THURSDAY, JANUARY 17, 1878

THE DENSITY OF LIQUID OXYGEN

THE magnificent experimental methods devised by MM. Cailletet and Pictet have already begun to increase the number of the "Constants of Nature." M. Pictet, although in a neck-and-neck race he was beaten by Cailletet in the liquefaction of hydrogen, has left his competitor in the rear with regard to a result of the first importance on the density of oxygen. The noble rivalry between the École Normale Supérieure of Paris and the Atelier de Physique of Geneva bids fair not only to continually increase in interest, but to become the central feature in the progress of physical science for some time.

A telegram from M. Pictet announcing that hydrogen had been solidified was sent to M. Dumas on January 11. The illustrious chemist read the telegram at a sitting of the Société d'Encouragement, of which he was the chairman, and which was holding its regular semi-monthly meeting on that very evening. M. Dumas reminded his hearers with his wonted force and propriety of expression, that in the first edition of his "Traité de Chimie," published about forty years ago, he had called hydrogen a *gaseous metal*. He said he had been led to hold this view by seeing how small was the affinity of hydrogen for metals and how great for metalloids.

M. Dumas said moreover that his peculiar ideas had received some degree of confirmation from the discovery of the large conductibility of hydrogen for heat and electricity, but that the first real demonstration had been given by MM. Cailletet and Pictet. It was for him a great satisfaction having lived long enough to see that most important fact established so clearly, "*That you may feel certain, gentlemen, that in drinking a glass of water you are certainly absorbing a metallic oxide.*"

M. Pictet, in the experiments, the results of which were telegraphed to M. Dumas, as we have seen, prepared the hydrogen by the decomposition of potassic formiate by means of potassic hydrate. This reaction, according to Berthelot, gives the gas of the utmost purity. The pressure was commenced at 8.30 P.M., it was increased gradually, and in a little more than half an hour (at 9.7) it reached 650 atmospheres. At this moment the pressure remained stationary for some seconds, the stop-cock was opened, and a jet of a *steel blue colour* escaped with a strident noise, comparable to that heard when a bar of iron is plunged into water.

This jet suddenly became intermittent, and the spectators observed a hail of solid corpuscles projected with violence on the ground, where they produced a crackling noise. The stop-cock was then again closed, the manometer indicating 370 atmospheres. This slowly descended to 320, at which point it remained stationary for some minutes. Then it rose to 325. The stop-cock was again opened, the jet was now so intermittent, that it was believed that an actual crystallisation of hydrogen (!) had gone on inside the tube. This was proved by the fact that liquid hydrogen flowed out of the jet when the temperature was increased by the stoppage of the pumps.

M. Dumas, considering oxygen as belonging to the sulphur group, and isomorphous bodies as having the same atomic volume, *i.e.*, the quotient obtained when the atomic weight is divided by the density, had concluded that, the atomic volume of sulphur being $\frac{32}{2}$, that of oxygen would be $\frac{16}{1}$, and reciprocally, that the density of liquid or solid oxygen would be $\frac{16}{16}$, that is the atomic volume divided by the atomic weight = 1, which is the density of water.

M. Dumas having communicated these considerations to M. Pictet, has elicited a most interesting response from him. He writes :—

"You arrive at the expression of the density of liquid oxygen as being represented by $\frac{16}{16} = 1 = \delta$ in the solid state, and probably the liquid one also, neglecting the variation due to expansion.

"I have the great satisfaction of being able to announce to you the complete experimental demonstration of the theoretical views enunciated by you now some time ago at Geneva. This demonstration has been arrived at as follows :—

"I know directly and very exactly—

"I. The exact volume of the interior of the wrought iron shell and the volume of potassic chlorate decomposed into oxygen and potassic chloride.

"II. The temperature of the shell at the moment of complete decomposition.

"III. The volume of the tube in which the condensation of oxygen is brought about.

"IV. The pressure before and after condensation.

"V. The pressures indicated by the manometer after two or three successive jets, till the moment the point of saturation is reached, and after which the gas issues in a gaseous form.

"These various data, combined with the gaseous density pressure and temperature lead me to the conclusion that a difference of 74·26 atmospheres on the manometer represents the variation of pressure corresponding to the condensation of oxygen in the tube immersed in the carbonic acid.

"This variation has been exactly observed in the three last experiments which I have made with the assistance of many of my colleagues here at Geneva.

"The quantity of liquid oxygen which we had in the tube was 45·467 grammes, corresponding to a volume of 46·25 cubic centimetres. But it is possible that the highest part of the thin tube had some centimetres in length not occupied by the liquid. This may explain the difference of 0·8 gramme found.

"Moreover, very volatile liquids have such considerable expansions that it is indispensable to have exactly the temperature to which they are subjected, in order to determine their true density. However this may be, there is an absolute verification, within small limits, of error of the theoretical calculation regarding this physical constant."

In addition to this important result, in another experiment, M. Pictet has used polarised light to determine the presence or absence of solid particles of oxygen in the jet. The jet was illuminated by means of the electric light, and observed with two Nicol prisms. A very strong polarisation was observed, indicating the presence of solid particles, which in all probability were really solid particles of oxygen.

FRANKLAND'S RESEARCHES IN CHEMISTRY

Experimental Researches in Pure, Applied, and Physical Chemistry. By E. Frankland, Ph.D., D.C.L., F.R.S. &c. (London: John Van Voorst, Paternoster Row.)

THE numerous and valuable investigations of Dr. Frankland in general chemistry are so well known, that chemists will doubtless regard the issue of his collected researches with lively satisfaction, partly on account of the ease with which the various memoirs can be referred to in the fine volume before us, but chiefly because the work is likely to prove of special value as an aid in the higher education of chemical students.

Any criticisms of the statements of fact or of theory contained in such a set of "collected researches" would be so clearly out of place in NATURE, that we need offer no apology for dealing with the work before us from a general rather than from a technical point of view. Indeed, almost all the *matter* contained in the volume has long been the common property of all engaged in the pursuit of chemistry, while the *manner* in which the investigations are presented to the reader is alone new. The chief interest of the work as a whole is due to the fortunate circumstance that its varied contents have been grouped by the distinguished author of the researches, who has bound them together with a species of commentary that enables the reader clearly to appreciate the relations of the parts in each line of inquiry, and to obtain such glimpses into the working of the mind of the investigator as the study of formal papers can rarely afford.

The subject-matter of this fine volume of rather more than 1,000 pages is conveniently divided into three sections. Section I. contains the author's researches in Pure Chemistry; Section II., those in Applied Chemistry; and Section III., the investigations that belong to the physical side of the science.

Section I. is fitly introduced by a chapter on the peculiar system of notation now employed by Dr. Frankland. This introduction was rendered necessary by the translation of the older formulæ employed in the earlier memoirs into those more recently adopted by the author. Although Dr. Frankland's system of notation is undoubtedly interesting, we fear that its use throughout the volume will detract from the educational value of the work in the eyes of those chemists who think that the expressions in common use can be made to serve the same purposes as those employed in the South Kensington School.

As the work stands, however, the chapter in question is useful in its place, and it may induce some chemists to adopt the author's system who have hitherto held aloof from it.

The first of the series of researches given is that on the transformation of cyanogen into oxatyl. This well-known inquiry was carried on in conjunction with Dr. Kolbe at a time when the investigation of the then recognised "compound radicles" had commenced to excite much interest, more especially in view of Liebig's recently propounded theory of conjugated compounds. The investigation led to the highly important conclusions that most of the organic acids owe their acidity to the presence of the group COOH (the semi-molecule of oxatyl), and that their basicity depends on the number of these groups contained within their molecules; while it was shown that the synthesis of many acids of the acetic series could be effected by the conversion of the cyanogen of alcoholic cyanides into the oxatyl semi-molecule by the action of alkalies. This research has since borne rich fruit, and it seems to have led, almost directly, to the most important of the author's discoveries, namely, to the isolation of the alcohol radicles by the action of zinc on iodides of radicles containing half the number of atoms of carbon. Although this research was one of the most important contributions to synthetic chemistry that had then been made, its full value was not understood till M. Wurtz completed Dr. Frankland's work by the discovery of methyl-ethyl, and other mixed radicles, which he prepared by the action of zinc on mixtures of alcoholic iodides, thus filling up the gaps in Frankland's list, and rendering the method a general one for ascending the homologous series.

In the course of experiments on the action of zinc on the iodides of alcohol radicles, Frankland made the remarkable discovery that the metal can unite directly with the alcohol radicles and form the curious and interesting compounds now termed "organo-metallic," of which zinc-methyl and zinc-ethyl are those most commonly known. The author says "zinc-methyl and zinc-ethyl were the first of these bodies with which I became acquainted; they were discovered on July 12, 1849, in the laboratory of Prof. Bunsen at Marburg, during my work on the isolation of the organic radicles. After making the reaction for the isolation of methyl by digesting methylic iodide with zinc, and after discharging the gases, I cut off the upper part of the tube in order to try the action of water upon the solid residue. On pouring a few drops of water on this residue a greenish blue flame several feet long shot out of the tube, causing great excitement amongst those present. Prof. Bunsen, who had suffered from arsenical poisoning during his researches on cacodyl, suggested that the spontaneously inflammable body, which diffused an abominable odour through the laboratory, was that terrible compound which might have been formed by arsenic present as an impurity in the zinc used in the reaction, and that I might be already irrecoverably poisoned. These forebodings were, however, quelled in a few minutes by an examination of the black stain left upon porcelain by the flame; nevertheless, I did afterwards experience some symptoms of zinc poisoning."

The discovery of the large group of organo-metallic bodies and the secondary investigations to which the author was thereby led induced him to propound the theory of "atomicity," now taught in one form or another in our schools of chemistry.

Having discovered the organo-metallic bodies just referred to, Dr. Frankland appears to have turned his attention to the production of analogous compounds containing *unmetallic* bodies united directly with alcohol radicles, and in this direction he was successful, as he showed that boron could be made to afford some highly interesting compounds of the desired kind. This line of investigation, however, was not pursued to any considerable extent, as the author evidently desired to concentrate his attention upon the study of the action of members of the organo-metallic group upon various organic bodies, hoping thereby to succeed in replacing the oxygen of many oxygenated compounds by alcohol radicles derived from zinc-methyl, zinc-ethyl, and allied bodies. In the primary research of this new series, nearly all of which were conducted in conjunction with the late Mr. B. F. Duppa, ethylic oxalate was the subject of experiment, with the result that a portion of its oxygen was replaced by methyl, and the first step taken in the synthesis of acids of the lactic series. A large number of new compounds were discovered, and the relations of the members of the lactic series of acids to each other and to the acrylic and to the fatty group of acids clearly made out. Then followed researches on the members of the acrylic series which were suggested by those on the lactic acids and which also afforded a rich harvest of results.

Up to this point Dr. Frankland's investigations are seen to have been intimately connected with one another and to have resulted in some of the most valuable contributions yet made to synthetical chemistry; but the last research of importance included in this section of the volume seems to stand alone, for it is concerned with the synthesis of acids, ethers, and ketones of the fatty series by a method differing from that previously employed in the important particular that the alcohol radicles were substituted for hydrogen and not for oxygen. These new investigations resulted in the discovery of a mode of effecting the synthesis of the acids of the fatty series and of bodies related to them, of dissecting their molecules, and thus, in some measure, of determining their structure. Although these researches were not directly connected with those that preceded them, there can be scarcely a doubt that they were suggested by the insight into the constitution of the acids gained in the course of Dr. Frankland's previous researches.

A few short papers—on Gas Analysis, on the Composition of Air from Mont Blanc, on the Analysis of Organic Compounds containing Mercury, and on the Combustion of Iron in Compressed Oxygen—bring Section I. to a close.

Section II. contains the author's researches on Artificial Light, on Drinking Water, on the Purification of Foul Water; together with miscellaneous work in Applied Chemistry. Section III. includes Dr. Frankland's valuable memoirs on the Influence of Atmospheric Pressure on Combustion, on the Spectra of Gases of Vapours (an investigation carried out in conjunction with Mr. Lockyer), on the Source of Muscular Power, and on Climate.

The contents of these two sections are much too interesting to be lightly passed over—and those of Section II. in some degree challenge criticism—but we must leave them for consideration in another article and now return to Section I. This section forms just half the book, and by far the most important half. In fact Dr. Frankland's work is so naturally divisible into two parts that we regret he has not issued it in two volumes rather than in its present form, for its value as a work of reference would not have been lessened thereby, while the section of chief educational importance (Section I.) would have been rendered more easily accessible to students. This is, however, but a trifling fault—if a fault it happens to be—but the really important fact remains that we can point students to the volume before us for a clear and detailed account of some of the most remarkable researches of our time in synthetic chemistry. It is difficult to over-estimate the importance of inducing senior students to consult original memoirs rather than abstracts of researches. The temptation to rest content with a statement of results is great, but we have no hesitation in expressing the opinion that the careful experimental study of a single good memoir, on a subject suited to the capacity of the student, is of far greater value to him than the immediate knowledge of the contents of a volume of the "Abstracts" given in the *Journal* of the Chemical Society, useful though these are when properly employed. The publication of such groups of researches as Dr. Frankland's will, we believe, do much to promote the kind of higher chemical education referred to, and to foster a taste for research amongst senior students of chemistry.

J. Emerson Reynolds

(To be continued.)

OUR BOOK SHELF

Bericht über die Thätigkeit der botanischen Section der schlesischen Gesellschaft im Jahre 1876. Erstattet von Prof. Dr. Ferdinand Cohn, zeitigem Secretair der Section.

