in this class of oven is not distinguishable from a joint roasted before an open fire.

(3) If a flue is carried up from the top of the back part of the oven into the kitchen chimney, the fumes from the oven cannot enter the general air of the kitchen. In all gas apparatus of whatever sort, some means must be provided for carrying off the products of combustion of the gas, and this is especially necessary in the case of gas cooking stoves. Ventilation of the oven is obtained by air passing in from below to ascend and escape with the products of combustion by the flue. The valve guarding the flue outlet is capable of regulating the ventilation, and is usually so constructed that it cannot entirely close the flue.

(4) The larger gas cooking stoves are now very usually supplied with boilers, which can be attached to the side of the stove, and can be heated below by a ring of atmospheric burners. [The burners at the top of the stove for boiling kettles and saucepans, making toast, grilling, and stewing, should also be atmospheric.] There can be no doubt that for heating a large supply of water, gas is not economical as compared with coal, but these boilers have this great advantage that they can be easily inspected and cleaned, and the fur—caused by the deposit of lime salts where the water to be heated is hard—can be easily removed. In towns and districts which are supplied with hard water (containing much carbonate of lime in solution), the ordinary kitchen boiler must be opened occasionally to remove the fur—a proceeding causing much inconvenience. If the fur deposit is allowed to accumulate too long an explosion may take place. This may happen in one of two ways; either the mouth of the supply pipe may become choked, cutting off the water from the boiler, or the boiler plates having become much heated, whilst the water in the boiler is cool owing to the intervention of a thick non-conducting layer of fur, if this deposit should crack, the cold water coming suddedly into contact with the red hot iron would cause a dangerous evolution of steam. The boilers sent out with gas cooking stoves can supply hot water for the kitchen only; they are not made to give a hot water supply under pressure available at any part of the house, as is the ordinary kitchen high-pressure boiler, so that for upstairs bath and lavatory purposes, hot water must be obtained from some form of gas bath-heater, of which we will speak presently.

(5) The gas stoves now made—being well packed and losing but little heat by radiation—certainly do not warm the general air of the kitchen as the kitchen fire does, and this negative quality in summer is a great advantage, as the kitchen remains cool instead of being at the usual unbearable temperature. In winter. if the kitchen fire is retained, this should be lighted early in the day until the room is warm, or some form of gas fire may be used—or it is even possible now to obtain a gas stove combining an open gas fire below, in front of which a small joint may be roasted, with a small gas oven above. The open gas fire will sufficiently warm a small kitchen.

The consumption of gas in a stove of the size required for a family of nine or ten persons varies from 15 to 20 cubic feet per hour (at an average pressure of 8/10) if the oven burners alone are lighted and turned full on. In most cooking operations the amount of gas required would be only two-thirds of these quantities; the supply of gas being easily regulated to this or any other amount. If all the top burners in addition be lighted and turned full on, the average run of gas is from 40 to 60 cubic feet per hour. Twenty feet an hour for six hours a day is a fair representation of the amount of cooking required in a middle class family of ten persons. At 3*s.* per 1,000 cubic feet, this would entail an expenditure of 4·32*d.* per day, or 2*s.* 6¼*d.* per week, or 1*l.* 12*s.* 9¼*d.* per quarter. To raise a gallon of water in a copper boiler from 50° F. to 170° F., requires on the average a consumption of about 3 feet of gas, so that if very much hot water is required for culinary or domestic purposes the gas bill may be expected to show a corresponding increase.

Cooking by gas will not be introduced all at once. Gas stoves are now very generally obtained to supplement the kitchen range, for which purpose they are excellently adapted; and as their possibilities and advantages are more clearly appreciated they will no doubt come into more general use. We have indicated some of the chief points in their construction and management, and while we do not advise any one utterly to discard coal fires for cooking, we would recommend a trial of gas as being likely, where it can be obtained of good quality at moderate prices, and where the stoves will be treated with care and attention, to be found economical, cleanly, and useful.

Water and Bath-heaters.—In a house where gas is entirely used for heating and cooking, or where there is no high-pressure kitchen boiler connected with a hot water cistern by circulating pipes, capable of giving a supply of hot water on the upper floors, one of these appliances will be found very useful. There are numerous forms of this apparatus, and most of them are contrived in a very ingenious manner. The plan usually adopted is to receive the cold water at the top of the apparatus—which is of copper or copper tin-lined—where it is spread out in the form of spray or thin films to pass slowly down over surfaces of copper, receiving in its passage the necessary heat from gas burners below, to the bottom of the apparatus, where it flows out by a spout. The temperature of the issuing water will vary with the quantity of gas consumed and with the flow of the water, *i.e.* the amount passing through the apparatus in a given time. The object generally aimed at is to obtain a bath of 30 gallons of water at 100° F. in twenty minutes or thereabouts. For this purpose the water must be heated to about 105°, as when in the bath it gradually cools whilst this is filling. In the best forms of bath-heater, 25 to 30 cubic feet of gas must be consumed—at ordinary pressures, 7/10 to 10/10—to raise 30 gallons of water from 50° to 100° in 15 or 20 minutes. Here then we have an apparatus which at the cost of little more than 1*d.* is capable of providing ample material for a good warm bath. We would unhesitatingly recommend these bath-heaters, were it not the custom of most of the makers—with one or two exceptions however—to send them out without any flues or chimneys, and even sometimes to assert that no flue is necessary, as there is no smoke, and nothing unpleasant is produced by the combustion of the gas. There have however been some very unpleasant consequences from taking a bath in a small highly heated room, the air of which was loaded with carbonic acid—fainting and even partial asphyxia having been recorded under these circumstances. That the danger is no imaginary one will be seen when we consider that if in a room containing 500 cubic feet of space—the size of very many bath rooms—50 cubic feet of carbonic acid are produced by burning 25 cubic feet of coal-gas, the percentage of carbonic acid in the air is raised from ·04 to 10, and the entire oxygen of 200 cubic feet of air is destroyed. Fatal results have been known from the inhalation, even for a short period, of air containing 10 per cent. of carbonic acid. The temperature of the air of the room will also be very much raised, and will tend to help in the production of perhaps fatal syncope. We cannot then too strongly insist on the absolute necessity of providing a flue to carry off the products of combustion to the outer air of an apparatus which can produce such an enormous volume of carbonic acid in so short a space of time. The flue should be carried into a chimney with a good draught, as the escaping products are generally much cooled down by having parted with much of their heat to the water flowing through the apparatus. There are other varieties of water-heater constructed for various purposes, only one of which we are able to notice in the present article. This is a spiral water-heater for lavatories, the invention of Mr. Fletcher. In two minutes this little apparatus, at a cost of half a foot of gas, can raise nearly two quarts of water to 100° F. It is an ingenious contrivance, and free from the objections attending most of the larger apparatus described above.

Gas Fires.—These may be classified as radiation stoves, the room being heated entirely by radiation; and ventilation stoves, warm air issuing from the stove and displacing the colder air of the room. But many of these latter also warm the room by radiation from the incandescent asbestos or from the warm sides of the stove. Mr. Fletcher has calculated that with gas at 3*s.* per 1000 cubic feet, his open incandescent radiation gas fires cost for the same work about as much as coal fires when the coal is 30*s.* per ton, but with ventilating stoves the cost is about two-thirds of this. As in cooking by gas however, there are no dust, dirt, or cinders, and the fire can be immediately lighted or extinguished and requires no attention when alight. Nearly all the patterns of radiation stove now made depend on the heating of fibre or lump asbestos by non-luminous flames from atmospheric burners. The average consumption of gas required to maintain a room containing 5000 or 6000 cubic feet of space at a suitable temperature in winter, varies between 12 to 20 cubic feet per hour, depending on a large variety of circumstances. Most people when sitting in a room prefer to be warmed by radiant heat, as from an ordinary open coal fire, and to leave the ventilation of the room to accidental circumstances—which usually means a cold draught along the floor towards the fire. Ventilation stoves, if they fulfil the proper conditions, are certainly better adapted for warming large apartments, such as shops, workrooms, and halls, than radiation stoves. The conditions to be fulfilled are that the air be taken from a pure source in the outer atmosphere, that it be warmed by its passage through the stove, but not overheated or burnt—as is so often the case—and that it enter the room in an ascending direction towards the ceiling. In many cases it may be necessary that the air, rendered dry by its passage through the stove, should be moistened by passing over a tray of water before entering the general air of the room. Radiation stoves are perhaps better suited for private houses, especially for bed rooms and other apartments where a fire is only occasionally required. The flues of these stoves should open into the chimney at the back of the fireplace. The temperature of the air and products of combustion escaping through the flue will generally be found very high, but the heat thus lost is necessary to create a draught up the chimney, and assists in the ventilation of the room.

It has been said that the more general adoption of gas for heating and cooking would solve the smoke difficulty in London and those large towns where domestic and not factory smoke is the chief offender. A London pea-soup fog is certainly due to the coating of the particles of moisture suspended in the mist with "a carbonaceous sulphurous cuticle" as Mr. Harold Dixon has expressed it, and by preventing the daily evolution of millions of small particles of unconsumed carbon from our chimneys, we should do away with the acrid yellow character of our fogs. But the mists due to the position of London on the estuary of a large river, would remain to the same extent as now, and there would still be the same amount of sulphurous acid given off into the air to be precipitated with the rain as sulphuric acid, and carry on its work of destruction on building stones and mortar. One cubic foot of coal-gas produces on combustion 0·2 to 0·5 grains of sulphurous acid, so that the amount evolved would continue to be, as now, enormous. Still the air would be deprived of its sooty particles to a great extent, and the old familiar features, characteristic of grimy London, might in time disappear. The carbonic acid which is the chief product in the combustion of coal-gas, is diffused at once into the general body of the atmosphere, and the marvellous rapidity with which this is effected is revealed to us when we know that the air of our open streets and parks differs only by the most minute quantities—if at all—in its contained carbonic acid, from the air of the mountains or the sea.

THE TOPOGRAPHIC FEATURES OF LAKE SHORES[1]

Introduction

THE play of meteoric agents on the surface of the land is universal, and there is a constant tendency to the production of the forms characteristic of their action. All other forms are of the nature of exceptions, and attract the attention of the observer as requiring explanation. The shapes wrought by atmospheric erosion are simple and symmetric, and need but to be enumerated to be recognised as the normal elements of the sculpture of the land. Along each drainage line there is a gradual and gradually increasing ascent from mouth to source, and this law of increasing acclivity applies to all branches as well as to the main stem. Between each pair of adjacent drainage lines is a ridge or hill standing about midway and rounded at the top. Wherever two ridges join there is a summit higher than the adjacent portion of either ridge; and the highest summits of all are those which, measuring along lines of drainage, are most remote from the ocean. The crests of the ridges are not horizontal, but undulate from summit to summit. There are no sharp contrasts of slope; the concave profiles of the drainage lines change their inclination little by little, and they merge by a gradual transition in the convex profiles of the crests and summits. The system of slopes thus succinctly indicated is established by atmospheric erosion under the general law of the interdependence of parts. It is the system which opposes the maximum resistance to the erosive agents.

The factor which most frequently, and in fact almost universally, interrupts these simple curves is heterogeneity of terrane or diversity of rock texture. Different rocks have different powers of resistance to erosion, and the system of declivities which, under the law of interdependence, adjusts itself to diversity of rock texture, is one involving diversity of form. Hard rocks survive, while the soft are eaten away. Peaks and cliffs are produced. Apices are often angular instead of rounded. Profiles exhibit abrupt changes of slope. Flat-topped ridges appear, and the distribution of maximum summits becomes in a measure independent of the length of drainage lines.

A second factor interrupting the continuity of erosion profiles is upheaval, and this produces its effect in two distinct ways. First, the general uprising of a broad tract of land affects the relation of the drainage to its point of discharge or to its base level, causing corrosion by streams to be more rapid than the general waste of the surface, and producing cañons and terraces. Second, a local uprising by means of a fault produces a cliff at the margin of the uplifted tract, and above this cliff there is sometimes a terrace.

A third disturbing factor is glaciation, the *cirques* and moraines of which are distinct from anything wrought by pluvial erosion; and a fourth is found in eruption.

The products of all these agencies except the last have been occasionally confused with the phenomena of shores. The beach-lines of Glen Roy have been called river terraces. The cliffs of the Downs of England have been ascribed to shore waves. Glacial moraines in New Zealand have been interpreted as shore terraces. Beach ridges in our own country have been described as glacial moraines, and fault terraces as well as river terraces have been mistaken for shore marks. Nevertheless, the topographic features associated with shores are essentially distinct from all others; and when their peculiar characters are understood there is little occasion for confusion. It is only where the shore record is faintly drawn that any difficulty need arise in its interpretation. In investigating the history of Lake Bonneville and other Quaternary water bodies of the Great Basin, the writer and his assistants have had constant occasion to distinguish from all others the elements of topography having a littoral origin and have become familiar with the criteria of discrimination. Their endeavour to derive from the peculiarities of the old shore lines the elements of a chronology of the lake which wrought them, has led them to study also the genesis of each special feature.[1]

In the discussion of shore phenomena there is little room for originality. Not only has each of the elements which go to make up the topography of a shore been recognised as such, but its mode of origin has been ascertained. There appears, however, to be room for a systematic treatment of the subject in English, for it is only in continental Europe that its general discussion has been undertaken. The writings of Elie de Beaumont include a valuable contribution,[2] and Alessandro Cialdi has devoted a volume to the motion of waves and their action on coasts.[3] These cover a large portion of the ground of the present essay, but treat the subject from points of view so diverse that the essay would be only partially superseded by their translation. The title of a work by H. Keller ("Studien über die Gestaltung der Sandküsten") indicates another discussion of a general nature, but this I have not seen. American and British contributions are contained chiefly in the reports of engineers on works for the improvement of harbours and the defence of coasts. The most comprehensive which has fallen under my eye, and one, at the same time, of the highest scientific character, is contained in the annual report of the United States Coast Survey for 1869, where Prof. Henry Mitchell, in treating of the reclamation of tide lands, describes the formation of the barriers of sand and shingle by which these are separated from the ocean.