This is a journal of the proceedings of the ten ordinary and one extraordinary meetings of the Silesian Society held during the year 1876. The chief contributors are Professors Goeppert and Cohn, and their communications relate to a great variety of subjects. The most important paper of Goeppert's is on the effects of the cold of December, 1875, on the vegetation in the Breslau Botanic Garden, much interesting information being given on the action of cold on plants, the effects of snow in protecting vegetation, and the action of frost on roots. Another interesting paper, by the same author, is on Plant Metamorphoses. The indefatigable industry of Prof. Cohn is well shown in this journal, as he contributes a large number of valuable papers. His recent visit to Britain affords materials for two papers, while a short communication on Spontaneous Generation is interesting on account of the ingenious form of the tube in which the experiments were made, the shape being that of a capital N turned upside down. The other papers of interest are chiefly connected with the newly-published "Cryptogamic Flora of Silesia," noticed a short time since in our columns. The last paper is by Uechtritz on the Phanerogams of the Silesian Flora, and occupies a large part of the whole *Bericht*.

A List of Writings Relating to the Method of Least Squares, with Historical and Critical Notes. By Mansfield Merriman, Ph.D. (From the *Transactions* of the Connecticut Academy, vol. iv., 1877, pp. 151–232.)

Mr. Merriman is already favourably known as the author of a good text-book on the "Elements of the Method of Least Squares." In this work he gave a short "list of literature," and said he could easily have extended its limits; indeed he hoped some time to publish an extended list. All students of this branch must be greatly indebted to Mr. Merriman and to the Connecticut Academy for this excellent critical list of writers. There are 408 titles, classified as 313 memoirs, 72 books, and 23 parts of books, dating from Cotes (1722) down to 1876. Of these 408, 312 are described from actual inspection. We could wish for similar lists in other branches, for then much time would be saved and students could easily determine what books would be most advantageous to them, and also get an idea of what had already been done by previous investigators. There are numerous clerical errors, easily to be corrected, but we are surprised that so well-informed and painstaking a writer should call Sir W. Thomson, Thompson, and Dedekind, Dedakind, as he does on all occasions when their names occur.

LETTERS TO THE EDITOR

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

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

The Radiometer and its Lessons

I AM sorry to have again to correct Mr. Stoney; but I cannot allow the statements contained in his letter to pass unnoticed.

1. There is nothing in my earlier paper that is "*admittedly erroneous.*" If there is error in these papers I am not aware of it.

2. These papers do not "conclude with Prof. Reynolds's own expression of opinion that residual gas is not the cause of the force observed by Mr. Crookes." Nor have I ever held or anywhere expressed such an opinion.

3. In the passage to which Mr. Stoney refers, Clausius does not imply that the law established by himself and Maxwell, viz., that the only condition of thermal equilibrium in a gas is that of uniform temperature, depends on the mean path of the molecules; and it was this law that I instanced as being at variance with Mr. Stoney's assumptions (1) that gas is a perfect non-conductor of heat; (2) that a layer of gas across which the temperature varies can exist in a state of thermal equilibrium without the passage of heat from the hotter to the colder part. Mr. Stoney has nowhere that I can see given any proof of these assumptions, and I venture to prefer the authority of Professors Maxwell and Clausius, supported as it is by the whole evidence of facts.

4. Mr. Stoney says that I have excluded the polarisation of gas from my explanation. Mr. Stoney has not, that I am aware, defined what he means by polarisation, but if he measures the polarisation of a gas conducting heat by the excess of momentum carried across any ideal surface in one direction over and above that which is carried in the opposite, this polarisation is independent of the length of the mean path, and forms an essential part of my explanation.

There is one statement in Mr. Stoney's letter which is not erroneous. He says:—"I cannot find anywhere in Prof. Osborne Reynolds's writings an explanation of the thing to be explained, viz., that the stress in a Crookes's layer is different in one direction from what it is at right angles to that direction."

I do not at all admit that this is "the thing to be explained," and I am quite sure that Mr. Stoney would find no explanation of it in my writings.

In the passage quoted above Mr. Stoney has, for the first time, so far as I know, expressly stated his belief that Mr. Crookes's phenomena depend on such a difference of stress. I have thought all along that his views were based on such an assumption, but I did not like to take it for granted. It is almost a pity, if I may use the phrase, that he did not express himself thus clearly at first, as in that case I might have done before what I am about to do now, viz., prove definitely that such a condition of stress can have nothing to do with the cause of Mr. Crookes's results—that, so far from explaining, such a condition of stress is inconsistent with, these results, and this, not in mere matters of detail, but as regards the fundamental direction in which the force acts.

Throughout all the experiments that have been made one invariable law as to the direction of motion has been found to maintain, which is that the force always tends to drive the vanes or bodies in the direction of their colder faces. Thus when a body is free to move in a sufficiently rarefied medium, if its front be heated it will move backward, while if its front be cooled it will move forward, always moving towards its colder face. There are no exceptions to this rule.

Let us now suppose that we have two bodies, A and B, free to move in a sufficiently rarefied medium. Suppose A to be initially hot and B cold, while the medium and surrounding surface are at the mean temperature of A and B. Then, owing to the radiation of heat between the two bodies, that side of A which is opposite to B will be cooled faster, and hence be colder than the other side of A. Hence according to the law stated above, A must move towards B, and this it is found to do by experiment. On the other hand, that side of B which is opposite to A will become heated by radiation faster, and hence become hotter, than the other side of B, and hence B will move away from A. Thus if both bodies were free to move, we should have B running away from A, and A running after B.

This aspect of the phenomenon is perhaps the most paradoxical that presents itself; it is nevertheless in strict accordance with experiment, and it was by instancing this case that I was enabled to show that the force could not by any possibility be directly due to radiation (see *Phil. Trans.*, vol. 166, p. 728).

The same reasoning now enables me to show, just as conclusively, that the force which causes the motion in the bodies cannot be due to the stress, in the layer of gas which separates the bodies, being greater in the direction joining the bodies than it is at right angles to this direction. For the only effect of such a difference in the stress would be to cause the bodies to separate; therefore, instead of A following B, it would be forced back in the direction of its hottest side, or in a direction opposite to that in which it is found experimentally to move.

This case, therefore, shows the fundamental error of Mr. Stoney's view. Although he allows that the intervening gas is the medium of communication, he assumes, none the less, that the force acts directly between the two bodies (the heater and cooler), in which case action and reaction must be equal between the two bodies. Experiment, on the other hand, shows conclusively that the force acts independently between each body and the gas which surrounds it; the pressure being always greatest on the hottest side. The force which acts on the body reacts on the gas, causing it to move in the opposite direction, and the wind thus caused tends to carry all opposing obstacles with it. Hence, in the case above, the motion given to the air at the one body must to some extent affect the opposing surface, but this surface forms only one obstacle, while the action of the wind is distributed throughout the entire chamber, in which it acts in the manner so beautifully shown by Dr. Schuster's plan of suspending the vessel. A simple analogy to what happens in the case of A and B is furnished by two steamboats, the one following the other. The water thrown back by the screw of the first would stop the second, but only to a small extent.

When answering Prof. Foster in a former letter, I said "that it is contrary to the kinetic theory that the increase resulting from rarefaction in the mean path of the gaseous molecules should favour the action." In making this statement all I meant to imply was that the action was independent of any relation between the mean path and the distance of the hot surface from the cold surface, which was the only point in question. Although my statement was strictly true in this sense, it appears to me, on further consideration, that it might include more than I intended.

I hope that nothing I have said, either in my earlier papers or in this controversy, has led any one to suppose that I regarded my explanation as entirely complete. I suggested, and to some extent established, the true source of the force, namely the heat communicated to the residual gas, and although now my suggestion appears to have been universally accepted, it may be remembered that at the time my first paper was written the only other suggestions as to the cause of the motion observed by Mr. Crookes were of a widely different character. As regards the working out of the detail of my explanation, there has been one point which I could not quite see through, viz., the influence which the hot molecules receding from the surface might have on the rate at which the cold ones would come up, and although I have been trying to satisfy myself on this point ever since my first paper was published, it is only within the last three months that I succeeded.

Now, however, I have arrived at a result which, although somewhat unexpected and striking, will, I hope, be found to reconcile what has hitherto appeared to be anomalous in the phenomena already known, and to have suggested certain hitherto unexpected phenomena which now only await experimental verification.

OSBORNE REYNOLDS

January 15

Sun-spots and Terrestrial Magnetism

PRECISELY because the article (NATURE, vol. xvii. p. 183) on "The Sun's Magnetic Action at the Present Time," is by so able a mathematical physicist as Mr. John Allan Broun, and because of all sides of the solar problem there is none wherein he is so *facile princeps* as the magnetic, I venture to think this a good opportunity for asking a question which has troubled me much of late, and which is this:—

The sun-spot cycle and the terrestrial magnetic diurnal oscillation cycle are looked on now generally as being, if not actual cause and effect, at least as equally both of them effects of one and the same cause, and necessarily, therefore, synchronous. Yet if we inquire of the sun-spot observers the length of their cycle, they declare it (as see Prof. Rudolph Wolf's admirable and exhaustive paper in the last volume of the *Memoirs* of the Royal Astronomical Society) to be 11·111 years. While if we ask the magnetic men the length of the cycle of their needle manifestations, they (as in Mr. Allan Broun's first paragraph on p. 183) declare it as confidently to be 10·5 years.

Wherefore I would request to be kindly informed if the maxima of the two cycles do approximately agree just now, where will they be, relatively to each other, after a dozen cycles hence? And the answer may or may not assist in clearing up certain apparent anomalies in the Edinburgh earth-thermometer observations. PIAZZI SMYTH

15, Royal Terrace, Edinburgh, January 11

On the Insects of Chili and New Zealand

IN Mr. McLachlan's note "On Some Peculiar Points in the Insect Fauna of Chili" (NATURE, vol. xvii. p. 162), I see, with surprise, the remark that "the large islands of New Zealand furnish us with no indication whatever of forms parallel with those found in Chili," for it is well known that many Lepidoptera belonging to European genera do occur in New Zealand, although, perhaps, neither *Argynnis* or *Colias*. Amongst a small number of Lepidoptera from New Zealand which lately came into my hands, I notice species of the following European genera:—*Sesia*, *Cloantha*, *Nonagria*, *Heliothis*, *Hybernia*, *Larentia*, *Fidonia*, *Cidaria*, *Coremia*, *Camptogramma*, *Asthena*, *Acidalia*, *Scoparia*. Except in the case of *Sesia tipuliforme*, it is not probable man has had any hand in the introduction of them. None, except the *Sesia*, are identical with European species, although several approximate, and the causes which have led to the existence of *Agynnis* and *Colias*, in Chili, are probably the same as those which have planted the insects I have named in New Zealand.

In Mr. Darwin's "Origin of Species," Chapter XII., we find a suggested Explanation of the Presence of the Forms of the Northern Temperate Zone in South America and New Zealand in the occurrence of alternate glacial epochs at the North and South Poles, and although the observations especially refer to plants, they are applicable to the insects which would, doubtless, accompany them in their supposed migrations. Perhaps it is not an entirely satisfactory explanation, and with his usual candour, Mr. Darwin admits that it does not meet all difficulties. In describing the wanderings of the plants, Mr. Darwin uses terms (figurative of course) which endow them with extraordinary if not voluntary powers of locomotion, as, indeed, they would seem to require in reality, for effecting such wonderful migrations, and as regards insects Mr. McLachlan goes further, and suggests that some of them "mistook the points of the compass and went southward."

Now the pertinacity with which the Lepidoptera adhere to particular plants and stations, and prefer death to change of either, is a much more noticeable character than their ability to emigrate, and seems to me a serious bar to the acceptance of a theory involving great changes of food and a double journey across the equator; possibly some of the polyphagous species might survive it, but even these, according to Mr. McLachlan, appear to have got a little muddled in their reckoning. Most of the insects I have named are eminently select in their diet, and how are we even to conceive of the wingless female of Hybernia performing the vast journey?

I do not know that we have evidence that change of climate induces migration of the Lepidoptera. There is a large colony of *Bryophila perla*, which has been stationed on an old wall here for the last twenty years, and although there are miles of similar lichen-covered walls in the neighbourhood, I have never seen a specimen fifty yards from head-quarters, and even under the threat of a new glacial epoch, I do not think it would consent to move on.

In saying there are no indications of similar forms on the northern portions of the Andes, I am not sure whether Mr. McLachlan refers to Lepidoptera or Trichoptera, so I will mention that I have received several species of *Colias* captured on the eastern Cordillera of New Granada. The genus probably ranges through the whole chain of the Andes.

Douglas, Isle of Man, January 2 EDWIN BIRCHALL

Macrosilia cluentius

IN NATURE (vol. viii. p. 223) I have spoken of a *Sphinx* which, with its proboscis of 0·25 metre length, would be capable of obtaining nearly all the nectar of *Anagræcum sesquipedale*. Lately my brother, Fritz Müller (Itajahy, Prov. St. Catharina, Brazil), sent me the wings of another specimen of the same species, and Dr. Staudinger, of Dresden, stated by comparison of these wings with the Sphingidæ of his collection that the name of the species is *Macrosilia cluentius*, Cramer.

Lippstadt, January 9 HERMANN MÜLLER

Meteor

I TAKE the liberty of forwarding the following particulars relative to a meteor which I saw on Sunday last at 4h. 24m. P.M., that is to say, about twenty minutes after sunset. As, however, the day had been very fine, there was not only full daylight in the west, but only a trace of twilight in the north-west direction, in which I saw the meteor. I may add that the sky was slightly overcast by watery clouds in that direction:—

Point from which seen, Salthill, near Kingstown; direction in which seen, north-west; elevation above horizon, 10° to 15°; length of luminous "tail," 5° to 6°; inclination from vertical, about (towards south) 10°; time, 4h. 24m. P.M.; colour of tail and of globe of explosion, light blue.