It is proper to add that the writer became acquainted with these works only after the body of this essay was prepared. The objective studies on which his conclusions are based had been completed, and the discussion had acquired nearly its present shape before he became aware of the extent of the affiliated literature. His conclusions have, therefore, the quality of independence, and, so far as they coincide with those of earlier writers, have a corroborative value.

The engineering works whose construction has led to local investigations of shores are chiefly upon maritime coasts, where tides exert an important influence, and the literature of lake shores is comparatively meagre. It is

[1] From a paper by Mr. G. K. Gilbert in the "Fifth Annual Report of the Geological Survey of the United States for 1883-84." (Washington, 1885.)

[1] Partial outlines of the subject have been presented by the writer in connection with various accounts of Lake Bonneville, and a fuller outline was published by Mr. I. C. Russell in a paper on Lake Lahontan in the "Third Annual Report of the Geological Survey."

[2] "Leçons de géologie pratique;" tome premier; septième leçon, "Levées de sable et de galet," pp. 221-52.

[3] "Sul moto ondoso del mare e su le correnti di esso specialmente su quelle littorali pel comm" Alessandro Cialdi. Roma, 1866.

true that the phenomena of lake margins are closely paralleled by those of tide-washed coasts, but this, unfortunately, does not render the literature of the latter the more applicable, for there is a tendency to ascribe to the action of tides features which the students of inland lakes are compelled to account for independently of that agent.

It should be noted also that the point of view of the civil engineer is somewhat different from that of the present study. He is, indeed, concerned with all the forms into which the shore material is wrought by the action of the waves, but he is not at all concerned with their internal structure; and he knows them, moreover, only as subaqueous banks to be determined by sounding, and not at all as features of the dry land. The geologic student has, too, some facilities for study which the engineer lacks, for he is frequently enabled to investigate the anatomy of shore structures by means of natural cross-sections, while the engineer is restricted to an examination of their superficial forms.

Earth Shaping

The earth owes its spheroidal form to attraction and rotation. It owes its great features of continent and ocean bed to the unequal distribution of the heterogeneous material of which it is composed. Many of its minor inequalities can be referred to the same cause, but its details of surface are chiefly moulded by the circulation of the fluids which envelop it. This shaping or moulding of the surface may be divided into three parts—subaërial shaping (land sculpture), subaqueous shaping, and littoral shaping. In each case the process is threefold, comprising erosion, transportation, and deposition.

In subaërial or land shaping the agents of erosion are meteoric—rain, acting both mechanically and chemically, streams, and frost. The agent of transportation is running water. The condition of deposition is diminishing velocity.

In subaqueous shaping, or the moulding of surface which takes place beneath lakes and oceans, currents constitute the agent of erosion. They constitute also the agent of transportation; and the condition of deposition is, as before, diminishing velocity.

In littoral shaping, or the modelling of shore features, waves constitute the agent of erosion. Transportation is performed by waves and currents acting conjointly, and the condition of deposition is increasing depth.

On the land the amount of erosion vastly exceeds the amount of deposition. Under standing water erosion is either *nil* or incomparably inferior in amount to deposition. And these two facts are correlatives, since the product of land erosion is chiefly deposited in lakes and oceans, and the sediments of lakes and oceans are derived chiefly from land erosion. The products of littoral erosion undergo division, going partly to littoral deposition and partly to subaqueous deposition. The material for littoral deposition is derived partly from littoral erosion and partly from land erosion.

That is to say, the detritus worn from the land by meteoric agents is transported outward by streams. Normally it is all carried to the coast, but owing to the almost universal complication of erosion with local uplift, there is a certain share of detritus deposited upon the basins and lower slopes of the land. At the shore a second division takes place, the minor portion being arrested and built into various shore structures, while the major portion continues outward and is deposited in the sea or lake. The product of shore erosion is similarly divided. A part remains upon the shore, where it is combined with material derived from the land, and the remainder goes to swell the volume of subaqueous deposition.

The forms of the land are given chiefly by erosion. Since the wear by streams keeps necessarily in advance of the waste of the intervening surfaces, and since, also, there is inequality of erosion dependent on diversity of texture, land forms are characterised by their variety.

The forms of sea beds and lake beds are given by deposition. The great currents by which subaqueous sediments are distributed sweep over the ridges and other prominences of the surface and leave the intervening depressions comparatively currentless. Deposition, depending on retardation of currents, takes place chiefly in the depressions, so that they are eventually filled and a monotonous uniformity is the result.

The forms of the shore are intermediate in point of variety between those of the land and those of the sea bed; and since they alone claim parentage in waves, they are *sui generis*.

Ocean shores are genetically distinguished from lake shores by the co-operation of tides, which cannot fail to modify the work accomplished by waves and wind currents. The shores which constitute the objective basis of the present discussion were tideless; and the discussion is therefore limited to lake shores. It is perhaps to be regretted that the systematic treatment here proposed could not be extended so as to include all shores, but there is a certain compensation in the fact that the results reached in reference to lake shores have an important negative bearing on tidal discussions. It was long ago pointed out by Élie de Beaumont[1] and Desor[2] that many of the more important features ascribed by hydraulic engineers to tidal action, are produced on the shores of inland seas by waves alone; and the demonstration of wave-work pure and simple should be serviceable to the maritime engineer by pointing out the results in explanation of which it is unnecessary to appeal to the agency of tides.

CAPILLARY ATTRACTION

THE heaviness of matter had been known for as many thousand years as men and philosophers had lived on the earth, but none had suspected or imagined, before Newton's discovery of universal gravitation, that heaviness is due to action at a distance between two portions of matter. Electrical attractions and repulsions, and magnetic attractions and repulsions, had been familiar to naturalists and philosophers for two or three thousand years. Gilbert, by showing that the earth, acting as a great magnet, is the efficient cause of the compass needle's pointing to the north, had enlarged people's ideas regarding the distances at which magnets can exert sensible action. But neither he nor any one else had suggested that heaviness is the resultant of mutual attractions between all parts of the heavy body and all parts of the earth, and it had not entered the imagination of man to conceive that different portions of matter at the earth's surface, or even the more dignified masses called the heavenly bodies, mutually attract one another. Newton did not himself give any observational or experimental proof of the mutual attraction between any two bodies, of which both are smaller than the moon. The smallest case of gravitational action which was included in the observational foundation of his theory, was that of the moon on the waters of the ocean, by which the tides are produced; but his inductive conclusion that the heaviness of a piece of matter at the earth's surface, is the resultant of attractions from all parts of the earth acting in inverse proportion to squares of distances, made it highly probable that pieces of matter within a few feet or a few inches attract one another according to the same law of distance, and Cavendish's splendid experiment verified this conclusion. But now for our question of this evening. Does this attraction between any particle of

[1] "Leçons de Géologie pratique," Paris, 1845, v. i. p. 232.

[2] "Geology of Lake Superior Land District," by Foster and Whitney, Washington, 1851, v. ii. pp. 262, 266.

matter in one body and any particle of matter in another continue to vary inversely as the square of the distance, when the distance between the nearest points of the two bodies is diminished to an inch (Cavendish's experiment does not demonstrate this, but makes it very probable), or to a centimetre, or to the hundred-thousandth of a centimetre, or to the hundred-millionth of a centimetre? Now I dip my finger into this basin of water; you see proved a force of attraction between the finger and the drop hanging from it, and between the matter on the two sides of any horizontal plane you like to imagine through the hanging water. These forces are millions of times greater than what you would calculate from the Newtonian law, on the supposition that water is perfectly homogeneous. Hence either these forces of attraction must, at very small distances, increase enormously more rapidly than according to the Newtonian law, or the substance of water is not homogeneous. We now all know that it is not homogeneous. The Newtonian theory of gravitation is not surer to us now than is the atomic or molecular theory in chemistry and physics; so far, at all events, as its assertion of heterogeneousness in the minute structure of matter apparently homogeneous to our senses and to our most delicate direct instrumental tests. Hence, unless we find heterogeneousness and the Newtonian law of attraction incapable of explaining cohesion and capillary attraction, we are not forced to seek the explanation in a deviation from Newton's law of gravitational force. In a little communication to the Royal Society of Edinburgh twenty-four years ago,[1] I showed that heterogeneousness does suffice to account for any force of cohesion, however great, provided only we give sufficiently great density to the molecules in the heterogeneous structure.

Nothing satisfactory, however, or very interesting mechanically, seems attainable by any attempt to work out this theory without taking into account the molecular motions which we know to be inherent in matter, and to constitute its heat. But so far as the main phenomena of capillary attraction are concerned, it is satisfactory to know that the complete molecular theory could not but lead to the same resultant action in the aggregate as if water and the solids touching it were each utterly homogeneous to infinite minuteness, and were acted on by mutual forces of attraction sufficiently strong between portions of matter which are exceedingly near one another, but utterly insensible between portions of matter at sensible distances. This idea of attraction insensible at sensible distances (whatever molecular view we may learn, or people not now born may learn after us, to account for the innate nature of the action), is indeed the key to the theory of capillary attraction, and it is to Hawksbee[2] that we owe it. Laplace took it up and thoroughly worked it out mathematically in a very admirable manner. One part of the theory which he left defective—the action of a solid upon a liquid, and the mutual action between two liquids—was made dynamically perfect by Gauss, and the finishing touch to the mathematical theory was given by Neumann in stating for liquids the rule corresponding to Gauss's rule for angles of contact between liquids and solids.

Gauss, expressing enthusiastic appreciation of Laplace's work, adopts the same fundamental assumption of attraction sensible only at insensible distances, and, while proposing as chief object to complete the part of the theory not worked out by his predecessor, treats the dynamical problem afresh in a remarkably improved manner, by founding it wholly upon the principle of what we now call potential energy. Thus, though the formulas in which he expresses mathematically his ideas are scarcely less alarming in appearance than those of Laplace, it is very easy to translate them into words by which the whole theory will be made perfectly intelligible to persons who imagine themselves incapable of understanding sextuple integrals. Let us place ourselves conveniently at the centre of the earth so as not to be disturbed by gravity. Take now two portions of water, and let them be shaped over a certain area of each, call it A for the one, and B for the other, so that when put together they will fit perfectly throughout these areas. To save all trouble in manipulating the supposed pieces of water, let them become for a time perfectly rigid, without, however, any change in their mutual attraction. Bring them now together till the two surfaces A and B come to be within the one-hundred-thousandth of an inch apart, that is, the forty-thousandth of a centimetre, or two hundred and fifty micro-millimetres (about half the wave-length of green light). At so great a distance the attraction is quite insensible: we may feel very confident that it differs, by but a small percentage, from the exceedingly small force of attraction which we should calculate for it according to the Newtonian law, on the supposition of perfect uniformity of density in each of the attracting bodies. Well known phenomena of bubbles, and of watery films wetting solids, make it quite certain that the molecular attraction does not become sensible until the distance is much less than 250 micro-millimetres. From the consideration of such phenomena Quincke (*Pogg. Ann.*, 1869) came to the conclusion that the molecular attraction does become sensible at distances of about fifty micro-millimetres. His conclusion is strikingly confirmed by the very important discovery of Reinold and Rücker that the black film, always formed before an undisturbed soap bubble breaks, has a uniform or nearly uniform thickness of about eleven or twelve micro-millimetres. The abrupt commencement, and the permanent stability, of the black film demonstrate a proposition of fundamental importance in the molecular theory:—The tension of the film, which is sensibly constant when the thickness exceeds fifty micro-millimetres, diminishes to a minimum, and begins to increase again when the thickness is diminished to ten micro-millimetres. It seems not possible to explain this fact by any imaginable law of force between the different portions of the film supposed homogeneous, and we are forced to the conclusion that it depends upon molecular heterogeneousness. When the homogeneous molar theory is thus disproved by observation, and its assumption of a law of attraction augmenting more rapidly than according to the Newtonian law when the distance becomes less than fifty micro-millimetres is proved to be insufficient, may we not go farther and say thet it is unnecessary to assume any deviation from the Newtonian law of force varying inversely as the square of the distance continuously from the millionth of a micro-millimetre to the remotest star or remotest piece of matter in the universe; and, until we see how gravity itself is to be explained, as Newton and Faraday thought it must be explained, by some continuous action of intervening or surrounding matter, may we not be temporarily satisfied to explain capillary attraction merely as Newtonian attraction intensified in virtue of intensely dense molecules movable among one another, of which the aggregate constitutes a mass of liquid or solid.