Judging from the elevation and from the fact of its being visible notwithstanding the strong twilight and the interposed clouds, I conclude that this meteor must have been remarkably brilliant and that it exploded over or beyond the West Coast of Ireland. It is for these reasons that I take the liberty of calling attention to it, as others may have seen it under more favourable conditions. P. W. REILLY

Royal College of Science for Ireland,
Stephen's Green, Dublin, January 15

Philadelphia Diplomas

IN NATURE, vol. xvii. p. 183, there appears a note by Dr. C. M. Ingleby on the "Philadelphia Diplomas." Permit me to say that the only institutions in Philadelphia legally authorised to grant medical diplomas are the University of Pennsylvania, a school which has long ago celebrated its centenary, and the Jefferson Medical College. The so-called University of Philadelphia is a hybrid concern, the medical department of which is under the management of the Eclectic Medical School.

January 10 RICHD. C. BRANDEIS

Great Waterfalls

I SHALL be much obliged if you, or any of your readers, can inform me in what book I can find accounts of any of the following great waterfalls:—The Tequendama Fall, near Sta. Fé de Bogota, South America; the Cauvery Falls, near Seringapatam, India; the Alatau Falls, Alatau Mountains, Central Asia; the Guava, or Guayra Falls, on the Alto Parana, South Brazil; Falls of the Rio Grande, near Guadalajara, Mexico. These great falls, five of the most remarkable in the world, are shortly noticed in books of geography, but I have hitherto been unable to obtain any detailed particulars or description of them.

Eltham, January 7 ARTHUR G. GUILLEMARD

BIOLOGICAL NOTES

SELF-FERTILISATION OF PLANTS.—This subject, around which the genius of Mr. Charles Darwin has thrown a halo, seems likely to give rise to further controversy. The Rev. G. Henslow, in a communication laid before the first meeting this session of the Linnean Society, gave an exposition of the views he had arrived at; these in many respects being at variance with those promulgated by Mr. Darwin. The author acknowledged how indebted he stood towards the latter, whose vast storehouse of facts and close reasoning necessitated constant reference to his writings; but the author's own deductions therefrom, and additional researches, nevertheless, confirmed him in hesitating to accept some of Mr. Darwin's conclusions. According to Mr. Henslow, the chief facts and bearings of the self-fertilisation of plants may thus be summarised: 1. The majority of flowering plants are self-fertile. 2. Very few are known to be physiologically self-sterile. 3. Many are morphologically self-sterile. 4. Self-sterile plants become self-fertile by (*a*) withering of the corolla, (*b*) its excision, (*c*) loss of colour, (*d*) closing, (*e*) not opening, (*f*) absence of insects, (*g*) reduction of temperature, (*h*) transportation. 5. Highly self-fertile forms may arise under cultivation. 6. Special adaptations occur for self-fertilisation. 7. Inconspicuous flowers are highly self-fertile. 8. Cleistogamous flowers are always self-fertilised. 9. Conservation of energy in reduction of pollen. 10. Relative fertility may equal or surpass that of crossed plants. 11. It does not decrease in successive generations. 12. It may increase. 13. Free from competition self-fertilised plants equal the intercrossed; (*a*) as seedlings, (*b*) planted in open ground. 14. They may gain no benefit from a cross from the same or a different stock. 15. They are as healthy as the intercrossed. 16. They may be much more productive than flowers dependent upon insects. 17. Naturalised abroad they gain great vigour; and (18) are the fittest to survive in the struggle for life.

PHYSIOLOGICAL ACTION OF NICOTIN.—About twenty years ago the Rev. Prof. Haughton called attention to the fact that there was an antagonism between the actions of nicotin and of strychnia. His experiments were on frogs. About ten years afterwards Dr. Wormley experimented in the same direction with cats; and some five years ago Dr. Reese performed a series of experiments with these drugs on dogs. Not satisfied with the results of any of these experimenters and recognising the great importance of the subject, Dr. Haynes has made a long series of experiments on dogs, cats, rabbits, and rats, and after some 143 experiments, has come to the following conclusions:—"The recorded cases of strychnia poisoning treated by tobacco are extremely unsatisfactory. If they prove anything it is merely that tobacco is a powerful emetic." "Haughton's experiments on this subject (really only two in number) were performed in such an unscientific manner as to be utterly valueless." "Strychnia and nicotin are in no degree antagonistic poisons." "Strychnia increases the convulsive action and does not diminish the motor paralysis of nicotin." "Nicotin (even in paralysing doses) increases the convulsive action of strychnia." "Both poisons cause death by paralysing the respiratory organs. They may affect respiration in different ways, but the result is the same." Animals may be killed by injecting together doses of the two drugs which, singly, are not fatal. (*Proceedings* of the American Philosophical Society, vol. xvi., No. 99.)

GLASSY SPONGES.—Drs. W. Marshall and A. B. Meyer have published a memoir, as one of a series of communications to the Zoological Museum at Dresden, "on some new or little-known sponges belonging to the Hexactinellidæ found in the Philippines." It seems but the other day since one could have numbered on the fingers of one hand all the known species of this family, so well known to many by that beautiful typical form, the Venus's flower-basket (*Euplectella*), and now the number of described species is very large. In 1872 one of the authors (Dr. Meyer) was staying at Cebú one of the Philippine group, where *Euplectella aspergillum* is a regular article of trade, quoted at so much a dozen, and where it is not surprising that he should discover a number of other lovely forms in this memoir described and figured. Among the more interesting forms are the following:—*Hyalocaulos simplex*, *Myliusia zittelii*, and two species of *Aulodictyon*, all of these found living attached to the basal portion of *Euplectella*. *Semperella schultzei* is figured of a natural size from a specimen twenty-one inches in length, and figures of the spicules of the various new species are also given.

A MALE NURSE.—The interest of the reproduction of Batrachians is by no means yet exhausted. A Spanish naturalist, Jimenez de la Espada, has recently discovered additional facts respecting *Rhinoderma darwinii* (of Chili), which was first made known by Mr. Darwin. He finds that the supposed viviparous birth of the young from the female is a very different phenomenon. It is the males which are the nurses, and they have an extraordinary brood-sac, developed as a pouch from the throat, and extending over a great portion of the ventral surface of the animal. In this cavity a number of living tadpoles were found, in number of individuals, and the length of the tadpoles was about 14 mm. How these are first developed and nourished is not yet known. Dr. J. W. Spengel translates a portion of the Spanish paper in the current number of the *Zeitschrift für wissenschaftliche Zoologie*, vol. xxix. part 4.

STRUCTURE OF CYCADEÆ.—E. Warming, of Copenhagen, publishes (in Danish with French abstract) some fresh researches on this subject ("Recherches et Remarques sur les Cycadées," Copenhagen, 1877). He confirms in general the results previously arrived at by A. Braun and others, from the structure of the ovule and seed, the pro-embryonic characters, the mode of formation of the pollen and pollen-plant, and of the growth of the stem and roots, &c., that the Cycadeæ are very nearly allied to the Coniferæ; and in particular he places them near to the Gingko (*Salisburia adiantifolia*). Among Cryptogams he considers them to come nearest to Marattiaceæ and Ophioglossaceæ among Filicineæ. He proceeds then to discuss the homology of the ovule of Phanerogams, on which he thinks the structure of that of the Cycads—intermediate between Vascular Cryptogams and Angiosperms—throws much light. The phanerogamic ovule he considers to be composed of two parts, of different morphological origin, viz., a nucleus which is homologous with the macrosporangium; and a lobe of the leaf which bears the nucleus, consisting partly of the funiculus and partly of the integuments. In Angiosperms the nucleus rests on the surface of the leaf; in Gymnosperms it is partly imbedded in it. No part of the ovule is of axial origin (*caulome*).

THE BRAIN OF A FOSSIL MAMMAL.—Prof. Cope has been able to take a cast of the cranial cavity of a specie of the Tapiroid genus Coryphodon, from the Wahsatch beds of New Mexico. This has revealed remarkable primitive characters: (1) the small size of the cerebellum; (2) the large size of the region of the corpora quadrigemina; (3) the cerebral hemispheres were small, and (4) the olfactory lobes were very large. The medulla oblongata is wider than the cerebral hemispheres. In profile the brain closely resembles that of a lizard. These characters are so extraordinary that Prof. Cope considers them sufficient to mark a primary division of mammalia, which he, following Owen, calls Protencephala. Prof. Cope describes and gives figures of a cast, the skull cavity, in the *Proceedings* of the American Philosophical Society, vol. xvi., No. 99.

INSECTIVOROUS PLANTS[1]

SINCE the appearance of Mr. Darwin's work on "Insectivorous Plants" the want of direct proof that the plants profit by their carnivorous habits has been somewhat widely felt. Thus we find expressions to this effect by MM. Cassimir de Candolle, Cramer, Duchartre, Duval-Jouve, Faivre, Göppert, E. Morren, Munk, Naudin, W. Pfeffer, Schenk, &c., &c.

The assent which many naturalists have given to Mr. Darwin's explanation of the meaning of the structure and physiological properties of carnivorous plants rests on a sound basis, namely, the impossibility of believing that highly specialised organs are unimportant to their possessor, and the difficulty of giving any rational explanation except the one proposed in "Insectivorous Plants." Mr. Darwin himself felt the desirableness of direct evidence on this head, and the experiments intended to

[1] From a paper "On the Nutrition of *Drosera rotundifolia*," by Francis Darwin, M.B., read before the Linnean Society, January 17, 1878.

decide the question only failed through an accident. The present research by Dr. F. Darwin is practically a repetition of the same experiments.

The widely-spread belief that insectivorous plants thrive equally well when deprived of animal food rests on very insufficient grounds. Many observers have based their opinion on the general appearance of the plants, and in no case has observation been sufficiently extended in point of time or details of comparison. The plan of the present research was therefore (1) To cultivate a large number of plants. (2) To continue observation for a considerable space of time, during which artificial starving and feeding of two sets of plants was to be kept up. (3) To compare the starved and fed plants in a variety of ways and especially as to the production of seed.

With this object about 200 plants of *Drosera rotundifolia* were transplanted (June 12, 1877), and cultivated in soup-plates filled with moss during the rest of the summer.

Each plate was divided into halves by a low wooden partition, one side being destined to be fed with meat, while the plants in the opposite half were to be starved. The plates were placed altogether under a gauze case, so that the "starved" plants might be prevented from obtaining food by the capture of insects. The method of feeding consisted in supplying each leaf (on the fed sides of the six plates) with one or two small bits of roast meat, each weighing about one-fiftieth of a grain. This operation was repeated every few days from the beginning of July to the first days of September, when the final comparison of the two sets of plants was made. But long before this it was quite clear that the "fed" plants were profiting by their meat diet. Thus, on July 17 it was evident that the leaves on the "fed" side were of a distinctly brighter green, showing that the increased supply of nitrogen had allowed a more active formation of chlorophyll-grains to take place. It may be inferred, partly from microscopical examination of the starch in the leaves, but more certainly from the final comparison of dry weights, that the increase of chlorophyll was accompanied by an increased formation of cellulose. From this time forward the "fed" sides of the plates were clearly distinguishable by their thriving appearance and their numerous tall and stout flower-stems.

The advantage gained by the fed plants was estimated in many ways. Thus, on August 7 the ratio between the number of "starved" and "fed" flower stalks was 100 : 149·1. And by comparing the number of stems actually in flower it was clear that the starved plants were losing the power of throwing up new flower stems at an earlier date than their rivals. In the middle of August the leaves were counted in three plates, and were found to be 187 on the starved, and 256 on the fed side—or in the ratio of 100 : 136·9.

At the beginning of September the seeds being ripe, all the flower-stems were gathered, and the plants of three plates were picked out of the moss and carefully washed. As it seemed probable that one advantage of the fed over the starved plants would be the power of laying by a larger store of reserve-material, three plates were allowed to remain undisturbed after the flower-stems had been gathered. The relative number of plants which will appear in the spring on the "fed" and "starved" sides will be a means of estimating the relative quantities of reserve-material.

The following list gives the result of counting, measuring, and weighing the various parts of the two sets of plants. It will be seen the number of plants (judging from the three plates examined) were fairly equal on the starved and fed sides of the partitions so that a direct comparison of their produce is allowable :—

Ratio between the number of starved and fed plants	100 : 101·2[1]
Ratio between weights of the plants *exclusive* of flower-stems	100 : 121·5
Total number of flower stems	100 : 164·9
Sum of the heights of the flower stems ...	100 : 159·9[1]
Total weight of flower stems	100 : 231·9
Total number of capsules	100 : 194·4
Average number of seeds per capsule ...	100 : 122·7
Average weight per seed	100 : 157·3
Total calculated *number* of seeds produced	100 : 241·5
Total calculated *weight* of seeds produced	100 : 379·7

[1] In all cases "starved" = 100.

The most important feature in the general result is that the advantage gained by the fed plants is far more conspicuously shown in all that relates to the seeds and flower-stems than in any other part. Thus the ratio between the weights of the plants, exclusive of flower-stems were as 100 to 121·5; while the weights of the flower-stems, including seeds and capsules, were as 100 to 231·9. The highest ratio is seen to be between the total weights of seed produced, namely 100 : 379·7; and this is intelligible, because a store of nitrogen is laid by in the albuminous seeds.

Another point is that the difference between the starved and fed plants is more clearly shown in the comparison of weights than of numbers or heights. It is clear that increase of weight is a better proof of increased assimilation than any other character.

It may fairly be said that the above experiments prove beyond a doubt that insectivorous plants are largely benefited by a supply of animal food, and it can no longer be doubted that a similar benefit is gained in a state of nature by the capture of insects.

ALBERT VON HALLER

ON December 12 last the republic and city of Berne celebrated the centenary of the death of one who is universally recognised as their greatest citizen. The important part played in science by Albert von Haller last century is a sufficient excuse for us, profiting by the occasion of the recent celebration, to enable our readers to appreciate the marvellous aptitude of this eminent man for every kind of work, theoretical and practical; he was at once a statesman, theologian, and poet, as well as a physiologist, anatomist, and botanist.

Albert Haller was born at Berne in October, 1708, of a family originally of St. Gall, one of whose members fell by the side of Zwingli in 1531. Very weak in body, like Isaac Newton, in his infancy, he exhibited, like him, an extraordinary precocity, and his avidity for books was something indescribable. Having finished his classical studies brilliantly and rapidly, he went to Tübingen at the age of fifteen years to study medicine, then soon after to Leyden to follow the clinic of the illustrious Boerhaave, on whose works he at a later time published a commentary which greatly contributed to his renown. Albinus taught him anatomy and J. Gessner botany. At eighteen and a half years he obtained the degree of doctor, and afterwards attended, in London, the teaching of Dr. Winslow. After a sojourn at Paris he returned to Switzerland and studied mathematics with Jean Bernoulli, and that with such ardour that his friends were constrained to look after him.

In 1728 he made, with Gessner, his first great Alpine excursion, which, many times repeated, made him, in an eminent degree, master of the Swiss flora. His most celebrated poem, entitled "Die Alpen," was another result of his mountain journeys, which contributed to diffuse among those far away the magic charm of that magnificent scenery.[2]

[1] Therefore the average height of the fed stems is slightly less (100 : 99·9) than that of the fed. But since equal numbers of *plants* are taken, the total yield of flower stems is the fair criterion.

[2] Prince Radzivil, Commander of the Polish Confederates, having at a later period become acquainted with the poem, could not think of anything better to signify to the author his satisfaction, than to send him a commission of Major-General.

His first anatomical instruction was obtained at Bâle, and was continued during five years, after which Haller returned to his native country, where an active medical practice did not hinder him from ever and ever reading to increase the field of his already vast knowledge. He read at table, in journeying on foot or on horseback, during his visits and consultations, which made those shake their heads who could not understand his marvellous clearness of perception.

His botanical labours were then very extensive, and brought him his first encouragement from abroad. In December, 1733, the Royal Academy of Sciences of Upsala received him among the number of its members, and proposals were made to him to become a professor there. At Berne his success was not easy; in 1734 he obtained the modest position of librarian. This was the epoch when, while carrying on his work as a practitioner, he gave himself especially to poetic composition, but which came to an end in 1736.

It was at this time he received a call from the newly-founded University of Göttingen, to go there as Professor of Anatomy and Botany. This call was accepted, and although it was for him the occasion of a great grief, in the death of his wife soon after their arrival, he displayed in this new centre a remarkable activity and capacity. His desire and his plans for the foundation of an anatomical theatre were soon realised. Measures were taken that subjects should not be wanting for dissection; and at the same time conformably to his proposals, a botanical garden was created which soon became one of the most important in Germany. He was the soul of his faculty and of the entire university, and his reputation caused students to flock to Göttingen from all countries, whom he encouraged in every way, prescribing to them various works in connection with his own and for the prompt development of the physiological sciences. He founded at Göttingen the Royal Academy of Sciences, of which he was appointed president, a position he retained to the end of his life, notwithstanding his return to his own country.

It was at this time he published his commentaries on the work of Boerhaave, when he commenced his "Elementa Physiologiæ," his "Anatomical Plates," his "Flora of Switzerland," and other works. In 1749 the King of England appointed Haller his private physician, and confirmed the titles of nobility which had been conferred on him by the Emperor Francis I. The Royal Society of London, the Academy of Stockholm, those of Berlin and Bologna, enrolled him on their lists of members. Frederick the Great of Prussia attempted to get him to Berlin, but Haller would only leave Göttingen to return to Berne, and he decided to do so in 1753. His zeal for public affairs caused him to accept in his native country official functions in which his aptitudes of every kind found their application. Appointed Bailiff of the district of Aigle, near the eastern extremity of the Lake of Geneva, he explored and worked the sources of salt; at Berne he contributed to the creation of an orphanage and a large hospital, upon which he inscribed the beautiful device, "Christo in pauperibus." In 1754 he received from the French Institute the great distinction of being nominated one of its foreign associates; of the eight then existing, three were Swiss—Jean Bernoulli, Euler, and Haller. He regretted that his administrative occupations absorbed much of the time he would have wished to devote to science; and yet even during this period of his life his productiveness was enormous. Besides a large number of monographs and dissertations on subjects in the domains of botany, medicine, anatomy, and physiology, he published more extensive works, such as: Two parts of anatomical plates in folio, a quarto volume of surgical dissertations, four volumes "Disputationes practicæ selectæ," and six volumes of his "Elementa Physiologiæ Corporis humani." He occupied himself more especially with the anatomy of the eye, the formation of the bones, and the comparison of the brains of birds and fishes. He was chiefly original in his experiments on the movement of the blood, in his researches on the development of the chicken in the egg, and on that of the fœtus of quadrupeds, as well as in his teratological studies.

In his physiology he introduced the dominant idea, which was his principal discovery, of irritability considered as a force peculiar to muscular fibre, independent of sensibility properly so called, and differently distributed. In his hands this force became a new law, with which he connected nearly all the animal functions. He can only be blamed, perhaps, for having distinguished it too absolutely and in too decided a manner from the nervous force on which it always depends. As to generation, Haller maintained the doctrine of the pre-existence of germs, and he gave it the most solid support in his studies on the fœtal development. Not knowing the chemical action of the air on the blood he was unable to understand the exact idea of respiration.

All his writings show immense erudition, the fruit of his extensive reading, with the assistance of a prodigious memory. In four Bibliothecæ," published under his auspices at Berne, Zurich, and Bâle, he spoke of 52,000 different scientific works or treatises all known by him and annotated by his hand to make known the text, the sources, and the authors.

A similar erudition rendered him eminently apt at bibliographical work. Thus we have from him in his "Methodus Studii Medici" of Boerhaave a classification of works, in which their degree of merit is distinguished by one, two, or three asterisks. But few living authors were content with the number of asterisks which he accorded to their works, and this attempt made him numerous enemies. He had collected for his use about 20,000 volumes, which were bought after his death by the Emperor Joseph II. and given to the University of Paris.

On many occasions attempts were made to bring Haller back to Göttingen. In 1770 King George III. personally made overtures for this purpose; but the republic of Berne valued too highly his presence to consent to a new departure. The Council, while assuring the king of its friendship and its desire to please him, was opposed to this departure, not being able to be deprived of a man so necessary to the public weal in a place for life created expressly for him, and in view of the general service of the state. The passionate love which he had for his country made him respond in the most efficacious and the most varied manner to the hopes which his fellow-citizens had placed in his activity, more especially in the great start which agriculture took in his time and under his influence.

However, in the midst of so many matters, for which Haller was always of easy access, his health was constantly delicate. With advancing age many infirmities presented themselves which would have arrested a man of less energy, and which led to very painful crises. Gout and insomnia tormented him more and more, and he did not conceal from himself that the use of opium, by means of which he combated them, had serious drawbacks. One of his friends advising to change the *régime*, he replied in Italian:—

"Sono venti tre ore e mezza."

Haller died December 12, 1777, in his seventieth year, observing till the last moment the ebbing of his life, and indicating at last by a sign the moment when his pulse stopped. But he saw the approach of death with the calmness of a confirmed Christian, having all his life preserved a sincere faith, without fearing more than Newton, Euler, or Linné, that that faith could be contradicted or compromised by the scientific researches which he had pursued with a zeal which has scarcely been surpassed.

E. G.

THE MODERN TELESCOPE[1]

IV.

THE next point to which Mr. Grubb refers is one to which much interest attaches. It is now a long time ago since Sir J. Herschel investigated the effects of differently shaped apertures upon the images of stars. The figure shows the effects they produce due to diffraction.

An effect is also produced on the image if a round, or triangular, or square patch is placed in the centre of the object-glass. With the former the discs of the stars are smaller, and the position of the diffraction rings is changed, so that double stars can thus be measured, while in ordinary circumstances the companion is hidden by one of the rings.

Now in a reflector, unless, indeed, we use the front view, the central patch is always present, and it is to this and to the arm which supports it that the peculiar look of a star in a reflector is due. Mr. Grubb does not hesitate to ascribe to this the great difference of opinion that exists as to the performance of the two classes of instruments, and adds :—

"A veteran and well-known worker with refractors declared 'he never looked into a reflector without drawing away his eye in disgust;' and workers with reflectors cannot understand how the refractor workers can bear that dreadful fringe of colour from the secondary spectrum. The same applies to other matters. Newtonian observers cannot understand how those who observe with refractors or Cassegrain reflectors can bear to strain their neck so in looking up through the tube; while the refractor and Cassegrain workers cannot understand how the Newtonian workers will break their backs sitting or standing bolt upright when they might be reclining comfortably on an easy chair as they do. After all, when this comes to be investigated it resolves itself into but little more than a question of to which telescope the observer has been most accustomed. Each observer becomes in time *wedded to his own instrument;* he has done his work with it, the credit of his discoveries is due to it, and he naturally falls into the idea that no other can be as good."

We next come to those points in which the reflector is stated to be superior to the refractor. These are absence of secondary spectrum, superior applicability for physical work, possibility of supporting mirrors irrespective of size, and handiness of reflectors due to their short focal length, and especially if the Cassegrain form be employed. With regard to the first point, the experiments of Mr. Vernon Harcourt and Prof. Stokes, in which they attempted to produce two kinds of stars with rational or nearly rational spectra, have failed to lead to any great hopes being formed as to ultimate success, and the superior advantage

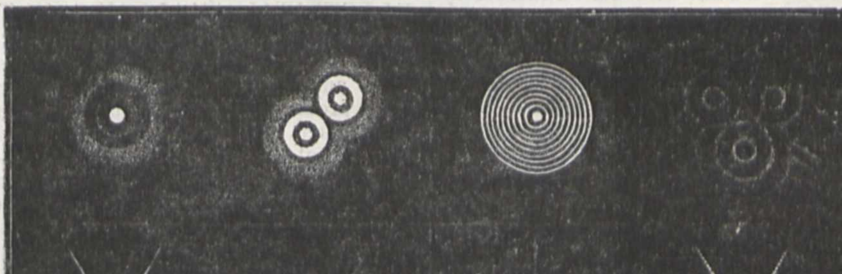


FIG. 10.—Diffraction effects produced by apertures and stops of different shapes (Herschel).

of the reflector in the fact that there is no colour will doubtless long remain. The superior applicability for physical work is much more doubtful. At present we know too little about reflection from metals and many other points to lay down the law with certainty, and in my own opinion Mr. Grubb's dictum is far too absolute with regard to spectroscopic work.

In another part of his valuable paper Mr. Grubb measures the advantage of the reflector with regard to the question of support; he shows that an object-glass may be supported by a central arm without loss of definition. and even that the tube may be filled with compressed air. He says: "The pressure required would be very small. Suppose the objective to be forty inches aperture, and 600 lbs. weight, and that it was purposed to lift $\frac{2}{3}$ of its weight on the air cushion, a pressure of about $\frac{1}{3}$ of a pound to the square inch, or say $\frac{1}{50}$ of atmosphere would suffice, even when the telescope is at its maximum elevation."

The remarks of Mr. Grubb on the practical difficulties which supervene when increased aperture is required, are best given in his own words :—

"It may be said that the difficulty of manufacture is a question for the instrument-maker alone, and not to be discussed by those whose business it is to decide on the form of instrument employed; but it should be remembered that any advance in the size of telescopes, refractors, or reflectors, over those at present in existence, must be considered to be to a certain extent, an experiment, and the nature of the difficulties which will be encountered can at present only be speculated upon, even by the most experienced; and therefore it behoves those whose province it is to decide on the matter to inquire diligently into the relative practicability of the various forms of telescopes in order that they may not decide on a form which might be, if ever accomplished, of great usefulness, but which on trial would be found to be, in the present state of art, impossible to manufacture.

"With respect to refractors, the first great difficulty to be met with is that of procuring suitable discs of glass. Of our glass manufacturers only two firms seem to possess the secret of manipulation of optical glass, viz., Messrs. Chance, Brothers and Company, of Birmingham, and M. Feil, of Paris, a descendant of the celebrated Guinand. Of these one at least speaks confidently of producing discs up to one metre in diameter; but when I consider the difficulty which I know was experienced in moulding the 27-inch discs for the Vienna objective I cannot say that I feel the same confidence. These 40-inch discs would require to be obtained in one single

[1] Continued from p. 189.

piece, just three times the quantity of homogeneous glass that the Vienna discs required, and though I am not of course in the secrets of the glass manufacturers, it appears to me that the chances of obtaining 40-inch discs in the present state of the art are remote.

"The other difficulties of manufacture of refractors consist in the nicety of the operation connected with the calculations of the curves, the manipulation of such extremely costly material, and the enormous labour and trouble of the figuring and perfecting of the objective. All these, however, I have no doubt will be overcome by the optician for any size which the glass-maker is at all likely to produce.

"Now, as to the difficulties connected with the manufacture of reflectors, whether metallic or silver on glass.

"First, as to the difficulty of producing the metallic or glass disc to work upon.

"Lord Rosse has succeeded years since in casting, annealing, and perfecting discs of six feet in diameter, and any difficulties he met with were not such as to lead me to the belief that the limit of possible size has been by any means reached. As regards glass mirrors, the question has never been discussed, for in any sizes that have been made up to the present time, it was only necessary to go to the plate-glass manufacturers and say, 'I want a disc of crown glass of such a diameter and such a thickness,' and forthwith the glass disc was delivered without any trouble; but, when we come to these extraordinary sizes, it is quite a different matter. For the 4-foot disc of glass for the Paris reflector, in place of that which has so recently resulted in failure, the St. Gobain Glass Company require twelve months' time to perfect (although, be it remembered, the quality of the glass is here of no consequence whatever); and I have been myself in correspondence with the principal glass manufacturers here and on the Continent, and not one of them is willing to undertake even a 6-foot glass disc; so that it would appear that, above that size, the silver-on-glass mirrors are out of the question.