But now for the present, and for the rest of this evening, let us dismiss all idea of molecular theory, and think of the molar theory pure and simple, of Laplace and Gauss. Returning to our two pieces of rigidified water left at a distance of 250 micro-millimetres from one another. Holding them in my two hands, I let them come nearer and nearer until they touch all along the surfaces A and B. They begin to attract one another with a force which may be scarcely sensible to my hands when their distance apart is fifty micro-millimetres, or even as little as ten micro-millimetres; but which certainly becomes sensible when the distance becomes one micro-millimetre, or the fraction of a micro-millimetre; and enormous, hundreds or thousands of kilogrammes' weight, before they come into absolute contact. I am supposing the area of each

[1] *Proceedings* of the Royal Society of Edinburgh, April 21, 1862 (vol. iv.).
[2] Royal Society *Transactions*, 1709-13.

of the opposed surfaces to be a few square centimetres. To fix the ideas, I shall suppose it to be exactly thirty square centimetres. If my sense of force were sufficiently metrical I should find that the work done by the attraction of the rigidified pieces of water in pulling my two hands together was just about four and a half centimetre-grammes. The force to do this work, if it had been uniform throughout the space of fifty micro-millimetres (five-millionths of a centimetre) must have been nine hundred thousand grammes weight, that is to say, nine-tenths of a ton. But in reality it is done by a force increasing from something very small at the distance of fifty micro-millimetres to some unknown greatest amount. It may reach a maximum before absolute contact, and then begin to diminish, or it may increase and increase up to contact, we cannot tell which. Whatever may be the law of variation of the force, it is certain that throughout a small part of the distance it is considerably more than one ton. It is possible that it is enormously more than one ton, to make up the ascertained amount of

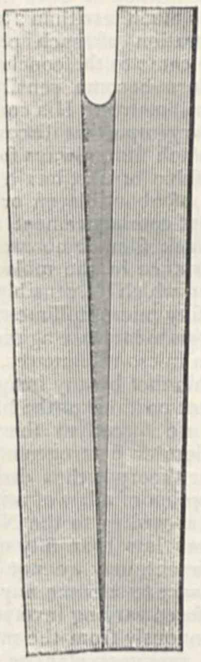


FIG. 1.

work of four and a half centimetre-grammes performed in a space of fifty micro-millimetres.

But now let us vary the circumstances a little. I take the two pieces of rigidified water, and bring them to touch at a pair of corresponding points in the borders of the two surfaces A and B, keeping the rest of these surfaces wide asunder (see Fig. 1). The work done on my hands in this proceeding is infinitesimal. Now, without at all altering the law of attractive force, let a minute film of the rigidified water become fluid all over each of the surfaces A and B : you see exactly what takes place. The pieces of matter I hold in my hands are not the supposed pieces of rigidified water. They are glass, with the surfaces A and B thoroughly clean and wetted all over each with a thin film of water. What you now see taking place is the same as what would take place if things were exactly according to our ideal supposition. Imagine, therefore, that there are really two pieces of water, all rigid, except the thin film on each of the surfaces A and B, which are to be put together. Remember also that the Royal Institution, in which we are met, has been, for the occasion, transported to the centre of the earth so that we are not troubled in any way by gravity. You see we are not troubled by any trickling down of these liquid films—but I must not say *down*, we have no up and down here. You see the liquid film does not trickle along these surfaces towards the table, at least you must imagine that it does not do so. I now turn one or both of these pieces of matter till they are so nearly in contact all over the surfaces A and B, that the whole interstice becomes filled with water. My metrical sense of touch tells me that exactly four and a half centimetre-grammes of work has again been done ; this time, however, not by a very great force, through a space of less than fifty micro-millimetres, but by a very gentle force acting throughout the large space of the turning or folding-together motion which you have seen, and now see again. We know, in fact, by the elementary principle of work done in a conservative system, that the work done in the first case of letting the two bodies come together directly, and in the second case of letting them come together by first bringing two points into contact and then folding them together, must be the same, and my metrical sense of touch has merely told me in this particular sense what we all know theoretically must be true in every case of proceeding by different ways to the same end from the same beginning.

WILLIAM THOMSON

(*To be continued.*)

THE TOTAL SOLAR ECLIPSE, 1886 *AUGUST* 28-29

THE Eclipse Expedition will leave England on the 29th inst. in the Royal Mail Steamship *Nile*, timed to arrive at Barbados on August 11. We regret to learn that Her Majesty's ship *Canada*, which was told off to assist the Expedition, chiefly by supplying artificers and assistance in camping and in the observations, has been withdrawn on some "diplomatic" service. This is a serious blow to the probabilities of good results.

From data supplied by Mr. Hind, the following details have been computed for the Island of Grenada :—

	Latitude N.	Longitude W.	Commencement of totality G.M.T.	Local time
	° ′	° ′	h. m. s.	h. m. s.
Levera	12 13·5	61 37	23 17 19	19 10 51
Caliveny	12 0·0	61 43	23 17 14	19 10 22
Point Saline ...	12 0·5	61 48	23 17 10	19 9 58
Fort Frederick.	12 3·0	61 44	23 17 13	19 10 17

	Duration of totality	Sun's Azimuth	Sun's True altitude	Angle from N. point
	m. s.	° ′	° ′	
Levera	3 45	84 12	18 56	87° to W.
Caliveny	3 52	84 6	18 48	73° ,,
Point Saline ...	3 48	84 4	18 42	72° ,,
Fort Frederick.	3 49	84 3	18 46	77° ,,

The sun's altitude and azimuth and the angle from N. point are given for the commencement of totality.

The time of first contact for the middle of the island [assumed lat. 12° 6′·0, long. 61° 43′·0] is 18h. 11m. 55s. local mean time at 77°·0 N. to W. on the sun's limb ; and ends at 20h. 20m. 44s. at 105° N. to E. on the limb.

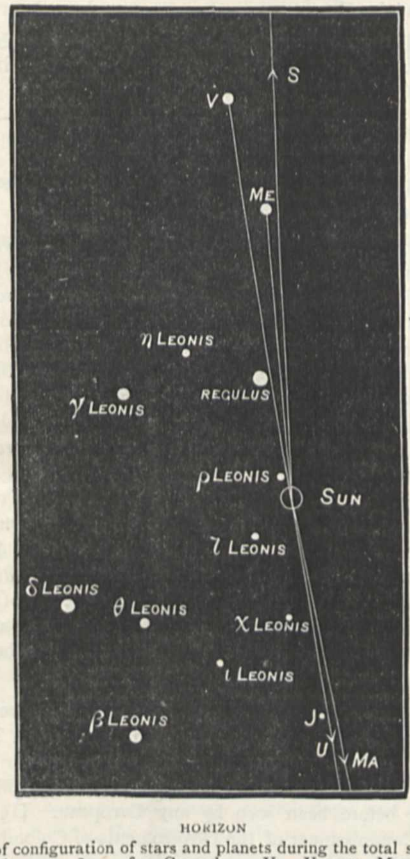
A diagram is given below showing the position of the principal stars and planets at the commencement of totality. The distances of the planets from the sun are very roughly as follows (the positions of Mercury and Venus being shown absolutely, and the directions of the others indicated by arrows) :—

Mercury (Me) = 4 | Mars (Ma) = 15
Venus (V) = 6 | Saturn (S) = 12

Jupiter } almost in conjunction { (J) } = 8.
Uranus } { (U) }

Local mean time of transit of Polaris and δ Ursæ Minoris for Caliveny (Grenada), long. 61° 43′ W. :—

Date 1886		Transit of δ Ursæ Minoris h. m. s.		Transit of Polaris h. m. s.
August 14	...	8 35 46	...	15 43 24
15	...	8 31 49	...	15 39 28
16	...	8 27 52	...	15 35 33
17	...	8 23 55	...	15 31 37
18	...	8 19 58	...	15 27 41
19	...	8 16 1	...	15 23 46
20	...	8 12 4	...	15 19 50
21	...	8 8 7	...	15 15 54
22	...	8 4 11	...	15 11 58
23	...	8 0 14	...	15 8 3
24	...	7 56 17	...	15 4 7
25	...	7 52 20	...	15 0 12
26	...	7 48 23	...	14 56 15
27	...	7 44 26	...	14 52 20
28	...	7 40 30	...	14 48 24
29	...	7 36 33	...	14 44 28



HORIZON

Diagram of configuration of stars and planets during the total solar eclipse, 1886 August 28-29, for Grenada. V = Venus; ME = Mercury; MA = Mars; J = Jupiter; S = Saturn; U = Uranus.

We reprint from *Science* the following paper by Mr. J. Norman Lockyer:—

In order to obtain the greatest amount of assistance from observations of the eclipsed sun, it is necessary to consider in the most general way the condition of solar inquiry at the time the observations are made. If any special work commends itself to those interested in the problem,—work which may be likely to enable us to emphasise or reject existing ideas,—then that work should take precedence of all other.

Next, if the observers are sufficient in number to undertake other work besides this, then that work should be arranged in harmony with previous observations; that is, the old methods of work should be exactly followed, or they should be expanded so that a new series of observations may be begun in the light and in extension of the old ones.

In my opinion, and I only give it for what it is worth, the three burning questions at the present time—questions on which information is required in order that various forms of work may be undertaken to best advantage (besides eclipse-work)—are these:—

(1) The true constitution of the atmosphere of the sun. By this I mean, Are the various series of lines of the same element observed in sunspots, *e.g.*, limited to a certain stratum, each lower stratum being hotter, and therefore simpler in its spectrum, than the one overlying it? and do some of these strata, with their special spectra, exist high in the solar atmosphere, so that the Fraunhofer lines, represented in the spectrum of any one substance, are the result of an integration of the various absorptions from the highest stratum to the bottom one? This view is sharply opposed to the other, which affirms that the absorption of the Fraunhofer lines is due to one unique layer at the base of the atmosphere.

I pointed out before the eclipse of 1882 that crucial observations could be made during any eclipse, including the time both before and after totality. I made the observations: they entirely supported the first view, but I do not expect solar inquirers to throw overboard their own views until these observations of mine are confirmed; and I think one of the most important pieces of work to be done during the next eclipse is to see whether these observations can be depended upon or not.

One observer, I think, should repeat the work over the same limited region of the spectrum, near F; another observer should be told off to make similar observations in another part of the spectrum. I have prepared a map of the lines near E, for this purpose, showing those brightened on the passage from the arc to the spark, and those visible alone at the temperature of the oxy-hydrogen flame. Whereas some of the spark lines will be seen seven minutes before and after totality as short, bright lines, some of the others will be seen as thin, long lines just before and after totality. We want to know whether the lines seen at the temperature of the oxy-hydrogen flame will be seen at all, and, if so, to what height they extend.

(2) The second point to which I attach importance is one which can perhaps be left to a large extent to local observers, if the proper apparatus, which may cost very little, be taken out.

With this eclipse in view, I have for the last several months gone over all the recorded information, and have discussed the photographs taken at the various eclipses in connection with the spots observed, especially at those times.

The simple corona observed at a minimum with a considerable equatorial extension (twelve diameters, according to Langley), the complex corona observed at maximum when the spots have been located at latitudes less than 20°, have driven me to the view, which I shall expand on another occasion, that there is a flattened ring round the sun's equator, probably extending far beyond the true atmosphere; that in this ring are collected the products of condensation; and that it is from the surfaces of this ring chiefly that the fall of spot-forming material takes place.

If we take any streamer in mid-latitude, we find, that, while the spots may occur on the equatorial side of it, none are seen on the poleward side. I regard the streamers, therefore, like the metallic prominences, as a sequel to the spot; and there is evidence to suggest that a careful study will enable us to see by what process the reaction of the photosphere and underlying gases produced by the fall of spot-material tends to make the spot-material discharge itself in lower and lower latitudes, as the temperature of the sun's lower atmosphere gets enormously increased.

The observations of Profs. Newcomb and Langley at the minimum of 1878, on the equatorial extension, are among the most remarkable. Prof. Newcomb hid the moon and 12′ of arc around it at the moment of totality by a disk of wood, carefully shielding his eyes before totality. Prof. Langley observed at a very considerable elevation. It is therefore quite easy to understand why this ring has not been seen or photographed at maximum. At maximum no precautions have been taken to shield the eye; no observations have been made at a considerable elevation; while the fact that the ring, if it exists, consists of cool material, fully explains how it is that the photographic plates have disregarded it.

I would propose, therefore, that the repetition of Prof. Newcomb's observations of 1878 be made an important part in the arrangements of the eclipse for this year. A slight alteration in the method will be necessary, as the ring will be near the vertex and the lowest point of the eclipsed sun.

(3) Another point of the highest importance at the present moment has relation to the existence of carbon. Until Tacchini's observations of 1883, the only trace of carbon in the solar spectrum consisted of ultra-violet flutings. He observed other flutings in the green near the streamers in the eclipse referred to.

Duner's recent work puts it beyond all doubt that stars of Class III. *b* have their visible absorption produced chiefly by carbon vapour.

On any theory of evolution, therefore, we must expect the sun's atmosphere to be composed to a large extent of carbon at some time or other; so that the highest interest attaches to this question in connection with the height in the atmosphere at which the evidence of carbon is observed. The existence of the ultra-violet flutings among the Fraunhofer lines tells nothing absolute about this height, although I inferred, at the time I made the announcement, that it existed at some height in the coronal atmosphere.

These three points, then, are those to which I attach special importance at the present time.

We next come to photographs of the corona. I believe, that, with our present knowledge, the chief thing we have to seek in such photographs is not merely the streamers and their outlines, which we are sure to get anyway, but images on a larger scale; so that in a series of short exposures we may endeavour to get some records which will eventually help us in determining the directions of the lower currents. At present we do not know absolutely whether these flow to or from the poles. My own impression is that the panaches at the poles indicate an upper outflow.

In coming to the photo-spectroscopic observations, I am of opinion, that of the two attacks which I first suggested for the eclipse of 1875, and which have also been used in the last two eclipses of 1882 and 1883, one of them should be discarded, and the whole effort concentrated on the other.

We have learned very much from the use of the prismatic camera,—one of the instruments referred to; but the results obtained by it are not of sufficient accuracy to enable them to be fully utilised. On the other hand, though the slit spectroscope failed in 1875, it succeeded with a brighter corona and more rapid plates in 1882; and, with a proper reference spectrum, every iota of the facts recorded can be at once utilised for laboratory work and subsequent discussion.

On these grounds, then, I would suggest that slit spectroscopes alone be used for photographic registration. I think falling plates should be used, and that the work should begin ten minutes before totality, and continue till ten minutes after; provided the slit be tangential, or nearly so, to the limb.