"This much, however, is to be said: If anyone were to go to a brass- or bell-founder's and ask them to undertake a speculum of six feet in diameter, he would almost certainly be met with a refusal; and yet Lord Rosse has proved the feasibility of it. And so, reasoning by analogy, might the manufacture of a six- or eight-foot glass mirror be possible, if undertaken in the same scientific spirit in which Lord Rosse undertook his. I answer to this—Yes; perfectly true; but this is too purely a speculative matter to be considered at the present day in the choice of telescopes.

"The other great difficulty in the manufacture of reflectors is the annealing of the disc, and I believe it is this difficulty which limits to so narrow an extent the production of glass discs for silver-on-glass mirrors."

We can abundantly gather from this paper of Mr. Grubb's that our opticians are doing all that lies in their power to give us increased power in the future. The fact that in the last few years one refractor of 25 inches, and two of 26 inches, have been acquired to science, leads us to hope that for the present progress will lie in increasing the dimensions of that instrument. Mr. Grubb, indeed, has already in hand one of 27 inches for the Austrian Government. The *contretemps* to the four-foot Foucault in Paris will also help to set the tide in the same direction.

From what has preceded it will be seen that each increase in the power of the telescope is of little avail unless we use it in purer and purer air. It is quite true that in the telescope much of the injury to definition arising from currents in the tube may be got rid of by the employment of lattice-work; but this, of course, will not lessen the atmospheric effects of the column of air ever increasing in diameter between the telescope and the object.

Prof. Piazzi Smyth's astronomical experiences on Teneriffe will still be in the minds of many of our readers. He showed that an enormous advantage was secured from observations so soon as half the atmosphere was below the observer. A more recent experiment by Dr. Draper, however, has shown that it will not do to go blindly and put the telescope on any high mountain. The conditions of each place from this single point of view must be carefully studied. Summing up his experiences of the Rocky Mountains up to heights of 10,000 feet, Dr. Draper says:—

"On the whole, it may be remarked of this mountain region that the astronomical conditions, especially for photographic researches, is unpromising. In only one place were steadiness and transparency combined, and only two nights out of fifteen at the best season of the year were exceptionally fine. The transparency was almost always much more marked than at the sea-level, but the tremulousness was as great or even greater than near New York. It is certain that during more than half the year no work of a delicate character could be done. . . . Apparently therefore, judging from present information, it would not be judicious to move a large telescope and physical observatory into these mountains with the hope of doing continuous work under the most favourable circumstances."

J. NORMAN LOCKYER

(*To be continued.*)

ELECTRICAL ANALOGIES WITH NATURAL PHENOMENA

WITHIN the last few years M. Gaston Planté has at intervals described a series of very curious phenomena produced by electric currents of high tension, and has pointed out numerous analogies which they present with several atmospheric and cosmical phenomena. Without committing ourselves to the belief that these analogies are real, the phenomena described are so interesting that we are glad to be able, by the kindness of M. Planté, to reproduce some illustrations of them.

To obtain electric currents of high tension M. Planté has employed secondary batteries of sheets of lead, which, as is known, constitute powerful accumulators of voltaic electricity. By associating a very great number of batteries uniting from 400 to 800 of these secondary couples, a discharge is obtained equivalent, according to M. Planté, to that of from 600 to 1,200 Bunsen couples arranged in tension.

Fig. 1 represents the arrangement of 400 secondary elements divided into ten batteries. This is the source of electricity employed for some of the earlier experiments which we are about to describe. The more recent ones have been made with 800 secondary elements arranged in twenty batteries of forty couples. A second series of batteries similar to the first is arranged in another room, and the current which it furnishes is joined to that of the first series by conducting wires suitably adjusted. These batteries, associated at first in simple circuit by means of commutators, do not require to be charged all at once like two Grove or Bunsen couples. When they have not been out of use for too long a time a few hours suffice to charge them. We may then, by turning the commutators, unite all the secondary elements in tension and use at will, either in a few seconds or in a longer time, the enormous quantity of electricity resulting from the chemical work accumulated during two hours by Grove or Bunsen batteries.

Such was the powerful means adopted by M. Planté in making his late experiments. In his earlier experiments he used a much simpler apparatus.

The gyratory movements accompanied with luminous effects which M. Planté had observed with a powerful current of electricity, and the spherical and annular forms manifested by bodies submitted to that action, suggested to M. Planté the probability of the electric origin of the forms of some of the nebulous masses of matter which are not resolvable, and particularly of those which assume a spiral form.

He describes an experiment in which a cloud of metallic matter attracted to an electrode by the electric current assumes in the centre of the liquid a gyratory spiral movement under the influence of a magnet.[1] A glance at Figs. 2, 3, and 4, which represent this experiment, is sufficient to enable us to recognise their similarity to the forms of spiral nebulæ described by Lord Rosse. Some of these have the curvature of their spirals tending in a direction opposite to that of the hands of a watch, like those in Fig. 3, such as in the nebula

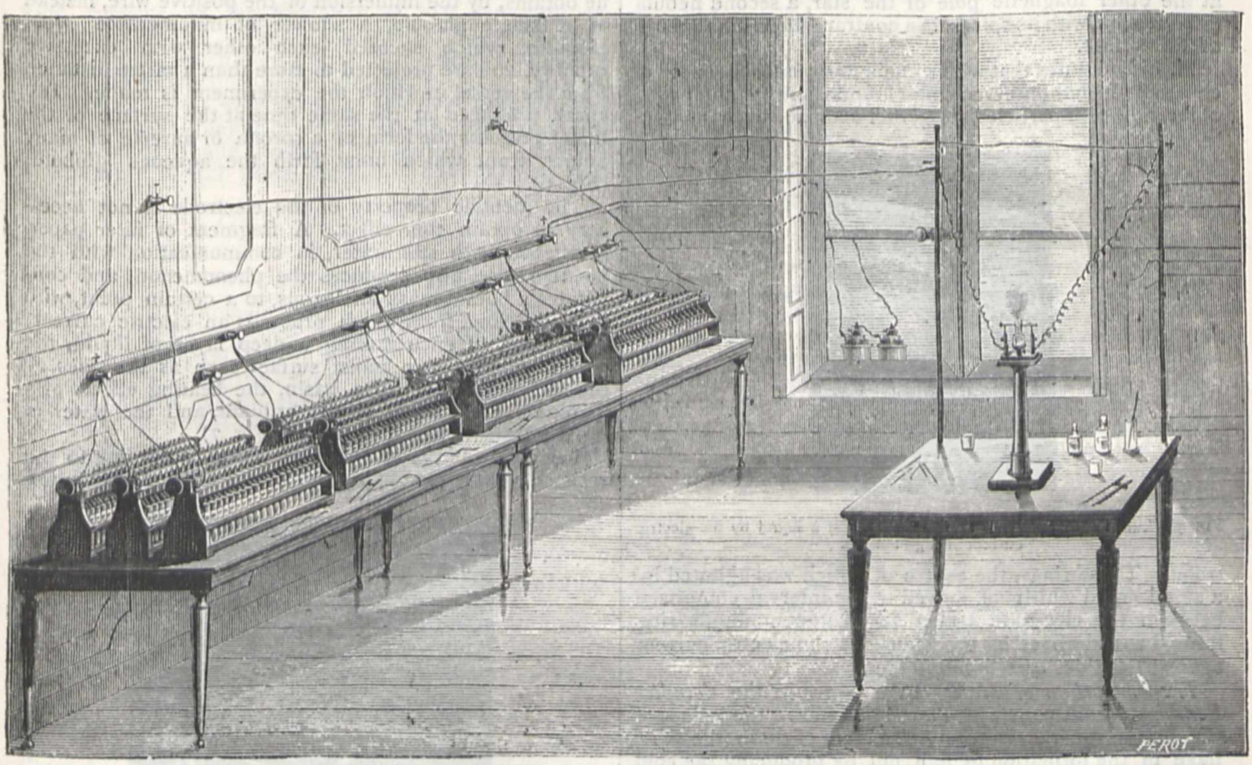


Fig. 1.—Arrangement of 400 couples in ten batteries for experiments with electric currents of high tension.

in Berenice's Hair; others have their spirals in the same direction as the hands of a watch, like that of Fig. 4, as in the nebula in Canes Venatici. M. Planté is inclined to believe that, in presence of an analogy so striking, we are authorised to think that the nucleus of these nebulæ may be constituted by a true centre of electricity; that their spiral form may be determined by the near presence of celestial bodies strongly magnetic, and that the direction

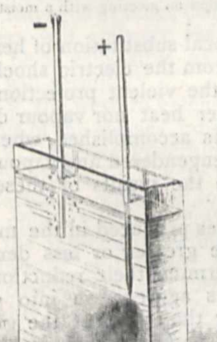


Fig. 2.

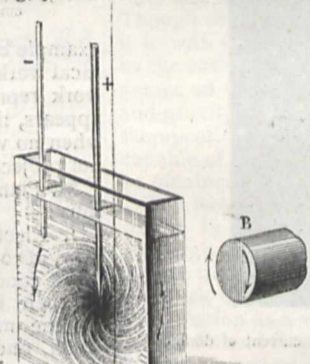


Fig. 3.

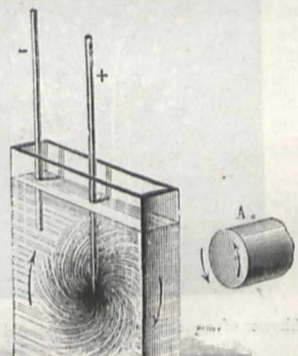


Fig. 4.

Fig. 2.—Cloud of metallic oxide formed in a voltameter before the approach of a magnet. Figs. 3 and 4.—Gyratory movement communicated to the cloud of metallic matter by the action of a magnet.

of curvature of the spirals may depend on the nature of the magnetic pole turned towards the nebula. He

[1] It is easy to reproduce this experiment and even throw the effect on a screen, by means of an electric current equivalent to that of fifteen Bunsen elements. The electrodes are copper wires; the liquid is acidulated with 1-10th of sulphuric acid. From the extremity of the positive wire escapes, with a slight hissing sound, a thick cloud of the protoxide of copper or of finely-divided copper, and this wire takes the form of a very sharp point. The arrows around the spirals in the figures indicate the gyratory movement which this cloud assumes under the influence of a magnet; and the arrows around the magnet represent the direction of the electro-magnetic currents; B is the north and A the south pole.

suggests that if we had powerful enough telescopes, the neighbourhood of the nebulæ should be searched to discover stars capable of exercising such a magnetic influence. If such a star was found likely to act thus on any nebula, then the line passing through the centre of the nebula and the star should be searched to discover if, at the other magnetic pole of the star, a second nebula did not exist, with its spirals in a contrary direction to those of the former.

M. Planté states that with a much more intense source of electricity he has observed small luminous rings, composed of incandescent particles, altogether detached from the electrode. These rings, the centre of which was agitated by a small liquid whirlpool, moved in the interval comprised between the electrode and a very large luminous ring formed round about by the shock of the electric current against the sides of the voltameter.

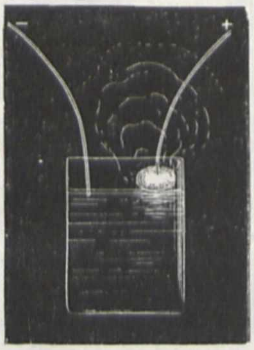


FIG. 5.—Luminous globule formed at the surface of a liquid by an electric current of high tension.

The Formation of Hail.—In a paper in the *Comptes Rendus*, t. lxxxi. p. 616, M. Planté had shown the influence which atmospheric electricity in a state of discharge must have in the formation of hail, not by producing the cold necessary to congelation, as is sometimes supposed, but by exercising, on the contrary, a powerful heating action, capable of rapidly vaporising the moisture, and of projecting the vapour into the cold regions of the atmosphere. To succeed in explaining the part played by electricity in this natural phenomenon, it is necessary to point out the mechanical action which may result from the passage of the electric fluid into the midst of aqueous masses, and thus to project into the air liquid globules susceptible of being transformed into hailstones.

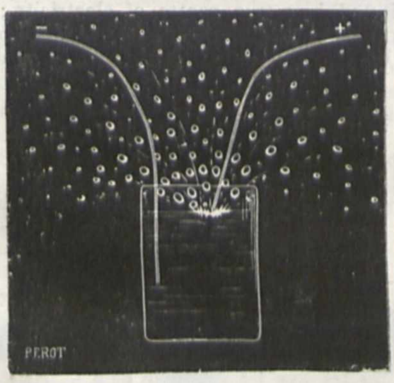


FIG. 6.—Shower of aqueous globules produced by a current of double the tension of the preceding.

In previous experiments M. Planté showed that with an intense source of voltaic electricity, the immersion of the positive wire in a conducting liquid, such as salt water, determines the aggregation of aqueous molecules around the electrode in the form of a luminous spheroid, in consequence of a double simultaneous effect of flow and aspiration, or of passage in two directions which seems peculiar to the electric current (Fig. 5).

But by employing a current still more intense, resulting from the discharge of a battery of 400 secondary couples, he obtains, by the immersion of the positive wire, instead of a single globule, a shower of innumerable ovoid globules, which succeed each other with excessive rapidity, and are projected to more than a metre distance from the vessel in which the experiment is made. The spark produced at the same time at the surface of the liquid presents the form of a corona or aureole of many points, from which burst forth the aqueous globules (Fig. 6).