I may state that arrangements have been made here to take such a series of photographs on the uneclipsed sun; and, with the improved apparatus, I am greatly in hopes that we may get something worth having.

This paper was communicated to the Eclipse Committee, and formed in part the basis for the plan of operations on this occasion, which, as approved by the Committee, are as follows:—

Coronagraph before and after totality.. Camera and prismatic camera during totality	Capt. Darwin
Camera and slit spectroscopes ... ... Integrated intensity of corona	Capt. Abney
Camera and slit spectroscopes	Dr. Schuster
,, ,, ,,	Mr. Maunder
Observations of chromosphere before and after totality, and search for carbon bands during totality	Rev. S. J. Perry
Observations of chromosphere before and after totality, and direction of solar currents during totality	Mr. Turner
Images of corona on large and small scale (2 inches and ¾ inch) with photoheliograph and a 6-inch object-glass by Henry	Mr. Lockyer

Prof. Thorpe replaces Capt. Abney in the above list, and Prof. Tacchini joins the expedition at the invitation of the Royal Society.

NOTES

We regret to learn of the death of Dr. Abich, the eminent Russian geologist.

Mr. David Stephenson, of Edinburgh, the well-known civil engineer, died at North Berwick on Saturday last. He was born in 1815, and was a son of Mr. Robert Stephenson, the celebrated engineer of the Bell Rock and other lighthouses. His abilities in his profession were soon recognised. He was appointed at an early age engineer to the Lighthouse Board, and while occupying that position he constructed a number of important lighthouses. In the course of his career he held the office of consulting engineer to the Highland and Agricultural Society and to the Convention of the Royal Burghs, as also engineer to the Board of Fisheries and the Clyde Lighthouse Trust. Mr. Stephenson was a voluminous writer; his more important works included "A Sketch of Civil Engineering in North America," "The Application of Modern Hydrometry to the Practice of Civil Engineering," "Reclamation and Production of Agricultural Land," and "Principles and Practice of Canal and River Engineering." He was an occasional contributor to the columns of Nature.

The death is announced of Mr. Charles Mano, seven days after leaving Colon for France, at the age of fifty-five. M. Mano had made various journeys in S, anish America for scientific purposes. In Mexico he discovered several ancient cities which had never before been seen by any European. He was the scientific Commissioner of the Governments of Colombia and of Guatemala.

The arrangements for the Brighton meeting of the British Medical Association on the 10th, 11th, 12th, and 13th proximo are rapidly approaching completion. In the section of pathology, the new science of bacteriology will receive a good deal of attention, and microscopic photographs of these mysterious organisms will be shown by Dr. Heneage Gibbes and Dr. Crookshank, while the latter will also exhibit the various organisms growing in gelatine, &c.

We learn from the *Sidereal Messenger* for July that the contract for mounting the 36-inch objective has been awarded by the Lick trustees to Warner and Swasey, of Cleveland, O., for 42,000 dols. The telescope is to be 57 feet long; the diameter of the tube 42 inches. Provisions are made by which it will be possible for the observer at the eye-end of the telescope to command all the possible motions, and these same motions can also be controlled by an observer stationed on a small balcony

20 feet above the floor. It is expected that the mounting will be completed in April 1887, and that the glass will be brought to Mount Hamilton and put in place some time during the summer following. The total cost of the equatorial and dome will will be about 164,850 dols.; the cost of the dome being 56,850 dols.; the mounting, 42,000 dols.; the visual objective, 53,000 dols.; the additional photographic lens, 13,000 dols.

WE have received a copy of the address of Sir William Manning, as Chancellor of the University of Sydney, at the annual commemoration. The report which it contains is one of progress in almost every direction. The death of Prof. Smith, who had long held the Chair of Experimental Physics, led to a re-arrangement of duties, a Professorship of Physics being substituted, with a wider and different range of teaching in Physical Science, including portions of the duties before discharged by the Professor of Mathematics as Professor also of Natural Philosophy. The list of private benefactions appended to the address is a remarkable one. It amounts to 317,414*l.* 12*s.* 6*d.* Of this, one amount, the Challis Bequest, is estimated at 180,000*l.*, and is anticipated to reach about 200,000*l.* As this noble donation has only recently fallen into possession, its application has not yet been fixed; the only point determined about it is that no part of it shall be used on buildings of any kind, but the capital shall be kept intact to produce an income for direct educational purposes. Another highly important gift is the Macleay Natural History Collection, valued at 25,000*l.* A building has been erected to receive the collection, and an endowment of 6000*l.* for a Curator has been promised. The other gifts include one of 30,000*l.* for the library. The amount of the donations since 1879 exceed a quarter of a million sterling —a magnificent sum for any community, however wealthy, to contribute in a few years to a single educational institution.

ON Thursday last week the Photographic Exhibition, promoted by the Glasgow Town Council, was opened in the Corporation Galleries with a numerously attended *conversazione.* It is the fullest exposition, historical, practical, and scientific, of the art of photography which has yet been given. By means of an admirable series of examples it illustrates the development of photography from the earliest attempts of Wedgewood, Niepce, Daguerre, Fox-Talbot, and numerous other discoverers, to the latest products of those who are acknowledged at the present day as masters of the art. In the department of photo-lithography the numerous methods of photo-engraving and phototype-printing are fully represented by means of exhibits from the principal workers in that line. One of the most interesting sections is that which illustrates the applications of photography to the various branches of science, divided into its relations to geography, ethnology, microscopy, meteorology, and astronomy. In the last of these, the greatest of the recent triumphs in celestial photography by the Brothers Henry, of the Paris Observatory, are admirably shown; and there are also splendid examples of a similar kind from the Royal Observatory, as well as from Mr. A. Ainslie Common and others eminent in that field. The apparatus range from the primitive appliances of Daguerre to the latest ones of Messrs. Mason and Co., Glasgow; Mr. Stanley, London; and Mr. Marion, of the same city. Mr. James Paton, the curator of the galleries, has superintended the arrangements for the exhibition, which are of a most satisfactory nature.

WE regret to learn of the probable early recall of the Commissioner of the Philippine Forest Department, and the practical suspension of the work in which he is engaged. The step is much to be regretted on many grounds, and it is to be hoped the Spanish Government will re-consider its decision in the matter. Until recently our knowledge of Philippine vegetation was extremely scanty, notwithstanding the collections made by the late Mr. Hugh Cuming. Even these it remained for Don Sebastian Vidal, Commissioner of Forests there, to place in accessible form, the materials for his recently-published "Phanerogamæ Cumingianæ Philippinarum" having been collected whilst engaged in working up his collections at Kew some two or three years ago. The extensive collections recently made by the Forest Department, a portion of which has been transmitted to Kew for determination, has, we believe, yielded a considerable proportion of novelties, including a number of genera not hitherto known from the islands. Information respecting these additions will probably be forthcoming in due course, as already we have an outline of the flora at the hands of one of the Kew staff. The above, together with the fact that the large island of Mindanao, and several others, is practically unexplored, shows how much yet remains to be done in this direction. From an economic stand-point, and for the development of the natural resources of the islands, the work of the department is an important one. The demand for timber, owing to the exhaustion of the forests in various directions, is assuredly forcing the forestry question into the foreground. As an example of how little we know of the Philippine flora, we may mention the St. Ignatius's bean, of which until recently nothing was known beyond the fact that it finds its way into the markets of this country as a source of the deadly poison strychnine, and was said to be sold in the market at Manila. Now, we believe, the plant has been discovered, and information respecting it will doubtless be shortly forthcoming. Such matters as these naturally engage the attention of the Forest Department, and it will be a matter for sincere regret if the work so well begun should come to a sudden termination, just at a time when its importance is beginning to be realised.

A PHILIPPINE correspondent, writing on May 24 last, informs us that the great volcano, Mayon, in the south of the Island of Luzon, is in eruption. He remarks:—"I tried the ascent, and climbed to about 5000 feet, when incandescent stones and ashes obliged me to come quickly down. I crossed a patch of forest —*Litsea verticillata*, *Myrica vidaliana*, and *Vaccinium* abundant—half burnt and covered with ashes. The sight was magnificent, but not much botanical work to be done there. I never saw anything like it as a sublime scene of devastation; ashes and stones and smoke everywhere, and a fearful noise like heavy artillery all around." *Myrica vidaliana*, it may be remembered, was described only about a year ago, from specimens collected at this very spot. At present it has not been found elsewhere, though it probably exists on other volcanic peaks in the island.

THE *Melbourne Argus* of June 11 gives some particulars of the eruption of Mount Tarawera, in New Zealand, which was briefly reported by telegram. The first news of the outbreak was received at Auckland from the telegraphist at Rotorua on the morning of June 10. He said:—"We have all passed a fearful night here. The earth has been in a continual quake since midnight. At 2.10 a.m. there was a heavy quake and a fearful roar, which made every one run out of their houses. A grand yet terrible sight for those so near as we were presented itself. Mount Tarawera, close to Lake Rotomahana, suddenly became an active volcano, belching out fire and lava to a great height. The eruption appears to have extended itself to several places southward. A dense mass of ashes came pouring down here at 4 a.m., accompanied by a suffocating smell as from the lower regions. An immense black cloud, which extended in a line from Tapeka to Pairoa Mountain, was one continued mass of electricity all night, and is still the same. The thunder-like roaring of three or four craters, the stench, and the continual quaking of the earth, had the effect of completely frightening people." Things became so threatening that the telegraphist deemed it prudent to abandon his post; but he afterwards returned. At Wairoa the schoolhouse was fired by the lightning and smothered in mud and stones, and two hotels were reduced to ruins. Twenty bodies were recovered. For about six miles north of Te Awamutu the whole of the surrounding country was covered with blue mud 3 feet deep. It was reported that all Rotomahana had disappeared. Many natives lost their lives; but the exact number is not known. The sounds of the explosion were heard at Hamilton, about eighty miles distant, early in the morning. They were like great guns at sea. The windows of houses in Hamilton were shaken. At Maketu there was darkness until 10 a.m. The earthquakes lasted from 2.30 a.m. till 8.15, with very strong lightning and earth-currents. Four volcanoes were going at Wairoa. The Tikitapu bush has been uprooted. All the country down to Tauranga was in total darkness, with thick clouds of sulphurous matter and gypsum in the air. The following description of the scene was given in a message from Taupo:—"At 3 a.m. a terrific report aroused the sleeping inhabitants of Taupo, when an immense glare of a pillar-shaped light was observed to the north-north-east. A great black cloud hung over this pillar, concave on the under-side, and convex on the upper, whilst meteors on all sides shot out from the cloud in every direction, shedding an unearthly bluish light. Loud reports, accompanied by very heavy shocks of earthquake, followed in quick succession, and kept on until 6 o'clock, when the daylight and the clouds of ashes rendered the sight invisible. At 2.15 a.m. the two extinct volcanoes of Ruawhai and Tarawera threw an immense column of flame and smoke into the heavens. Molten lava and hot mud were rained abroad, while huge rocks and masses of fire went up and around in all directions. The earthquakes were terrible. Tongariro is quiet. Heavy snow is falling on the ranges and the cold is intense. The rumbling still continues at Maketu, and dust is still falling. The whole country is covered from 1 to 6 inches with dust."

THE series of anthropoid apes at the Zoological Society's Gardens at the present time is well worthy of attention. Besides "Sally," the bald-headed chimpanzee (*Anthropopithecus calvus*), which has now been two years in the Regent's Park, there is a second chimpanzee of the ordinary species (*A. troglodytes*), which enables these two forms to be compared side by side. A young orang (*Simia satyrus*) has likewise recently arrived, and a white-handed gibbon (*Hylobates lar*), from Malacca, deposited by Mr. Dudley Hervey, Resident Councillor of the Straits Settlements, exemplifies the third type of the highest division of the Quadrumana. It is much to be wished that the long-talked-of plan of building a new compartment by the side of the existing monkey-house for the Anthropoids could be carried out. At present these highly interesting animals are not very conveniently lodged along with the sloths and ant-eaters, on the other side of the Gardens.

THE half-yearly general meeting of the Scottish Meteorological Society will be held to-day, when the following papers will be read:—"The Extent of the Areas of the different Mean Annual Rainfalls over the Globe," by Mr. John Murray; "On the Temperature of the Water in the Firth of Clyde and connected Lochs," by Dr. Hugh Robert Mill, F.R.S.E.

MR. FRANK E. BEDDARD, Prosector of the Zoological Society, has been appointed Lecturer on Biology at Guy's Hospital.

ACCORDING to the programme of the approaching celebration of the 500th anniversary of the foundation of Heidelberg University, a grand historical procession designed and to be personally directed by Prof. Carl Hoff, of the Karlsruhe School of Art, will march through the town on August 6, starting at 9 a.m. More than 900 persons with 300 horses and 14 state coaches will take part in the procession, which is to give a pictorial representation of the five centuries which have succeeded the foundation of the University, and to comprise the following groups:—(*a*) Founding of the University by Elector Ruprecht I., 1386; (*b*) public entry of Frederich the Conqueror after the battle of Seckenheim, 1462; (*c*) nurture of science and art by Elector Otto Heinrich, 1556–59; (*d*) life among the people of the Merry Palatinate at the end of the 16th century: procession illustrating the vintage of the Palatinate; (*e*) entry of the Elector Frederick V. with his consort, Elizabeth of England, June 17, 1613; (*f*) Bohemian Embassy, 1619; (*g*) time of the Thirty Years' War (1618–48), and of the War of the Orleans Succession (1688–97); (*h*) Elector Karl Ludwig, with retinue, 1632–80; (*i*) time of the Elector Karl Philipp, 1716–42: hunting cavalcade; (*k*) Elector Karl Theodor, 1742–99; (*l*) Restoration of the University by Karl Friedrich of Baden, 1803: the students of the nineteenth century; (*m*) the Burschenschaften; (*n*) the Corps; (*o*) the new German Empire. Judging by the arrangements now nearly completed, the procession may be expected to surpass all previous exhibitions of the kind in the splendour of its equipage and the historical truth of its representation, which will be carried into even its minutest details. For the sake of a proper view of the procession, stands are to be erected at all convenient points along the line of the procession, and the sale of tickets for the numbered seats of the stands has already begun. A plan of the procession, issued by the firm Koester, Heidelberg, (price 20 Pfennige) shows the arrangement of the stands, with the prices of the various seats, and gives information respecting hotel accommodation, &c. A very considerable number of lodgings, we learn, have already been engaged by strangers intending to be present at the ceremonies connected with the celebration. All intending visitors who have not yet secured accommodation in respect of board and lodging are invited to make early application to the Commission specially appointed for the negotiation of such business—Wohnungs Commission, Rathhaus, Heidelberg. Beds are still to be had at the moderate price of 15 marks for the whole term of the celebration, while hotel-keepers, &c., have publicly engaged to keep their prices within strictly reasonable limits.