The metallic property of the electrode is not necessary to obtain this effect. A fragment of filter paper, moistened with salt water, in communication with the positive pole, also produces the phenomenon, and constitutes a humid mass analogous, to a certain point, with that of a cloud from which proceeds an electric current. If, instead of encountering a deep layer of liquid, the current meets with a moist surface such as the sides or the inclined bottom of a basin, the heating effects predominate, the aureole is very brilliant, and the water is rapidly transformed into vapour (Fig. 7).

The action of the current then differs according to the resistance which is opposed to it, and we find here a new example of the reciprocal substitution of heat and mechanical work resulting from the electric shock. When the work represented by the violent projection of the liquid appears, there is neither heat nor vapour developed, and when no visible work is accomplished, when the liquid is not projected, heat is engendered and vapour disengaged.

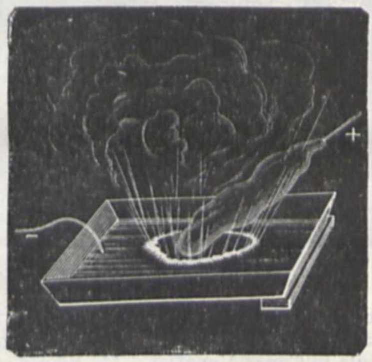


FIG. 7.—Jets of vapour and luminous streaks produced by an electric current of high tension on meeting with a moist surface.

M. Planté sums up the results of these experiments thus:—

1. Electric discharges produced in the midst of clouds may, according to the greater or less density of these moist conductors, determine their reduction into vapour, or their instantaneous aggregation into globules of a volume much greater than that of the globules of the cloud, and the liquid bombs thus formed may be projected to great heights, where the temperature is notably lower than that of the medium in which the discharges are produced.

2. The formation of hailstones, in the case where they do not present a series of opaque and transparent layers, but a structure radiating from the centre, is also explained by such a mechanical action; they must be produced by a single jet, and congealed under the same volume which they had at the moment when they were shot forth by the electric current.

3. The ovoid or pyramidal form of these hailstones, as also their angular parts, aspirates or protuberances, are due to their electric origin.

4. The gleam sometimes emitted by hailstones is due also to electricity; for although in the experiments described, it could not be distinguished whether the globules were self-luminous or shone by the reflection of the spark, it is probable that they were also rendered phosphorescent by the electric current which they contained.

M. Planté admits the action of other agents, such as wind currents, in the formation of hail, but only as accessories to the action of electricity. They are concurrent causes which only prepare the conditions favourable to its production, while electricity is the efficient cause which, by its very presence in the clouds and by the instantaneous power of its discharges, determines the sudden formation and the fall of the meteor.

M. Planté is still prosecuting his researches on this subject.

(*To be continued.*)

ENTOMOLOGY IN AMERICA

THE U.S. Entomological Commission which was organised and placed under the auspices of Prof. Hayden's Geological Survey for the purpose of investigating and reporting the entire subject of insect ravages throughout the western regions of our continent, have completed their field labour for the present season.

The members of the Commission have been busily engaged in the preparation of the several parts of their Annual Report, and will soon meet in Washington, where they will have a protracted sitting to get everything ready for the printer. This report is looked for with much interest by the farmers of the west, and the character of the commissioners is a guarantee that it will be creditable from the scientific, and valuable from the practical, standpoint. The Report will contain sixteen chapters, under the following heads:—Introduction, Riley; Chronological History, Packard; Statistics of Losses, Thomas; Classification and Nomenclature, Thomas; Geographical Distribution, Thomas and Packard; Migration and Meteorology, Packard and Thomas; Original Permanent Breeding Grounds, Riley, Packard, and Thomas; Habits and Natural History, Riley; Embryology, Packard; Metamorphoses, Riley and Packard; Invertebrate Enemies, Riley; Vertebrate Enemies, Thomas; Remedies and Devices for Destruction, Riley; Prairie Fires *versus* Locust Injury, Riley; Agricultural Bearings of the Subject, Thomas; Ravages of other Locusts, Packard and Riley; Locust Ravages in other Countries.

These chapters will embrace many sub-chapters, and the Report will be as exhaustive as the limited time for its preparation will permit.

In Chapter IV. the western extension and the northern and eastern limit of the species' range are fully given.

In Chapter V. the laws governing its migrations are for the first time defined. A very large number of data have been collected in reference to the subjects of this chapter. Not only are the general laws governing the movements of the insect now defined, showing a regular migration southward and return migration northward, which may be counted on and foreseen; but many important and highly interesting facts in reference to their local flights are brought to light, which will henceforward form a part of the history of the insect.

In Chapter VII. several other laws governing the species are also adduced; and the importance of the discovery of the laws which regulate the doings and movements of the pest, cannot be over-estimated. In said Chapter VII. many new facts will for the first time appear, and all that is definite and accurate be made known.

In Chapter X. many new discoveries will be recorded, some of them of great scientific interest and importance. Of these may be mentioned the transformation of the silky mite (*Trombidium sericeum*). This is an eight-legged creature, which preys on the locust eggs. It is proved to be the mature form of the little six-legged mite (*Astoma gryllaria*) which is parasitic on the locust. Insects described under different genera are thus proved to be specifically identical. The life-history of the blister-beetles will also be given, their larvæ feeding upon locust eggs, and undergoing singular changes called hypermetamorphoses. The interest attaching to this discovery among entomologists, as well as among farmers, is best appreciated when it is considered that absolutely nothing has heretofore been known of the larval habits of these blister-beetles, notwithstanding the fact that for half a century much attention has been given to the subject by scientific men, on account of the commercial value of Cantharis, or Spanish fly, and of the great injury to potatoes and other plants committed by several of our American species.

In Chapter XI. are given the locust feeding habits of many western animals not heretofore known to have that habit, and the good offices of birds are especially made manifest, examinations of the stomachs of over ninety species and 630 specimens having been made with special reference to their locust-eating habits. The record in reference to these examinations is very full, giving the dates, the locality, the common and scientific names of the species, and the number of locusts and other insects found in each. The value heretofore placed on these aids by entomologists is fully sustained by this record.

In Chapter XII., which will be one of the most extended and most important practically, it is clearly shown that the young locusts may be controlled, and by what means; while the way is pointed out how to better control the winged insects. Many valuable devices for destruction will be illustrated, among them one invented by Prof. Riley, which gave great satisfaction, and will, it is believed, supersede all others as a cheap and practicable remedy applicable at any season, whether the plants or the insects be small or large.

In Chapters II. and IV. are given statistics showing the immense losses inflicted on western agriculturists by the locust. These chapters also show what crops are most liable to injury and what are most easily protected; also the best methods of cropping in order to reduce the injury to a minimum. A chemical analysis of the dead locusts has been made, and is unusually interesting. The insects furnish a new oil, which will be christened Coloptine, and a very large per-centage of pure formic acid. Though this acid exists in the ant and some other insects, it is with difficulty obtained in large quantities, whereas by the action of sulphuric acid upon the locust juices it passes off with great readiness and in remarkable quantity and gravity. The various uses of this acid whether as a therapeutic agent or as laboratory re-agents, &c., are capable of great and valuable extension when it can once be obtained so readily and in such quantity.

The Report is expected to make about 500 pages, and will, it is hoped, be published in February or March. Although the Commissioners have divided the labour among them, the Report will form one complete whole, as the work of each will be discussed and revised by the Commission as a whole.

The Annual Report, which is intended more particularly for the practical farming public, will be followed by memoirs of a more purely scientific nature—one by Dr. Packard on Anatomy and Embryology; one by Prof. Riley on the Natural History of other Locusts, and one by Prof. Thomas on the classification of the *Acrididæ*.

While it has been the object of the Commission to cover as much ground as possible so as to make the Annual Report as full and valuable as the time would permit, there yet remain several important subjects that it has so far been impossible to properly and exhaustively study. The territory affected is so vast, embracing over a million square miles, that much of it was imperfectly explored, especially in the north-west. Mr. Riley had to cut short his investigations in British America both for want of time and want of funds. For similar reasons, and on account of Indian troubles, Montana, Wyoming, and Dakota, have been but superficially explored.

The year 1877 was an abnormal year, *i.e.* the insect had, the previous year, overrun a large section of country in which it is not indigenous, hatched in such country in the spring. This was most fortunate for many reasons, as it enabled the Commission to carefully study the insects in this their unnatural condition, and to carry on experiments with a view of learning how to control them. Much of the work of the Commission was with these young insects. The losses sustained through the devastation of the pest by young and struggling frontier populations, ill able to bear them, were immense; and there was so much discouragement that hundreds and thousands of persons were on the point of abandoning their new homes last spring. At this juncture the Commission went into the field, and by its encouraging predictions (which were all verified) and recommendations, imbued the people with hope and confidence, and drew westward again the emigration that had almost stopped. All this work, however, interfered with needed investigations into the proper range, the native home and breeding grounds, the source of swarms, and many other important questions which can only be properly studied during a normal year. It is, therefore, very important that the investigations be continued until every question is settled that human investigation can settle.

For the proper settlement of some of the questions the co-operation of the Dominion Government is desirable, and has been promised by the Canadian authorities if the work of the Commission should continue.

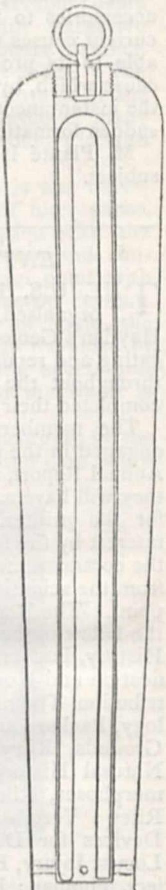
It will be unwise to stop the work of the Commission before completed. The work should be made so thorough as to obviate any necessity in future years of creating another commission for the same purpose. After careful estimates it is concluded that the work can be satisfactorily completed only with two more years' investigation and experiment. The Commission therefore ask for a continuance of the appropriation of 25,000 dols. asked for a year ago.

There are various other injurious insects of national importance, of which much has yet to be learned, and in addition to completing the locust investigation, the Commission contemplate, during the coming two years, studying and reporting on some of these worst enemies to American agriculture. They are especially desirous of reporting on the cotton-worm of the south, which, though often so disastrous to the cotton crop, has never been fully studied, and in the mere natural history of which there are yet many mysteries and conflicting theories.

Much has yet to be done in giving practical form to the conclusions arrived at and plans proposed by the Commission to enable the work already done to bear proper fruit. To bring about the needed co-operation of the two Governments, to cause proper laws to be enacted in all the states interested, and to enforce the truths that alone will make man master of the situation, is largely the work of the future.

SOUNDING APPARATUS

THAT Sir William Thomson's recent application of the pianoforte wire to sounding in small depths for the ordinary purposes of navigation is of great value, will be admitted readily by those who are familiar with the present process. But it occurs to me that a formidable objection to its general introduction into naval or mercantile vessels is to be found in the necessity of using chemically-prepared tubes for determining the depth of water. Sir William's latest device is (I believe) a straight glass tube two feet long, open at one end and inclosed in a brass tube attached above the sinker, in which air is compressed by the pressure of the water, the amount of compression being determined by the height to which the water rises in the tube. This height is marked by the decolorisation of a coating of chromate of silver on the inside of the tube, effected by the sea-water. A number of such tubes, properly prepared, must therefore be kept at hand, and when once used they must be coated anew, an operation of no little difficulty.



I have suggested a form of sinker in which these objections are obviated, while the principle is retained. The sinker is of iron three inches in diameter at the bottom, five inches at the top, and 26·5 inches long. It is cast with a cylindrical cavity, two inches in diameter, extending from the top to within an inch of its base. This cavity contains the glass tube by which the depth is determined. A tube about forty-eight inches long is taken, closed at one end and bent back on itself at its middle point, so as to make two legs each twenty-four inches in length. This is placed inside the sinker (the bend upward) and a screw tap, carrying a swivel-link for the sounding line, is screwed over it. Holes in the bottom of the sinker and through the screw tap allow the water access to the tube. As the sinker descends, in sounding, the air within the tube is compressed and the water rises in the open leg. When the column of water reaches the highest point of the bend, the pressure then corresponding to a depth of about five and a half fathoms, any further descent of the sinker will cause the water to pass over into the lower end of the closed leg. The compression of the air will then take place in the *upper part of the closed leg*, the maximum compression being indicated by the length of the column of water remaining in that leg when the sinker is lifted again to the surface. As the sinker is being raised, the air, expanding under the diminished pressure, drives the water out of the open leg. The inside and outside pressures are therefore equal at any instant. The tube may be graduated in inches and tenths, and a table will give the depth from the reading of the tube. The tube is then easily emptied and is ready for another cast. The form of the sinker is such that the bend of the tube is kept at a higher level than the open end in case the sinker should fall over when it reaches the bottom—the entrance of surplus water is thus prevented. An ordinary cup attachment for a bottom specimen can be applied to the end of the sinker.

The tube described will not indicate a depth less than five and a half fathoms. If it is desired to obtain casts in shoaler water a tube with the open leg shorter than the closed leg may be used. One in which the length of the open leg is one-fourth that of the closed leg will indicate depths of two fathoms and upwards.

I am aware that Sir Wm. Thomson has a tube for bringing up the column of water, but it requires the use of valves, which can never be kept tight under such enormous pressures as those to which the sounding-tubes are exposed.

I inclose a sectional drawing of the above-described tube and sinker.

THEO. F. JEWELL, Lieut.-Com. U.S. Navy

OUR ASTRONOMICAL COLUMN

THE VARIABLE STAR R AQUARII.—Harding notified his discovery of variability in this star in 1811, in the first volume of the *Zeitschrift für Astronomie*. The earliest attempt to determine the period appears to be that of Westphal, in the *Zeitschrift für Astronomie*, vol. iv. p. 218; he used Harding's observations between October 20, 1811, and January 19, 1817, which, though not numerous, sufficed to give an approximate value, while they also indicated that the star at times was as bright as 6·7 m., and at others was invisible in Harding's telescope. Westphal's period is 382·5 days. Although the variability of the star has thus been long known, it would seem that few of these objects have been less observed, and it may be recommended to the attention of those who are interested in this branch of astronomy, and whose positions enable them best to command a star at 16° south declination. In vol. vii. of the Bonn observations, Argelander deduces the following formula for the maxima:—

1843, September 4·7 + 388^{d}·011 E.,

which is adopted in Prof. Schönfeld's second catalogue (Manheim, 1875); the maximum of the present year would therefore fall on September 25, and may be well observed. In the same catalogue the degree of brightness at minimum is set down as "11 m (?)." Harding estimated the star 6·7 m. on October 20, 1811, and on January 24, 1812, it was not visible in his telescope, being then below what he called a tenth magnitude, so that observations for determination of the minima should probably be commenced not later than seventy days after the maxima, but it is hardly necessary to remark that in the actual state of our knowledge of the variations of this star, continuous observations through as long a period as its position allows, will possess much interest. The best determination of the place of R Aquarii will be that of the Greenwich Catalogue of 1864, giving for the beginning of the present year—

R.A. 23h. 37m. 30s·35, N.P.D. 105° 57′ 37″·3.

ε INDI.—When may we hope that some southern observer will find opportunity of attacking the parallax of this remarkable star, the large proper motion of which was first pointed out by the late Prof. D'Arrest, and confirmed by Moesta from the Santiago observations of 1856? Mr. Gill, who allows nothing to escape him, during his brief visit to the other hemisphere, wherein Lord Lindsay's heliometer enables him to do an astronomical service, states that he has measured the distance and position-angle of ε Indi relative to five surrounding stars, and hopes "that this may serve as the foundation at some future day of a determination of its parallax and proper motion," but it is obvious that the shortness of his stay at Ascension does not permit of an attempt to measure the amount of parallax—a very interesting undertaking in the case of this star, which, had time allowed, we do not think that Mr. Gill would have hesitated to attempt. And ε Indi is not the only star which holds out prospect of success in parallax investigations in the southern hemisphere.

THE SATELLITES OF MARS.—In the last number of the "Monthly Notices of the Royal Astronomical Society" is a communication from the director of the Observatory at Melbourne, giving the results of a search made for the satellites of Mars, in consequence of a telegram notifying their discovery, and received from Sir George Airy on August 22. At that time, from an accident to the declination movement, the large reflector was not available, but observations with it were commenced on September 26. Mr. Ellery states his search to have been fruitless, except that on one occasion it was believed that one of the satellites was seen. This was on the night of October 16, when Mars having occulted a star of the thirteenth magnitude at 22h. 15m. sidereal time, after its emergence a very faint point was seen half a diameter from Mars s.p.; "this was watched for nearly an hour, when its position indicated a motion with Mars," but the sky becoming cloudy, no measures could be made, and, it is added, "no other signs of satellites have been observed since."

If we use the elements of the exterior satellite employed for the ephemerides which have appeared in this column, and which agree precisely with measures of position-angle made by Mr. A. Common, of Ealing, with his eighteen-inch silver-on glass reflector on the date in question (October 16), we have the following angles and distances:—

Melbourne Sidereal Time. h. m.		Position. °		Distance. ″		Distance from Limb. ″
22 15	...	216·0	...	34·6	...	25·2
23 15	...	196·7	...	27·1	...	17·7
0 15	...	167·6	...	23·5	...	14·1

Therefore, although the satellite would be in the south-preceding quadrant up to about 23h. 45m. sidereal, its distance would be greater than that estimated at Melbourne, and it is doubtful if this satellite was seen.

As regards the inner satellite, it is not practicable from the measures hitherto published to form so close an estimate of the positions as late as October 16, but on calculation from elements which represent sufficiently well the measures to September 20, it would appear that the satellite was in the south-preceding quadrant after about 23h. 30m. sidereal time, and its distance from the limb at that time would be approximately a semi-diameter of the planet. Thus if either satellite were really observed, it was most probably the interior one—which, indeed, we are assured, is intrinsically the brightest. But the want of better success with the great Melbourne reflector would rather imply that however well adapted for delineation of nebulæ and similar purposes, the instrument fails with observations of such objects as the satellites of Mars.

NOTES

WE understand that on the representation of the Professors of the Royal School of Mines and of the Director-General of the Geological Survey as to the want of proper accommodation for geological teaching in the School of Mines in Jermyn Street, the Lords of the Committee of Council on Education have transferred the instruction in that subject to the Science Schools at South Kensington. As Prof. Judd is supplied with a complete collection of specimens for teaching purposes, and as a laboratory is now provided for him, he will be in a position to give that practical instruction which it is so desirable should be within the reach of geological students.

STUDENTS of pleistocene geology will be gratified to learn that the well-known very fine collection of Ilford fossils, formed by the late Dr. Richard Payne Cotton, F.G.S., has been bequeathed to the Museum of Practical Geology, Jermyn Street. The collection contains 246 specimens of vertebrate remains, consisting of bones belonging to species of mammoth, rhinoceros, ox, aurochs, hippopotamus, horse, deer, Irish elk, lion, bear, beaver, water-rat, wolf, and several kinds of birds. A very perfect lower jaw of the beaver (*Castor europæus*), with some well-preserved bones of the *Elephas primigenius*, the *Rhinoceros leptorhinus*, and the *Bos primigenius*, are among the gems of this private collection, which will form a welcome and most valuable addition to the contents of the National Museum of British Fossils—the more so as the series of late tertiary vertebrates in that collection is by no means so large and complete as could be desired. Every one interested in the geology of the metropolitan area is aware that the Cotton collection, together with that made by Sir Antonio Brady, which has lately been acquired by the British Museum, have formed the basis of those interesting researches which have been carried on by several distinguished palæontologists concerning the nature of the vertebrate fauna which inhabited the Thames valley during post-pliocene times. The nation is very fortunate in thus having secured for the use of students in the future both of these remarkably fine collections.

IT is with much regret that we have to record the death, on the 10th inst., of Andrew Murray, F.L.S., the eminent entomologist. In the field of scientific botany and forestry and in aid of our scientific intercourse with foreign countries he has done good service, and in his own special line as a practical entomologist, the Government collection at Bethnal Green stands as a monument of patient labour, as well as profound knowledge of his subject. A keen observer and unflinchingly truthful, the records of his original observations, or his careful compilations, given in his peculiarly terse and condensed style are a valuable legacy. A valued naturalist and assiduous worker he continued at his post till within a few days of his decease, and sunk away quietly and gently after some months of failing health. In private life he was greatly esteemed as a true-hearted friend, unwearied in aiding wherever he could be of assistance, and also for his high intellectual powers.

THE death is announced, on the 7th inst., of Prof. William Stokes, M.D., F.R.S., of Dublin.

ONE of the oldest, best known, and most useful of American naturalists, Dr. J. P. Kirtland, died on December 10. In 1848 Dr. Kirtland received the appointment of zoologist to the Geological Survey of Ohio, the duties of which he discharged with great fidelity, and his publications connected therewith constitute in a measure the bases of subsequent similar investigations in the West. His most prominent work was that in connection with the fishes of Ohio, for the accurate knowledge of which he laid the foundation, establishing and identifying many of the species of Rafinesque, which up to that time had been considered entirely mythical. He described many new species of western fishes, and the discovery of one species of bird of Ohio is due to his zeal.

AT a meeting held last week in Sheffield, a resolution was unanimously passed to invite the British Association to visit that town next year. Committees were appointed, and it was decided to raise a guarantee fund of 2,500*l*.

DR. SCHLIEMANN has been elected an honorary member of the Deutsche anthropologische Gesellschaft. The diploma of membership is a handsome specimen of artistic work, being encircled by allegorical representations of the excavations at Troy and Mycenæ, and bears the signatures of Virchow, Kollmann, Fraas, Schaafhausen, and Weismann.

THE new New York Natural History Museum was opened by President Hayes on the 22nd ult. The museum is in Manhattan Square, on a plot of land opposite Central Park, and the plan of the entire structure contemplates a colossal enterprise, which cannot be completed within the present century. It consists of buildings arranged in a parallelogram, of 850 by 650 feet, and of two lines of buildings which divide the interior space at right angles, thus forming four equal courts. At the centre of each side of the parallelogram, and at its four angles, lofty towers will be erected. At the intersection of the cross in the centre of the parallelogram, a dome is designed to cover a space of 120 feet diameter. The portion of this great structure which is now completed is a four-story building with a double attic; it has a length of 200 feet; it will form the southern one of the arms of the interior cross. The walls are three feet thick at the top. The whole building is of brick, and is regarded as strictly fire-proof. The city has appropriated $700,000 for it, besides giving the land.

MR. STANLEY will probably arrive in England this week. He has been received with enthusiasm at Rome, Marseilles, and Paris. The Chamber of Commerce and the Geographical Society of Marseilles presented Mr. Stanley with medals. No doubt our own Geographical Society will take the lead in the warm reception which will certainly be accorded in this country to one of the foremost of explorers.

THE Commission for reorganising the Observatory of Paris has ended its sittings, as we have already reported. The commissioners recommend no change in the present organisation of the International Meteorological Office; but, taking into consideration the actual wants of meteorology, it has advised the Minister of Public Instruction to appoint a Meteorological Commission, in order to suggest any measures which might be likely to promote the interests of meteorology at large, without interfering with the working of telegraphic weather forecasts sent by the International Office to the sea-ports and more than 1,200 parishes all over France.

THE Scientific Association of France, created by M. Leverrier, after having elected M. Milne-Edwards for its president, has decided upon organising a series of lectures at the Sorbonne, to describe important new inventions and discoveries. The first meeting will soon take place, when M. Cailletet's experiments will be exhibited and explained by M. Henri St Claire Deville. M. Dumas will also deliver an address summarising the history of the Association and reviewing the services rendered by it to science. It is stated that M. Dumas will propose to the Association to initiate a subscription for erecting a monument to the great astronomer who founded it.

IN several cities of Holland committees have been formed with a view to collect subscriptions to defray the expenses of the proposed expedition to the Arctic regions, to which we referred some time since.

MACMILLAN and Co. are about to publish "A Monograph on the Development of Elasmobranch Fishes," by Mr. F. M. Balfour, M.A., Fellow and Lecturer of Trinity College, Cambridge. The work is divided into twelve chapters, and contains the results of much original research on the part of the author, who, on certain points, as on the spinal and cranial nerves, advances views which are a modification of those previously accepted.

IT is announced that the *American Naturalist*, which has had so long and useful a career in Salem and Boston, will hereafter be published in Philadelphia by Messrs. M'Calla and Stavely, under the editorship of Dr. A. S. Packard and Prof. E. D. Cope.

REPORTS from the Island of Sylt, on the west coast of Schleswig-Holstein, state that the storm-flood, which caused such serious damage along the Continental shores of the German Ocean last autumn, has laid bare some remains of the village of Eidum, which perished in the year 1436 by the sea suddenly breaking over it and covering it up. Stone foundations of former dwellings, garden-walls, and wooden remains of various kinds are now seen there, also numerous well-openings, built of massive pieces of dried and baked peat. It is also stated that numerous old coins and utensils have been found there, as well as a well-preserved, carved, and engraved metal bracelet.

RECENT excavations made at Trèves, in the so-called Roman imperial palace, have yielded rich results in Roman antiquities.

ON December 26, at 8 A.M., two meteorolites fell near the village of Höhr (in the Prussian province of Hessen Nassau), close to the high road leading from Neuwied to Coblenz. It is stated that the noise caused by the fall was very characteristic.

THREE earthquakes were observed at Kirlibaba, in the Bukowina, on December 28 and 30 respectively. A fourth phenomenon of this nature was felt at Innsbruck, in the Tyrol, on the 3rd inst., at 8 46 P.M.

BERLIN is listening to an interesting series of lectures delivered under the auspices of the Society for African Exploration. On the programme we notice Dr. Nachtigal, "Ancient Darfour;" Dr. Güssfeldt, "The Arabian Desert;" Dr. Hildebrandt, "Pictures from Equatorial Africa," Prof. Hartmann; "Fauna of the Swedish Islands," &c.

THE two African Societies at Berlin, which have hitherto existed independently of one another, have now finally resolved to unite into a single society.

WE have received the first number of *The Midland Naturalist*, the journal of the associated societies and clubs of the Midland counties, the union of which we referred to some time since. It is a neat and well-printed journal, containing seven good papers, besides miscellaneous matter. Besides the opening address, explaining the formation and objects of the Union, there are papers on abnormal ferns, by Mr. E. J. Lowe, F.R.S.; on an improved aneroid, by Mr. W. J. Harrison, F.G.S.; on the marine zoology of Arran, by Mr. W. J. Hughes (giving the results of an excursion by the Birmingham Natural History Society last summer); Lepidoptera in the Midland Counties, by the Rev. C. F. Thornewill; Entomostraca, by Mr. Edwin Smith; and a paper on some new features in the geology of East Nottingham, by Mr. J. Shipman. This is a very good start, and we hope *The Midland Naturalist* will fill a useful place in our scientific literature. Hardwicke and Bogue are the London publishers.

REPORTS from the Bernese Alps state that the amount of snow fallen during the present month is much greater than has been experienced for a number of years.

THE wolves in Eastern France have become unusually bold during this winter, and reports are constantly received of their depredations in various parts of the country. In one instance a letter-carrier was driven back by them from his regular route.