AT the Conference of the Colonial and Indian Exhibition, held on the 30th ult., Prof. Fream read a paper on "Colonial Forestry," dealing with the present condition of forestry in the larger colonies. In Canada there is need of conservation and of tree-planting, and everything now seems ripe for the establishment of a department of forest conservancy in the Dominion. In New South Wales such a department is at work under the Ministry of Mines; in Victoria a considerable area is reserved, but even this is not commensurate with the demand for timber for industrial purposes. In South Australia, Queensland, and New Zealand, efficient forestry departments exist. In Australia and the Cape Colony, English forest trees are being successfully cultivated, and "in all the colonies the reckless waste and wanton destruction of former days have given place to wise systems of conservancy, such as are worthy of a tree-loving people."

A SERIES of photographic views from a balloon has been taken by M. Nadar, of Paris, whose father, twenty-five years ago, was the first to attempt photographing from a balloon, with only partial success. The stereotype plates of the views taken were presented to the Academy of Sciences at their meeting on July 12.

SEVERAL attempts have lately been made by the Marquis of Lorne to transmit live whitefish (*Coregonus albus*), which have been reared by the National Fish Culture Association, to the Isle of Mull, where his lordship is endeavouring to acclimatise this valuable American species. After several futile attempts two consignments of them have reached their destination in safety. Great difficulty attends the operation of removing white fish from one place to another. The best carrier for removing them in is an ordinary carboy filled to the top with water. Not more than fifty specimens of yearling fish should be placed in one carrier. The autumn is the best time for transmitting them.

WE are informed by Mr. W. August Carter, of the Colonial and Indian Exhibition Fisheries Section, that a large specimen of a smooth hound, recently imported into the aquarium of the Exhibition from Brighton, gave birth last week to ten young ones, this species being viviparous. She did not deliver them simultaneously, but two at a time, at intervals of about twenty hours, occupying six days in yielding the entire number. All the young on appearing were perfectly formed, and resembled in every respect their matured congeners with the exception of the colour of the upper portion of the body and fins, which was white throughout instead of grey. Unfortunately nine expired shortly after birth, lacking the conditions necessary to their existence, such as deep water, where in their natural state they always repair for six months during their alevin stage. The remaining fish was devoured by its parent, which is in excellent condition and moves actively around the tank.

FROM the report of the Stockholm Observatory for the last year, we learn that during the year Prof. Gyldèn continued the calculations for the development of certain theories respecting the chief planets, and that they are so far advanced as to already embrace the terms of the first and second orders in relation to the masses pertaining to the theory for the system Jupiter-Saturn-Uranus. The Astronomer-Royal also continued his lectures on theoretical astronomy, chiefly supported by King Oscar, which were attended by several eminent foreign astronomers. Several well-known astronomers from Russia and Germany have also pursued their studies at the observatory during the year, two of whom, Drs. Shdanow and Harzer, of Pulkowa, having, as the result of the same, published important papers on the astronomical theory of perturbation. Three more parts of the work, "Astronomical Observations and Researches at the Stockholm Observatory," were issued during the year.

BEFORE adjourning this summer the Swedish Parliament granted a sum of 325*l.* towards the continuation of the *Acta Mathematica* during the ensuing financial year 1886-87.

WE have received Nos. 45–47 of the first part, 34–36 of the second part, of the well-known and valuable "Encyclopædia of Natural Sciences," now in course of publication by the house of Eduard Trewendt, of Breslau. The three numbers of the first part include the seventeenth number of the "Manual of Botany," containing the beginning of an important note by Prof. Oscar Drude, of Dresden, on "The Systematic and Geographical Arrangement of the Phanerogams," illustrated with finely executed drawings by the author, and a map. The two other numbers belong to the "Alphabetical Manual of Zoology, Anthropology, and Ethnology," advancing that work from "Kalunda" to "Landrace." Nos. 34 and 36 of the second part carry on the "Alphabetical Manual of Chemistry" from "Essigsäure" to "Furfurangruppe." Of special interest is the excellent work by Dr. R. Nietzki, of Basel, on "Organic Colouring Materials." The 35th number, again, brings us nearer to the conclusion of the "Alphabetical Manual of Mineralogy, Geology, and Palæontology," containing, as it does, palæontological contributions by Dr. Fr. Rolles—Trias System, Birds, Wanderings of Plants and Animals in the Course of Geological Epochs, Mollusks, and Worms, as also mineralogical contributions by the Editor. The few articles that still remain to be written on geology, interrupted by the sudden death of Prof. von Lasaulx, will be taken up by Prof. Hœrnes, of Graz, so that this "Handwörterbuch" will be completed in the course of this summer.

THE Prince of Monaco has left Lorinet with his yacht *Hirondelle* to prosecute the series of marine observations begun last year. The cruise will be made between Cape Finisterre and the English southern coast. Five hundred tubes have been prepared, and will be thrown on the sea. They will carry printed forms of the same kind described on a former occasion. Dredgings and thermometric readings will be made on the bottom of the sea.

THE administration of the Jardin des Plantes of Paris has organised an exhibition of the objects collected on the Congo by M. Savorgnan de Brazza.

THE Franco-Algerian telegraph system is being completed to Biskra, but the communication between Biskra and Tugurth and Dabila oasis, situated at a great distance to the south, is kept up by means of the optical telegraph, the sun being utilised in daytime, and at night electricity. The optical system will be always kept in operation, as it is apprehended that nomads might cut the wires.

THE Kazan Society of Naturalists has issued the fourteenth volume of their *Memoirs* (*Trudy*), which contains a very interesting paper, by MM. Stuckenberg and Vysotski, on the Stone Age at Kazan. The commencement of a museum of Stone Age implements at Kazan was made in 1877, and now it already has a first-rate collection, both in the number and variety o implements, and M. Zausailoff is publishing a beautiful atlas of drawings representing them. The paper of MM. Stuckenberg and Vysotski contains most interesting details as to the places where remains of man were found, illustrated by three maps. Three different terraces are seen in the valley of the Volga. The upper terrace, rising 50 to 150 feet above the second, consists of yellow-brownish sandy clay, covering layers of sand. It contains remains of mammoths and other extinct mammals. The second terrace is much more recent; and it is on its surface, as well as on the slopes of the former, and sometimes on the surface of the third terrace, that the stone implements are found. The third terrace, which is still inundated by the Volga, was probably almost covered by its waters during the Stone Age. All implements found are Neolithic; that is, they belong to what we should call the lacustrine period. As to the implements themselves, many of which are figured on the sixteen plates which accompany the paper, they have mostly been made of the local flint originating from the Permian deposits. A few are made of the Eocene sandstone which extends to the south of the Kazan Government; and, finally, boulders of granite, diorite, gneiss, quartzite, and so on, have also been used for the fabrication of some of the hammers. Broken pottery, together with bones of horses, oxen, and pigs, accompany the stone implements.

M. PALMIERI, the director of the Vesuvian Observatory, has succeeded in exhibiting the negative electricity developed when steam is condensed by cold, and positive electricity liberated when evaporation takes place. A platinum shell is placed in communication with one of the plates of a condenser. The golden leaf is separated when a piece of ice is placed in the shell, and also when it is full of water if exposed to the rays of the sun. The electricity has been proved positive in the first instance, and negative in the second.

DURING the last few weeks great tracts of the fertile island of Seeland, in Denmark, have been devastated by maybugs, whole fields and meadows having been laid quite bare. Last year the damage done was very great, but this year it is far worse, being estimated at some 25,000*l.* The distress among farmers is in consequence very great.

A MIRAGE was observed at Algiers prior to the outbreak of the destructive thunderstorm which broke over the city on the 7th inst. Cape Matifan appeared from Algiers close at hand with a sharply cut rock of granite at its extremity. The temperature was 43°·2 C. in the shade, showing that the air above the sea was very hot, and that the explanation of the phenomenon is to be found in the same causes as those determining a mirage in the Sahara. The lowering of the temperature was very rapid, falling as much as 2° C. at Bouzarcah Observatory. The 7th inst. was the hottest day that has yet been felt there this season. Lightning struck the Government barrack at Mustapha, and ignited piles of hay, inflicting damage to the extent of 4000*l*.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. F. W. Steward; a Ring-tailed Lemur (*Lemur catta*) from Madagascar, presented by Mrs. Collcutt; six Prairie Marmots (*Cynomys ludovicianus*) from North America, presented by Mr. F. J. Thompson; two Common Foxes (*Canis vulpes*) from Russia, presented by Mr. Harrison Cripps, F.R.C.P.; a Common Rhea (*Rhea americana*) from South America, presented by Mr. J. W. Bell; four Red-bellied Squirrels (*Sciurus variegatus*) from Trinidad, presented by Mr. R. J. Lichmere Guppy; two Peba Armadillos (*Tatusia peba*) from South America, presented by Mr. J. Clements; a Greater Black-backed Gull (*Larus marinus*), British, presented by Mr. Henry Stevens, M.D.; twenty-four Sand-Lizards (*Lacerta agilis*), a Slowworm (*Anguis fragilis*), a Common Snake (*Tropidonotus natrix*) from Germany, presented by Mr. S. Schaefer; two Sarus Cranes (*Grus antigone*) from North India, eight European Tree Frogs (*Hyla arborea*) from Germany, purchased; two Long-fronted Gerbilles (*Gerbillus longifrons*), an Elliot's Pheasant (*Phasianus ellioti*), a Bronze-winged Dove (*Phaps chalcoptera*), a Barred-shouldered Dove (*Geopelia humeralis*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

SCHULHOF'S RESEARCHES ON THE ORBIT OF COMET 1873 VII. (COGGIA—WINNECKE).—The elements of Comet 1873 VII. bear a certain resemblance to those of Comet 1818 I., which was observed by Pons. Prof. Weiss asserts the identity of these two comets, and adopts sixty-two years as the most probable value of the period of revolution. In the *Bulletin Astronomique*, tome iii. p. 125 *et seq.* M. L. Schulhof has published a most exhaustive discussion of the orbit of Comet 1873 VII., and has gone into the question of its possible identity with 1818 I., as well as with 1457 I. (the observations of which by Toscanelli have recently been discussed by Prof. Celoria) in a most thorough manner. The opinion which he expresses, with some reserve, as the result of his investigations, is that the Comets 1873 VII. and 1818 I. are distinct bodies with a short period of revolution, having a common origin. The Comet 1457 I. is probably identical with 1873 VII., but it is also possible that the two comets, 1873 VII. and 1818 I. are fragments of 1457 I., which must have been a much more conspicuous object than either of them, to have been seen by Toscanelli and by the Chinese with the naked eye.

SOLAR ACTIVITY DURING THE FIRST HALF OF 1886.—The numbers and areas of sunspots have shown upon the whole a decided falling off during the past half-year as compared with the last six months of 1885, although no month of the present year has shown so low a daily average as December 1885. There has been, however, a steady increase in the number of days on which the sun's disk was free from spots, one side of the sun being, on the average, much less spotted than the other, causing an apparent short period in the variation of the spotted area, of about a synodic rotation of the sun in duration. The month in which the mean daily number of sunspots was least was February; that in which it was most was March. An exceedingly fine group was observed on May 8.

Prominences have shown fewer fluctuations in their numbers and size, but have been fully one-fourth less numerous on the average than in 1885.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1886 JULY 25–31

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on July 25

Sun rises, 4h. 15m.; souths, 12h. 6m. 14·6s.; sets, 19h. 57m.; decl. on meridian, 19° 38′ N.: Sidereal Time at Sunset, 16h. 11m.

Moon (one day after Last Quarter) rises, 23h. 35m.*; souths, 6h. 39m.; sets, 13h. 54m.; decl. on meridian, 11° 23′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 50	13 46	20 42	10 6 N.
Venus	1 37	9 46	17 55	22 22 N.
Mars	10 59	16 35	22 11	5 18 S.
Jupiter	9 47	15 54	22 1	0 32 N.
Saturn	2 43	10 51	18 59	22 15 N.

* Indicates that the rising is that of the preceding evening.

Occultations of Stars by the Moon (visible at Greenwich)

July	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
27	85 Tauri	6	0 4	0 49	90 224
27	σ^2 Tauri	5	3 6	3 43	10 297
27	σ^1 Tauri	5½	3 23	near approach	334 —

July	h.	
25	5	Mercury at greatest distance from the Sun.
28	22	Venus in conjunction with and 0° 6′ south of μ Geminorum.
28	23	Venus in conjunction with and 3° 46′ north of the Moon.

Variable Stars

Star	R.A. h. m.	Decl. ° ′		h. m.	
U Cephei	0 52·2	81 16 N.	July 28,	22 51	*m*
Algol	3 0·8	40 31 N.	,, 28,	1 47	*m*
			,, 30,	22 36	*m*
δ Libræ	14 54·9	8 4 S.	,, 31,	21 22	*m*
R Scorpii	16 10·9	22 40 S.	,, 31,		*M*
U Ophiuchi	17 10·8	1 20 N.	,, 27,	23 52	*m*
W Sagittarii	17 57·8	29 35 S.	,, 26,	0 0	*m*
β Lyræ	18 45·9	33 14 N.	,, 26,	2 0	m_2
η Aquilæ	19 46·7	0 43 N.	,, 25,	0 0	*M*
δ Cephei	22 24·9	57 50 N.	,, 25,	21 30	*M*

M signifies maximum; *m* minimum; m_2 secondary minimum.

Meteor Showers

The principal shower is that of the *Aquarids*, maximum July 28; radiant R.A. 340°, Decl. 13° S. Other showers are as follows:—The *Andromedes* (I.), R.A. 8°, Decl. 36° N.; near χ Persei, R.A. 32°, Decl. 53° N.; near β Ursæ Majoris, R.A. 165°, Decl. 53° N.; and near the Pole, R.A. 300°, Decl. 87° N.

ON LAYING THE DUST IN MINES

IN a paper recently contributed to the South Wales Institute of Engineers,[1] Mr. Archibald Hood, the President, says:—"It was probably first suggested by Faraday and Lyell about the year 1845 that coal-dust was in some way inflammable. This idea was subsequently set forth by several French engineers, but all that was done previous to the year 1875 bears the same relation to subsequent demonstrations as the steam-engine of Hero of Alexandria bears to the steam-engine of the nineteenth century."

Assuming Mr. Hood's date to mark correctly the commencement of the real battle between the new theory and its predecessors, it cannot surely be urged that the period of ten years which has since elapsed has been too long wherein to destroy the vast herd of previously existing chimeras, and to introduce and establish a new and different order of ideas. Doubtless the result attained up to the present has been prodigiously accelerated by the labours of the Royal Commission on Accidents in Mines, and of the

[1] "On the Watering of Dusty Mines." The South Wales Institute of Engineers, March 18, 1886.

similarly constituted bodies in France and Germany, all of which have been called into existence and have completed their labours within the period named. Indeed, scarcely had the ink with which the English Report was written been dry when the Home Office introduced a new Mines' Regulation Bill which provides, amongst other things, that "*In all dry and dusty mines the airways and travelling roads are to be kept clear of dust* OR *well watered, and a shot is not to be fired until the place and that near it is cleared of dust and then well watered*" ("*Mining Journal*").

The crudeness of the idea embodied in the first alternative, which appears to contemplate the possibility of removing the dust from roadways and airways without the simultaneous use of water, reminds one of an incident of the interview between Christian and the Interpreter ("Pilgrim's Progress"):—

"Then he took him by the hand and led him into a very large parlour that was full of dust because never swept; the which, after he had reviewed it a little while, the Interpreter called for a man to sweep. Now when he began to sweep the dust began so abundantly to fly about that Christian had almost therewith been choked. Then said the Interpreter to a damsel that stood by, 'Bring hither water and sprinkle the room,' the which, when she had done, it was swept and cleansed with pleasure."

It has all the appearance of being a compromise between efficiency on the one hand and ignorance or prejudice on the other, and closely resembles, in this respect, the first General Rule of the Act for the Regulation and Inspection of Mines, 1860 (23 and 24 Vic., cap. 151), according to which a mine was required to be ventilated only in such a way as to be safe *under ordinary circumstances.* But just as these qualifying words were found to be a cloak for all kinds of inefficiency in the matter of ventilation, and had to be ultimately expunged after a twelve years' trial, so we venture to predict will this other unscientific alternative, if passed into law, cause endless trouble and disaster, and require to be similarly dealt with at some future time.

To lay the dust sufficiently well to prevent the spread of an explosion requires a much smaller quantity of water than appears to be generally supposed.

This has been stated more or less directly several times in describing the results of coal-dust experiments; but it was very clearly brought out in the examination of the workings of Pochin Colliery, in Monmouthshire, after the great explosion in November 1884. The flame which in that case had all but filled the mine, and had penetrated into the remotest parts of three districts of workings ventilated by separate air-currents, was found to have been arrested by a slight dampness on one of the roadways leading to several working places. A cask conveying water from a dip place to a point more convenient to the pumps was hauled along this roadway four times every twenty-four hours, and it was stated by the manager of the colliery at the time that the dampness in question was due simply to accidental leakages from this cask and not to any intentional application of water for the purpose of laying the dust. At the inquest on Mardy explosion also, in January last, it was pointed out that a similar accidental or irregular system of watering appeared to have stopped the flame in four different directions, and to have saved the lives of many of the workmen (*Western Mail*, January 21, 1886).

Systematic watering with the avowed object of preventing the spread of explosions has hitherto been practised in very few collieries in this country. Llwynypia Colliery in the Rhondda Valley is a notable exception. Soon after the earliest coal-dust experiments had been made there in 1875 the intelligent proprietors and manager constructed a number of water-tanks on wheels, each provided with a perforated pipe at the back like an ordinary watering cart. Some of these were intended to be drawn by horses along the less frequented roadways, others to be attached to the trains of waggons which are drawn along the underground railways by means of wire ropes actuated by engine-power. The result of watering by this means was satisfactory and remarkable. The whole mine became cooler and more pleasant to live in. The dust, as such, disappeared not only from the floor of the roadways but also from the timbers and from the ledges formed by the irregular projections in the side-walls, and became consolidated into a firm, compact, and slightly humid mass under foot.

On their first arrival in this country in 1880, MM. Pernolet and Aguillon, who were sent by the Commission du Grisou to study the state of the English mines, expressed the opinion then generally held, that watering the floor of a dry mine would leave ample supplies of dust on the timbers and side-walls to carry on an explosion once begun. But after seeing the actual results in Llwynypia Colliery with their own eyes they altered their views considerably, as will appear from the following extract from their Report, which describes this incident of their visit:—

"*Ainsi, à Llwynypia, où les chantiers se développent jusqu'à* 1500 *mètres du puits, et où l'extraction est de* 550 *tonnes par jour avec un seul poste, il suffit par jour de* 5 *wagons d'une capacité d'un demi-mètre cube, soit de* 4·500*m. d'eau. Nous avons pu constater que les galeries étaient partout très propres et l'atmosphère très épurée, bien que cette mine passât auparavant pour une de celles où l'atmosphère était le plus chargée et le boisage le plus recouvert de poussières.*"[1]

About a year and a half ago the Home Office began unexpectedly to prosecute the managers of a few widely separated mines in different parts of the country for firing blasting shots while the men ordinarily employed were underground. The practice of blasting under these conditions had been going on unchallenged ever since the passing of the Coal Mines' Regulation Act, 1872, and it was with a feeling somewhat akin to consternation that the colliery owners viewed the new reading then for the first time seriously sought to be attached to part of one of the General Rules. The manager of the Standard Steam Coal Colliery in South Wales was selected out of hundreds of others in the same predicament, and a prosecution against him was begun. The colliery owners of the district rallied round the Monmouthshire and South Wales Collieries' Association, and undertook the defence. Happily, however, for the ends of justice, as well perhaps as for the cause of science, the case soon became involved in a whirlpool of legal formalities from which, as far as present appearances go, it is little likely to escape until after the passing of the new Mines' Bill.

During the earlier stages of this prosecution the representatives and advisers of the owners met the Inspector of Mines for the district (the late Mr. T. E. Wales) and asked him to represent to the Home Office that they were prepared immediately to submit to a new rule compelling them to water their mines systematically if the objectionable interpretation of the shot-firing rule were withdrawn. At the same time they expressed the opinion that the rule they were themselves proposing would afford a real protection to the lives of the miners, and that the one they desired to be superseded had been founded upon a misapprehension of the true causes of explosions. This intelligent proposal was, however, allowed to fall to the ground, and the Juggernaut of office rolled on its ponderous and relentless course.

Where simple tanks on wheels are difficult or expensive to manipulate, they may be advantageously replaced by a system of pipes bringing water from the surface, or from a reservoir at a convenient height in the shaft, and distributing it at different points of the workings, in the form of a fine spray. This arrangement has been successfully applied both at Llwynypia and Standard Collieries. At the latter colliery the pressure of water at the bottom of the shaft is regulated to fifty pounds on the square inch. The water pipes, which are one inch and a half in diameter, lie on the floor at one side of the roadway, or are supported on timber as the case may be. At distances of fifty yards apart upright branch pipes rise vertically from the main to a height of about four feet, each provided with a leaden plug with one minute hole. The jets of water are directed horizontally across the roadway, and the spray is carried along in the air-current, moistening the floor, more or less, all the way from one jet to the next. The cost of first establishment is stated to be about 5*l.* per hundred yards, and the cost of maintenance to be almost *nil.*

If the dew-point of the air entering a mine were by any simple means raised to the normal temperature of the strata in which the workings are situated, it is obvious that no system of watering would be necessary, and that any desirable degree of dampness could be maintained in the roadways. The only objection to this method is, that it would necessitate raising the general temperature of all dry mines.

A slight dampness, such as that which prevails in shallow mines at all times, is sufficient to lay the dust effectually; and it is highly probable that, so soon as anything approaching this condition is maintained also in deep mines, we shall have heard the very last of "Great Colliery Explosions."

W. GALLOWAY

[1] P. 287, "Exploitation et Réglementation des Mines à Grisou en Belgique, en Angleterre et en Allemagne." Rapport de Mission fait à la Commission chargée de l'étude des moyens propres à prévenir les explosions de grisou dans les Houillères, par MM. A. Pernolet et L. Aguillon, "Angleterre." Paris, 1881.

THE SUN AND STARS[1]

IX.

LET us consider the case, then, on the supposition of small masses of matter. Where are we to find them? The answer is easy;—in those small meteoric masses which an ever-increasing mass of evidence tends to show occupy all the realms of space.

In connection with this, perhaps I may be permitted to quote the following from one of my "Manchester Lectures":—

"There is one point to which I think I may be permitted to draw your attention, although at present it rests merely upon an unindorsed observation of my own. I thought it would be worth while to try what would happen if I inclosed specimens of meteorites, taken at random, in a tube from which I subsequently exhausted the air by a pump. After the pumping had gone on for some considerable time, of course we got an approach to a vacuum; and arrangements were made by means of which an electric spark could pass along this apparent vacuum, and give us the spectra of the gases evolved from the meteorites. Taking those precautions which are generally supposed to give us a spark of low temperature, and passing the current, we got a luminous effect which, on being analysed by the spectroscope, gave us that same spectrum of hydrocarbon which Mr. Huggins, Donati, and others have made us perfectly familiar with as the spectrum of the head of a comet. There, then, we get the atmosphere of meteorites, not necessarily carbonaceous meteorites, but meteorites taken at random; and this atmosphere is exactly what we get in the head of a comet.

"Now let me go one step further; and to take that step with advantage, allow me to refer to another point, . . . that whereas Schiaparelli has connected meteorites and falling stars with comets, Profs. Tait and Thomson, on the other hand, have connected comets with nebulæ, both of them being, according to those physicists, clouds of stones. Now how has one to carry these spectroscopic observations into the region of the nebulæ? A Leyden jar was included in the circuit, and we had what is generally supposed to be an electric current giving us a very much higher temperature than we had before. What, then, was the spectrum? The spectrum, so far as the known lines were concerned, was the spectrum which we get from the nebulæ; for the hydrocarbon[2] spectrum, which we get from the atmospheric meteorites at a low temperature, was replaced by the spectrum of hydrogen; the spectrum of hydrogen coming, of course, from the decomposition of the hydrocarbon, with the curious, but at present unexplained, fact that we got the spectrum indications of hydrogen without indications of carbon. In my laboratory work I have come across other curious cases in which compound vapours, when dissociated, only gave us one spectrum at a time—by which I mean that in a vapour consisting of two well-known substances, under one condition we only get the spectrum of one substance, and under another condition we get the spectrum of the other substance alone; so in others, again, of both combined. The evidence seems, therefore—though I do not profess to speak with certainty—entirely in favour of the ideas of Sir William Thomson and Prof. Tait on the one hand, and of Schiaparelli on the other."

I have given the above extract to show that a mass of meteorites at a temperature higher than that found to exist in a comet's head could give us the hydrogen spectrum which was discovered with such richness in the *Nova*, which is represented in the spectra of most nebulæ, and which remained in the spectra of the *Nova* after all the other lines had gone.

These considerations enhance the interest of the *Nova* to the spectroscopist if we accept the bright line observed in the star by Dr. Copeland and others to be veritably the chief nebula line.

This line brightened relatively with each decrease in the brilliancy of the hydrogen lines. On December 8, 1876, it was much fainter than F, while by March 2, 1877, F was a mere ghost by the side of it. On any probable supposition the temperature must have been higher at the former date.

Now it is well known that within certain limits the lines in the spectrum of a compound body get brighter with *decrease* of temperature, because at the higher one the compound almost entirely ceases to exist as such, and we get the lines of its constituents. It is a fair theory then to suggest that the famous nebula line may belong to a compound. Nay the fact as it stands alone further points to the possibility that the compound in question contains hydrogen as one of its constituents.

At present we know very little indeed about these new stars. The star which appeared last year in the nebula in Andromeda is, if possible, still more difficult to understand, because, although it was so near the centre of the nebula in apparent position, we do not know that it was near the nebula locally, or whether it was simply in the line of sight. Therefore the views with regard to that star are much complicated by the fact that it is uncertain whether it was associated with a nebula. It may have had nothing to do with it. I have received this morning from Paris a photograph taken by the Brothers Henry, who are working now at the Paris Observatory, recording the very interesting discovery that apparently growing out of the side of one of the stars of the Pleiades is a real nebula. Those of you who remember the photographs of the corona during different eclipses will imagine that there may be some connection between this star and the surrounding nebula. Now it seems certain that there is some connection between this star and the nebula, and it may be that, in fact, what we call nebula in this case is a very considerable expansion of the star's coronal atmosphere. So obvious is that suggestion, that I spent last night in trying to observe its spectrum. The fog was too much for me, but still, although there was very little light, it did look very much as if there were some bright lines in the bright part of the spectrum of the star. And if that is so, it will not only show you the possible connection of the nebula in Andromeda with the new star in Andromeda, but it also shows you the importance of the question of area which I brought before you in the previous part of the lecture, if the bright lines we got are due, not to the star itself, but to the incandescent area which surrounds it.

Finally, then, with regard to the new stars generally. That they are stars in our sense is, I think, quite impossible. Some of them, you know, lose their brilliancy in a very few weeks. Now we know that any body like the star which we are most familiar with—our sun—if ever it got to a sufficient degree of temperature to increase its light ten or twenty times, would not lose its temperature in ten or twenty days, or ten or twenty years, or ten or twenty thousand years, so that the more rapidly any of these bodies cool down, the less likely is it that the bodies which cool down have any considerable mass.

So obvious was that that on the appearance of the star in 1866 I made the suggestion, as I have said, that the body which gave us this light might be quite close to us. Well that was negatived. It was found that it was not—that it was at a stellar distance—that it was no more possible to tell its distance than it was that of an ordinary star.

We are driven then to the conclusion that, as we must account for a tremendous increase of light, and we know that this light was produced at a very great distance, and that one very large mass cannot be in question, we must distribute the light among a great many masses—the idea of a collision between two stars must give way to the idea of some action of a meteor-swarm in the case of a star already existing, like T Coronæ, and of a collision between two meteor-swarms in the case of a new one like that of 1876; that seems a possible explanation of a great many of these "stars"—the components of meteor-streams driven to incandescence supplying that light in consequence of the innumerable multitude of their components, the light dying out very quickly because these innumerable components are small and far apart.

The next order of variable stars to which I shall refer you is very well represented by β Lyræ. The curious point about this star is that it has a double minimum. Another star, η Argûs, with a bright line spectrum, is also remarkable from the fact that its maximum varies in the same sort of way.

In this star we get a number of differences. If you start from the maximum of the star you find it of three-and-a-quarter magnitude. It then in three-and-a-half days goes down to four-and-a-quarter. It then goes up so that in about six days it gets back again to its original brilliancy. It then goes down again, but does not stop where it did before, but goes half a magnitude lower, and then at last it ends the sequence of phenomena by getting up to its original brightness in thirteen days.

Now, although we cannot explain how it is, we have the fact that a curve of that kind is associated with a bright line spectrum. In η Argûs, one of the most remarkable stars in the heavens, we have very much the same conditions. This star is in the southern hemi-

[1] A Course of Lectures to Working Men delivered by J. Norman Lockyer, F.R.S., at the Museum of Practical Geology. Revised from shorthand notes. Continued from p. 230.

[2] The Lectures from which I am quoting were delivered many years ago, before the spectrum was recognised to belong to carbon.

sphere, and during the last twenty or thirty years a considerable discussion has been going on among astronomers as to whether the surrounding nebula is or is not changing its position with regard to the star. Now what happens to the star? I may tell you that the curve is only a rough one. But still you see the point fairly enough. This is, that this star, which has a bright line spectrum like β Lyræ, has a period not of thirteen days, but of seventy years. We find that the star, which is at first possibly below a sixth magnitude star, rises up to the first magnitude, but then goes down to the second, and so on. The curve shows a period of seventy years, the curve being very irregular.

The third and fourth classes, so far as we can see, resemble

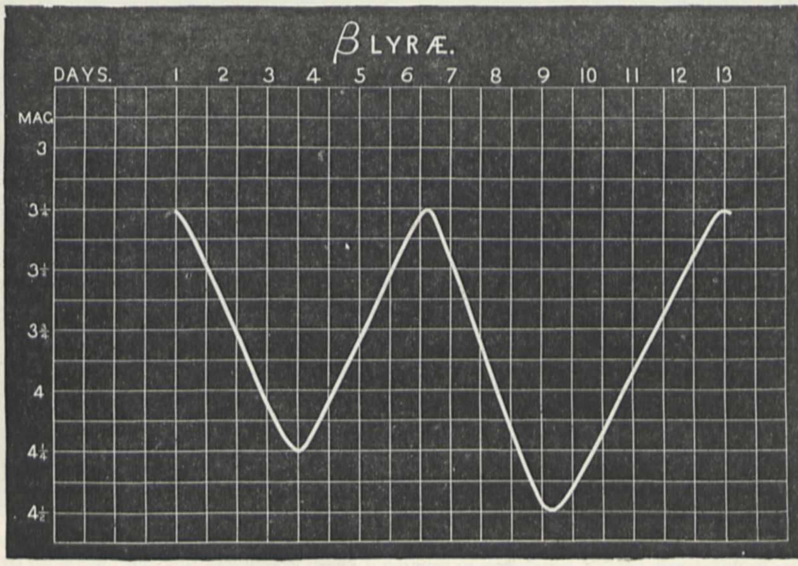


FIG. 27.—Light curve of β Lyræ.

our sun. The curves suggest that of the sun's spot period, when we can make anything out of them at all.

But when we come to another class, in which we get a large light change in one period, there is one star, the history of which is so extraordinary that it is quite worth while to throw its light curve on the screen. It is called Mira, or the Marvellous. It is in the constellation of the Whale, and what happens to it in just a little less than a year is this. First it is of the second magnitude, and then in about eighty days it descends to the tenth magnitude, and then, so far as the observations have gone, it is invisible. In about another hundred days it again becomes visible as a star of the tenth magnitude. It then increases its

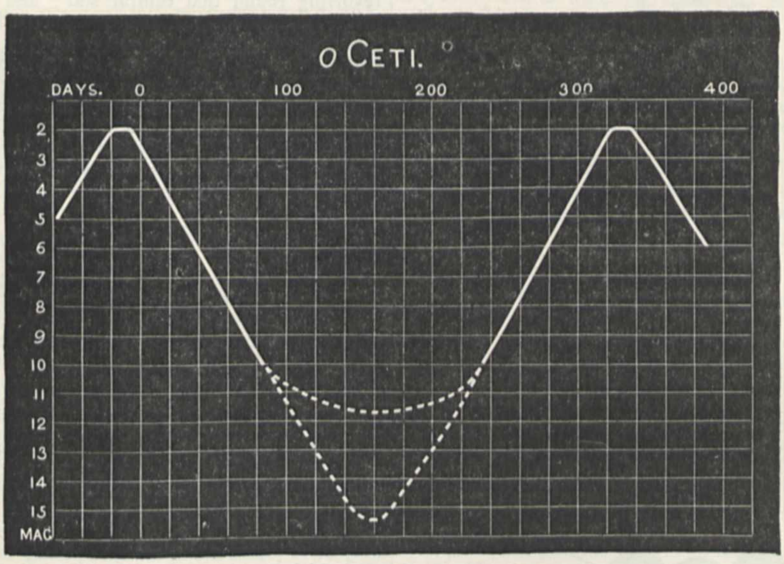


FIG. 28.—Light curve of Mira.

light to the second magnitude, and begins the story over again. But sometimes at the maximum its brilliancy is not quite constant. That is to say, sometimes it goes nearer the first magnitude than the second. What happens to the light of the star below the tenth magnitude it is impossible to say. Whether it follows more nearly either of the dotted curves in the diagram is not known. Below the tenth magnitude no observations have been made, because it is very difficult to observe a star under those conditions. What one knows is that it remains invisible for about 140 days or something like that, and then it begins its cycle over again.

The next diagram illustrates the last conditions of variability, the class of stars in which, if you remember, I told you that the variability probably did not depend upon the star itself, but upon its surroundings ; and this is the famous star Algol, which is always visible in our latitudes. The history of the light changes of Algol is this. If we take the beginning of a cycle it is a star of the second magnitude. Suddenly in three hours it goes down to the fourth, and then it comes up in another three hours to the second, and goes on again for very nearly three days ; and then it goes down again, comes up again, and goes on again for another three days, and so on. The diagram shows the exact

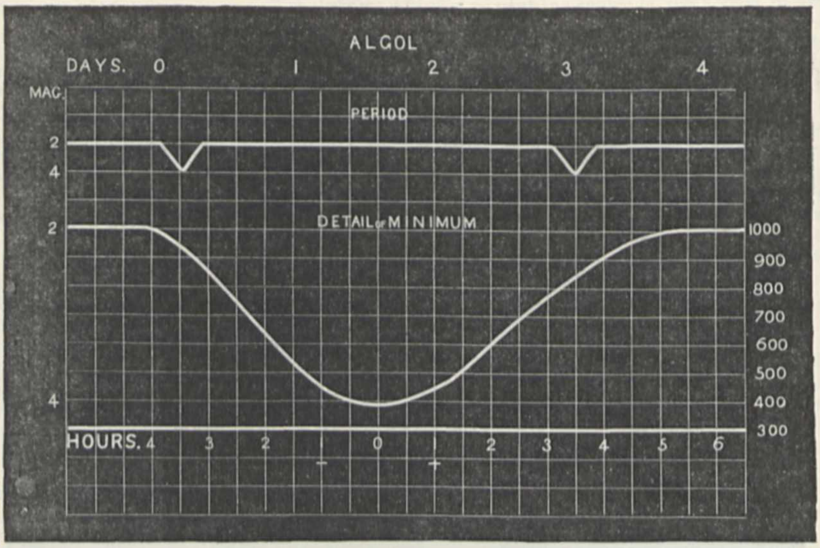


Fig. 29.—Light curve of Algol.

hape of the light curve as it has been determined by Prof. Pickering, dividing the light into a thousand parts.

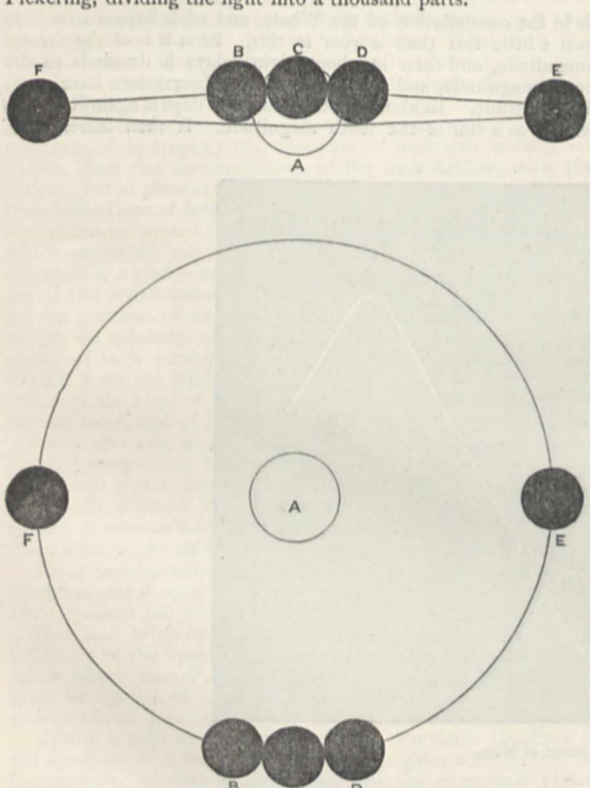


Fig. 30.—Plan and section of the orbit of the Companion of Algol.

There is another star very like this—a star which is in 81° N. declination, No. 25 in a well-known Catalogue. The difference between Algol and this is that the rise and fall are a little more rapid. Its light is feeble for about the same time as the other one, but at the bottom the curve is flat, by which I mean that, instead of going suddenly down and coming suddenly up again, it stops at its least luminosity for some little time.

Prof. Pickering has shown, I think, beyond all reasonable doubt that what is happening is this. If we take this diagram to represent in plan a large star giving out light, and B, C, D, E, F represent also in plan different positions of a dark body revolving round that central star ; and then if you take the thing in section, so that the star and its satellite are represented as they really are in the plane which joins the earth and the star, you will see that in one part of the revolution of the dark body it eclipses the light body. Now, a further investigation of those conditions in the case of the second star has shown that there must be a total eclipse, and therefore Prof. Pickering draws the conclusion that in the former case the light of the body which revolves round the central one may be considered as *nil*—that is to say, that it is a dark body ; but that in the case of the star D. 25—81° N.—there must be luminosity from the star which eclipses the other. And a very beautiful justification of that has recently been noted, because, although there is no change in the spectrum of Algol, there is a considerable change in the spectrum of that star the bottom curve of which is flat, showing that probably the companion has a large coronal atmosphere, and that the light of the central star has to pass through it. The light of the composite star practically changes from green to red very much as our sunlight would change if it had to pass through the atmosphere of another sun like itself coming between us.

I have prepared two or three other notes with regard to those special matters touching the stars which depend upon their distances, to show you that our sun, after all, is a small star—that there are several suns in the universe near enough to us to have had their distances already determined, which are considerably more brilliant and more imposing in every way than the star which is near us. But the clock tells me that I must leave all that to some other time, and I now end the course by thanking you very much for the indulgence that you have shown me in listening to what I have been able to tell you with regard to the constitution of our central body, and to the application of the knowledge which we have got in that way to an endeavour to cull some of the secrets of the physical construction of those suns which are very much farther removed from our ken.

J. Norman Lockyer

SOCIETIES AND ACADEMIES

London

Physical Society, June 26.—Prof. W. E. Ayrton, F.R.S., Vice-President, in the chair.—Mr. E. M. Langley was elected a Member of the Society.—The following communications were read:—On certain sources of error in connection with experiments on torsional vibrations, by Mr. Herbert Tomlinson. During a long series of researches on the torsional elasticity and internal friction of metals, the author has come across the following sources of error in connection with torsional vibrations. In some of the earlier experiments a horizontal brass bar was suspended by a wire and oscillated, the times of oscillation being observed by the ordinary lamp, mirror, and scale. The moment of inertia was varied by sliding two brass cylinders, suspended from the bar by fine wires, backwards and forwards along it. It was then found that under certain conditions the bar executed a few vibrations of rapidly decreasing amplitude, came to rest, and then commenced to swing again, the amplitude increasing to a maximum, again decreasing, and so on. This effect was finally traced to an approach to synchronism between the time of oscillation of the bar and that of the small cylinders about their axes of suspension, the absorption of energy being due to these being set in vibration. The effect entirely disappeared upon clamping the cylinders rapidly to the bar. On another occasion, however, the old phenomenon reappeared, and after much time spent in investigating it, was found to be due to a somewhat similar cause, a near approach to synchronism between the periods of torsional and pendulous vibrations. If the axis of the wire passed accurately through the centre of mass of the vibrator, this would not occur; and this condition it is practically impossible to fulfil. Another source of error lies in the fact that, in a wire recently suspended, the torsional vibration-period will always be found to be slightly greater than when it has been suspended for some time and frequently oscillated.—On a mode of driving electric tuning-forks, by Prof. S. P. Thompson. It is invariably found that the frequency of an electrically maintained fork is continually changing. This great inconvenience the author believes to be due to the fact that the impulses are given to the prongs at a disadvantageous moment, namely, when they are at the extremities of their swings. It is desirable that the impulse should be given at the middle of the swing, and to effect this it is suggested that each fork should make and break the circuit of the magnet influencing the other one, and it was shown how the electrical connections could be made to effect this in a simple manner.—Prof. Silvanus P. Thompson then read some further notes on the formulæ of the electro-magnet and of the dynamo. The author pointed out that a misapprehension of his former paper on this subject had given rise to certain critical remarks by Dr. O. Fröhlich, to which he replied. The author also explained the new form given recently by Dr. Fröhlich to the formula of the electro-magnet, rendering it much more readily applicable to the various equations of dynamo-machines. Formerly the Lamont-Fröhlich formula had been written—

$$m = M \frac{kx}{1 + kx},$$

where M and k are constants, and x the magnetising force. Dr. Fröhlich now suggested a formula of the form—

$$m = Y \frac{x}{x + x'},$$

where Y is the maximum value of m, and where x is either the current or the potential applied to the electro-magnet, and x' the diacritical value of the same; the "diacritical" value, as defined by the author in 1884, being that value which produced the state of half-saturation of the magnetic circuit. The author, folowing the lines laid down by Fröhlich in the use of this equation, showed that the general equation of the self-exciting dynamo is necessarily of the form

$$\psi = \Psi - \psi',$$

where ψ is either current or potential, ψ' the "diacritical" value of the same, and Ψ the "maximal" value of the same; that is to say, is the value which ψ would have if the given machine were run at the given speed and with the given internal and external resistances, but having its magnets independently excited to absolute saturation. Further deductions concerning the "dead turns" of the dynamo, their independence of speed, and dependence upon the resistances of the circuit and upon the construction of the machine were shown.

Sydney

Linnean Society of New South Wales, April 28.—Prof. W. J. Stephens, F.G.S., President, in the chair.—The following papers were read:—On some Lepidoptera from the Fly River, New Guinea, by E. Meyrick. Mr. Meyrick's paper contains an account of the Lepidoptera (Heterocera), collected by the recent New Guinea Expedition. Specimens of twenty-five species were met with, of which fifteen appear to be new, and are described by Mr. Meyrick. Nearly all of these may be said to be of normal Indo-Malayan types. A few specimens, from their bad condition, were unidentifiable or unfit for description.—Catalogue of the described Coleoptera of Australia, part 4, by George Masters. This part contains the names of, and references to, all the known species of the families—*Trixagidæ, Eucnemidæ, Elateridæ, Cebrionidæ, Rhipidoceridæ, Dascillidæ, Malacodermidæ, Cleridæ, Lymexylonidæ, Cupesidæ, Ptinidæ, Cioidæ, Bostrychidæ, Tenebrionidæ, Cistelidæ, Pythidæ, Monommatidæ, Melandryidæ, Lagriidæ, Pedilidæ, Anthicidæ, Pyrochroidæ, Mordellidæ, Rhipidophoridæ, Cantharidæ,* and *Œdemeridæ*, numbering 1494 species.—Miscellanea Entomologica, by William Macleay, F.L.S. This is the first of a series of papers descriptive of some of the new or rare Coleoptera in the Macleay Museum. The intention of the author is to accompany these descriptions with a general review of the genera or groups dealt with. The present paper is a revision of the genus *Diphucephala*, to which over twenty new species are added.—A revision of the Staphylinidæ of Australia, part 1, by A. Sidney Olliff, Assistant Zoologist, Australian Museum. The object of this paper is to furnish entomologists with descriptions of all the Australian Staphylinidæ at present known, to summarise the characters of the genera, and to make known a number of new forms. This first part contains the sub-family Aleocharinæ, of which the tribes Aleocharina, Gyrophænina, and Gymnusina are all represented. Among the most remarkable of the new forms belonging to the first of these tribes is a species from New South Wales described under the name *Apphiana veris* (gen. et sp. nov.), and characterised by having the basal joints of the antennæ enormously dilated on the outer side; the second joint being twice as broad as long, the third equally broad, but shorter, the fourth, fifth, and sixth shorter and gradually decreasing in breadth. In *facies* the species resembles a *Pelioptera.*—Notes from the Australian Museum, by E. P. Ramsay, F.R.S.E., and J. Douglas Ogilby. Two species of fish are described in this paper—*Myripristis carneus*, from the Admiralty Islands, presented to the Australian Museum by Capt. Farrell, and *Sygnathus parviceps*, from the Clarence River district, presented by Mr. Temperly, Inspector of Fisheries.—The Hon. James Norton exhibited a number of fossils (Chætetes and Spirifers) from Black Head, a few miles south of Kiama. Also, specimens of a porphyritic rock from Coolangatta, Shoalhaven, with the large crystals present in some, and decomposed by weathering in others.—Mr. Whitelegge exhibited specimens of a large species of *Nitella* with the following explanatory note. "A short time ago I found in the Parramatta River a very remarkable member of the above genus. It is an erect growing plant between 3 and 4 feet in height, mostly branching near the base, and giving off some five or six whorls of simple leaves, each leaf consisting usually of three cells, sometime of only two. The stem and leaves (six in number) are usually about $\frac{1}{16}$ of an inch in diameter. The internodal cells of the stem are usually 4 or 5 inches, but sometimes much longer. I have measured some of the largest yet found, and they are from 7 inches up to $8\frac{1}{2}$ long. It is highly probable that the cells of this plant are larger than those of any hitherto recorded. There are several other features which may not have been noticed in the genus. For instance, the leaves can be readily disarticulated from the stems without any apparent injury to either. When a cell is ruptured the sound produced is not unlike that of the bursting of the air-bladders of seaweeds. The rotation exhibited in the inner nodal cells differs from that of the stem and leaves, inasmuch as the chlorophyll granules take part in the general rotation. The protoplasm in the young leaves, when viewed under the microscope with the edge of the cell in focus, appears as a series of elevations and depressions, and with the higher part of the cell in focus, these elevations appear as clear spaces surrounded by small granules. Within the layer of protoplasm there exist large numbers of spherical clusters of needle-like crystals, which circulate along the line of demarcation between the cell-sap and the protoplasm."

PARIS

Academy of Sciences, July 12.—M. Jurien de la Gravière, President, in the chair.—On the relations that exist between the geodetic and geological sciences, by M. Faye. The author's remarks are intended to show that the distinction formerly drawn between these two sciences can no longer be maintained. Thus in geodesy, for example, the sum of the forces acting on the terrestrial globe cannot be considered apart from those incessantly modifying its relief. The recent objection regarding the Quaternary glaciers is specially dealt with, not from the geological standpoint, but from that of the attraction exercised by them on the seas.—Note on the navigation of the Suez Canal at night, by M. de Lesseps. The question of nocturnal navigation, which would practically double the capacity of the canal, has now been studied exhaustively, and successfully solved by the adoption of signal lights along the route and electric lights on board the vessels in transit.—Experiments on waves, and especially on the diminution of the mean lateral pressures of undulations in canals, by M. A. de Caligny. A series of experiments are reported made on a miniature artificial canal, with the view of testing the various actions of translation and side pressure of the waves on floating bodies.—Reflections on the critical remarks of M. Hugoniot, which appeared in the *Comptes rendus* of June 28, by M. Hirn. The reference is to the author's last experiments on the flow of gases, some of whose conclusions are here sustained against M. Hirn's objections.—Identity of origin of the fluorescence $Z\beta$ by reversion, and of the bands obtained by Mr. Crookes in vacuum, by M. Lecoq de Boisbaudran. It is shown that the red band 619 of Mr. Crookes's former spectrum of yttria is due to the same earth as the author's band $Z\beta$ obtained by reversion, and that this band does not consequently characterise a new element.—Observations made during the cholera epidemic of 1885, by M. A. Guérard.—This work, by the engineer-in-chief of the Marseilles harbour works, traces the progress of the epidemic during the years 1884-85, and attributes its virulence primarily to the contaminated waters of the little River Huveaune used for domestic purposes in the districts which suffered most.—Observations of the new planet 259 and of the comet Brooks III., made at the Observatory of Nice (Gautier equatorial), by M. Charlois.—Solar observations during the first six months of the year 1886, by M. Tacchini. These observations show a progressive diminution of the phenomenon of solar spots, as well as of the solar protuberances.—On the Peruvian metrical standard, by M. Foerster. Admitting the authenticity of this standard, the author asks that accurate determinations be made of the value in metres of its two lengths, in order that all geodetic measurements, old and recent, be reduced to the same unity, that is, the international metre. In some subsequent remarks the same course was urged by M. Wolf.—Note on M. G. A. Hirn's experiments on the discharge of gases through orifices, by M. Parenty.—A new method of constructing the screw, by M. Trouvé. During the course of protracted experiments on the application of electricity to the propulsion of ships, the author has been led to study the various forms of screw now in use, and to devise another, here described, of far more simple structure.—On a physiological condition influencing photometric measurements, by M. Aug. Charpentier.—On the heat of formation of selenhydric acid, by M. Ch. Fabre. The three methods here described for measuring this heat of formation yield a mean of -9.44 cal. for gaseous selenhydric acid.—On a new species of asparagine, by M. A. Piutti. This new substance, recently discovered by the author while assisting at the preparation of asparagine in M. G. Parenti's laboratory, at Sienna, has a rotatory power, as determined by Laurent's great polarimeter, equal to, and with contrary sign to that of ordinary asparagine. The paper elicited some remarks by M. Pasteur on the great difference in taste of the two varieties of asparagine.—Distribution of a base between two acids; special case of the alkaline chromates, by M. P. Sabatier.—On the titanates of crystallised baryta and strontian, by M. L. Bourgeois. This paper is devoted to a study of the crystallised earthy alkaline titanates, which are obtained by the application of the known method—fusion of the elements of the salt in the corresponding chloride.—Action of chlorine on the seleniocyanate of potassium, by M. A. Verneuil. From the experiments here described, it appears that the action of chlorine on the alkaline seleniocyanates differs greatly from that which it exercises on the corresponding sulphocyanates. Bromine and iodine give rise to analogous phenomena.—Transformation of glucose to dextrine, by MM. E. Grimaux and L. Lefèvre. The transformation here effected for the first time is shown to throw some light on the somewhat obscure history of the dextrines.—On the transformation of the amides to amines, by M. H. Baubigny.—Isomery of the camphols and camphors; camphol of valerian, by M. Alb. Haller. A comparison of the properties of this camphol and its derivatives with those of the camphol of N'gai and its corresponding derivatives shows complete identity between these two products. In a further communication the author hopes to show that these two camphols themselves are also identical with that derived from the spirit of madder.—Electrolysis of an ammoniacal solution with the electrodes of carbon, by M. A. Millot.—On an alcoholate of crystallised potassa, by M. Engel. The body here determined, and named "alcoholate of potassa," has the formula—

$$KOH + 2(C_2H_6O).$$

—On propionic acid, by M. Ad. Renard.—Researches on the development of beetroot (continued); general conclusion; by M. Aimé Girard.—The law of connections applied to the morphology of the organs of the Mollusks, and especially of Ampullaria, by M. E. L. Bouvier.—On the presence of Ricins (Mallophages) in the quills of birds' feathers, by M. Trouessart.—On the absorption of carbonic acid by leaves, by MM. Dehérain and Maquenne. From the experiments here described it is shown (1) that the proportion of pure carbonic acid absorbed under atmospheric pressure varies with the quantity of water contained in the leaves; (2) that the coefficient of absorption of this acid by the water contained in the leaves is in the normal temperature superior to the coefficient of solubility of the same gas in water; (3) that the absorption is extremely rapid, which explains how the foliage is able to extract the extremely minute quantities of carbonic acid (some ten-thousandths) contained in the normal atmosphere.—On the crystallographic association of the triclinic felspars, by M. R. Bréon.—On the "ophite" eruptive rocks of Corbières, by M. Viguier.—Note on the primitive and Cambrian micaceous schists of Southern Andalusia, by MM. Ch. Barrois and Alb. Offret.—On injections of toxic gaseous medicines through the rectum; successful treatment of pulmonary affections by this means, by M. L. Bergeon.

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