AN interesting experiment was lately carried out in the neighbourhood of Emmendingen, on the River Danube, to show its subterranean connection with the valley of the Rhine. The river is separated here by a range of Jura limestone from the district drained by the Rhine, and it has long been suspected that the Aach, which has its source in this range and flows into Lake Constance, was really supplied by the Danube. In order to solve the problem, recourse was had to fluorescin, the phthalein of resorein, a compound which yields with alkalies magnificent green fluorescent solutions capable of imparting this property to enormous masses of water. A solution of this substance was introduced into the Rhine at Emmendingen, and two and a half days later the bright green fluorescence was visible in the Aach, the source of which is about five miles distant, and lasted for thirty-six hours. This experiment shows most decisively that the Upper Danube shares its water between the Black Sea and the North Sea, and affords a most interesting explanation of the close similarity in the finny inhabitants of the two great European rivers.

WE notice the appearance, in Paris, of a French translation of the "Organic Chemistry" of Prof. Fittig, of Strassburg. This work, which in its present form is the tenth edition of the textbook originally issued by Prof. Wöhler, has long been a favourite with the German chemist on account of the scrupulous care and fidelity which have been exercised in preparing each successive edition. An English translation was prepared a short time since by Prof. Remsen, of Johns Hopkins University, formerly one of Fittig's assistants, the circulation of which is confined, however, chiefly to America.

ARRANGEMENTS are being made for the holding of an International Exhibition at Sydney in 1879, under the auspices of the Agricultural Society of New South Wales. It is anticipated that many of the articles shown at the coming Paris Exhibition will be trans-shipped to Sydney.

A propos of the remarkable relation established by Dr. Kerr, a short time ago, between light and electricity, an interesting experiment has been made by Mr. J. Mackenzie, in Berlin, at the instance of Prof. Helmholtz (*Pogg. Ann.*, No. 11). A glass plate, 161 mm. long, 12 mm. thick, and with tin foil on its opposite sides, from which proceeded copper wires to a Ruhmkorff coil (with six Bunsen elements), or a Holtz machine, and to earth, was supported and covered with larger glass plates, and placed between two Nicols, as in Dr. Kerr's experiment, the light-source being a lamp. The electric action gave no perceptible increase of brightness, nor was any such obtained when polarised sunlight was used to give greater sensibility, and a leaf of mica thick enough to give the violet colour was interposed between the glass plate and the analyser. Experiments with oil of turpentine likewise gave negative results. (The high sensibility of the polariscope is demonstrated by distinct experiments.) It is therefore concluded that the phenomenon observed by Dr. Kerr is not produced by electric tension itself, but possibly in a secondary manner, through the heating thus caused. Confirmation of this is found in the fact that in Dr. Kerr's experiments it was only after about thirty seconds from closure of the circuit that the action reached its maximum; it also disappeared slowly.

IN a paper in the *Bulletin* of the Belgian Academy of Sciences (Nos. 9 and 10), Prof. Van der Mensbrugghe discusses the causes of the seemingly spontaneous movements of bubbles of air in levels and of vaporous bubbles in the microscopical cavities of minerals, these researches being part of those into the tension of surfaces of liquids. Prof. Mensbrugghe explains these movements, as Mr. Hartley also does, by changes of tension in the surfaces of liquids produced by changes of temperature; when the temperature of the liquid at one end of the bulb becomes, for some reason, higher or lower than at the other end, however small the difference, the tension of the surface decreases at the warmer end, and the bubble moves towards it. But, a thin film of water remaining on the glass, the surface of the liquid is enlarged at the warmer end, and diminished at the opposite end, and this, according to experiments of the author, lowers the temperature and increases the tension at that end; so that if the temperature now ceases to rise the motion of the bubble is not only stopped, but the bubble also returns backwards. Thus each displacement of the bubble immediately gives rise to such forces as tend to produce a motion in an opposite direction; and the variations of tension produce the more obvious motions the smaller the masses of liquid in which the bubble is swimming. The same explanation may be applied also to the movements of bubbles in microscopical cavities of minerals filled with liquids. In that case, the bubble being produced by the vapours of the liquid, its movements are yet more rapid, as every change of temperature is followed by further evaporation of the liquid, or by condensation, both which alter the dimensions of the surfaces of the liquid and their tension. The author supposes also that the Brownian motions of powders suspended in liquids may be explained in the same way, and that those powders which absorb most gas will best display this kind of motion.

PROF. EMILIO CORNALIA, an eminent naturalist and Director of the Museum of Natural History at Milan, has been decorated by the Emperor of Russia with the order of St. Ann for his efficient co-operation in the foundation of the institute for "Bachicoltura" at Moscow and Tashkend.

THE scientific expedition to Lake Lob-Nor, sent out by the St. Petersburg Geographical Society, under command of Col. Prjewalski, and to which we have already referred, has yielded most interesting results in every direction and is of particular importance with regard to the exploration of Kashgar. The new details obtained in reference to Lake Lob-Nor are remarkable. The expedition continued its way from Korla, following the course of the Tarim River down to its confluence with the Rokala Darja. On their way to the Lob-Nor the travellers passed the ruins of three cities. Lake Lob-Nor is of a marshy nature; its length is some 100 kilometres, by only 20 kilometres breadth. Col. Prjewalski explored the western and southern shores, and through the current of the Tarim River reached the middle of the lake. There the shallowness of the water and impenetrable vegetation prevented further progress; almost the whole surface of the lake is thickly covered with reedy vegetation. The inhabitants of the Kara Kurchintz district, on the shores of Lake Lob-Nor, are on the lowest step of civilisation. They live along the shores as well as on islands in the lake, in miserable huts constructed of reeds and branches twisted together. The whole of their possessions are their clothes, which barely cover their nakedness and are made of the fibres of a kind of lake weed, their nets, and their canoes, which are hollow trunks of trees. Metal objects, such as knives, hatchets, &c., are extremely rare among them. Col. Prjewalski, besides his ethnographical results, has collected rich materials for ornithological investigations. He reports that it is impossible to conceive the enormous number of migratory birds which, on their journey from southern countries to the north, or *vice versâ*, select Lake Lob-Nor as a halting place. At present the Russian traveller has wended his way southward and is engaged in the exploration of Tibet.

IN an interesting paper, published by M. Ph. Plantamour in the December number of the *Archives des Sciences Physiques et Naturelles* (Geneva), regarding the earthquake experienced in the immediate neighbourhood of the Lake of Geneva on October 8 last, the author proves most conclusively that the phenomena known under the name of "Seiches," and consisting in occasional and sudden alterations in the level of the lake, have nothing whatever to do with upheavals or depressions in the bed of the lake. During the earthquake referred to, not the least movement of the surface was perceptible, and had an alteration of only one millimetre taken place in the level, the instruments employed by MM. Plantamour and Forel, which continually register these alterations, would have most certainly shown them. The explanation of these "Seiches," therefore, is still a matter of considerable uncertainty, and it even remains to be seen whether barometrical pressure has any influence upon them or not.

Two enterprising men in Paris, a merchant and a doctor of medicine, whose names will be surely blessed by future generations, have made the valuable discovery that the different elements contained in sea-water are infallible preservatives against all possible diseases, and at the same time are never-failing remedies against existing illnesses. These two philanthropists have therefore not only issued a seductive prospectus and widely circulated it in France and abroad, but have also prepared a large quantity of hygienic products, such as bread, biscuits, dry cakes of all descriptions, liqueurs, &c., which are all prepared with sea-water, and are endowed with the most marvellous healing properties. In the prospectus it is stated distinctly that the use of these preparations renders all other medicines or medical treatment unnecessary. There is only one little point which requires explanation. The "inventors" state that their preparations are made with distilled sea-water; we would ask them what becomes of the mineral and organic matter contained in sea-water during this distillation? But *mundus vult decipi!*

THE additions to the Zoological Society's Gardens during the past week include a White-handed Gibbon (*Hylobates lar*) from the Malay Peninsula, a Brown Monkey (*Macacus arctoides*) from Burmah, presented by Mr. W. H. Newman; two Black Francolins (*Francolinus vulgaris*) from India, a Chukar Partridge (*Caccabis chukar*) from North-West India, presented by Major Newton Pauli; four Common Marmosets (*Hapale jacchus*) from Brazil, deposited; two Rough Terrapins (*Clemmys punctularia*), a Scorpion Mud Tortoise (*Cinosternon scorpoides*) from Trinidad, purchased.

CERTAIN MOVEMENTS OF RADIOMETERS[1]

THIS morning (Dec. 20) I received from Mr. Crookes an account of the behaviour of a kind of radiometer which he was so good as to construct at my suggestion. The consideration of an experiment mentioned in a paper of his presented to the Royal Society, which will shortly be read, and which he has kindly permitted me to refer to, suggested to me the desirability of investigating the effect of mere roughness of surface, all other circumstances being alike, and the disc of the radiometer being metallic, so that the two faces may be regarded as practically at the same temperature. Mr. Crookes's experiment, above referred to, led me to suspect that mere roughness might increase the efficiency of a surface, and I suggested to him some experiments with heated glass shades, or with a hot poker presented to the radiometer, the bulb being covered with a cool tumbler to defend it from being heated by the rays easily absorbed by glass. The result in every case answered my expectation; and it may be stated shortly that the law of the motion is that when the fly is hotter than the bulb the rough surface is repelled, or, say, the motion is positive; when cooler, negative.

I subjoin Mr. Crookes's memorandum of the results of experiment:—

"*Aluminium Radiometer* (1326), *one side of the vanes being ruled closely with a sharp knife.*

"1. Exposed to standard candle three inches off. Continuous *positive* rotation (ruled side repelled) at rate of $3\frac{1}{4}$ revolutions a minute.

"2. Exposed to non-luminous flame of a Bunsen burner three inches off. Continuous *positive* rotation at the rate of $7\frac{1}{2}$ turns a minute.

"3. The Bunsen burner removed. The positive rotation gradually diminished till it stopped. No negative rotation.

"4. The bulb heated with Bunsen burner. Good *negative* rotation; then stopped, and rotated *positively* till quite cold.

"5. Bulb covered with a cold glass shade, and a large red-hot ring applied round equatorially. *Positive* rotation, but not very strong.

"6. On removing the shade and ring the positive movement soon comes to rest.

"7. Covered with a hot glass shade, *negative* rotation, with *positive* rotation on cooling (the same as 4).

"8. Plunged into hot water. *Negative* rotation.

"9. Removed from the hot water, and immediately plunged into cold. *Positive* rotation."

Results nearly identical were obtained with another radiometer described as "silver radiometer (1327), one side coated with finely divided silver, electro-deposited."

We must accordingly recognise three distinct conditions under which motion may be obtained in a radiometer, namely, (1) difference of temperature of the two faces, as in a pith radiometer, coated on one face with lampblack; (2) more favourable presentation of one face than the other, as in a radiometer with curved disks; (3) roughness of surface on one face (if this be really different from 2). These three conditions may be variously combined so as to assist or oppose each other, as the case may be, in producing motion.

[1] Paper read at the Royal Society, December 20, by Prof. G. C. Stokes, Sec. R.S. Continued from p. 175.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

LONDON.—At a meeting of Convocation of the University of London held on Tuesday, the supplemental charter empowering the granting of degrees to women was considered. After a long and warm discussion a resolution appoving of the draft of the supplemental charter was carried by 242 against 132.

EDINBURGH.—A letter has been received from the Treasury intimating that 20,000*l.*, the first instalment of the grant by the Government for the buildings of the University of Edinburgh, will be inserted in the estimates for this year.

LEEDS.—A course of ten lectures in connection with the Gilchrist Educational Trust will be delivered in the Albert Hall, Mechanics' Institution, Leeds, on Friday evenings, commencing Friday, January 25, by Prof. A. H. Green, M.A., on "The Geology of Coal;" Prof. L. C. Miall, F.G.S., on "Coal Plants and Animals;" Prof. T. E. Thorpe, Ph.D., F.R.S., on "The Chemistry of Coal;" Prof. A. W. Rücker, M.A., on "Coal as a Source of Power;" and Prof. J. Marshall, M.A., on "The Coal Question." An extra lecture will be given by Dr. W. B. Carpenter, F.R.S., on the "General Results of the *Challenger* Expedition." The admission is one penny.

HALLE.—The winter attendance at the University is 887, including, under theology, 189, law, 112, medicine, 106, philosophy and science, 480. Prussia is represented by 711. The attendance of foreigners is unusually small—England, 2, America, 5, Russia, 11, Austria, 20, &c. The corps of instructors numbers at present 90. The University library, one of the most valuable in Germany, possesses over 100,000 volumes.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, December 13, 1877.—On electrostriction, by Prof. Mills, D.Sc., F.R.S. If the bulb of an ordinary thermometer be coated chemically with silver, and then electrically with a metallic deposit, the mercury will traverse some portion of the scale, and finally take up a definite position independently of temperature. Of the metals hitherto worked with, copper, silver, iron, and nickel, constrict the bulb; zinc and cadmium distend it. The author shows that if y be the total obtainable effect after a time x; D the portion of it due to diametral constriction; L the portion of it due to longitudinal constriction; $d\,l$ two geometrical factors, we have, in the case of the cylindrical thermometer—

$$y = Dd^x + Ll^x,$$

D being always greater than L. For a spherical thermometer receiving more metal on its equatorial region than on its poles,

$$y = Dd^x - Ll^x.$$

For a spherical thermometer, with uniform deposition,

$$y = Dd^x.$$

The author determines in atmospheres pressure the total electrostrictive effect; and points out that, since the deposited metal can be removed by a chemical solvent, we are thus able to measure chemical effect in atmospheres pressure.

Linnean Society, December 20, 1877.—Prof. Allman, F.R.S., president, in the chair.—Dr. Maxwell Masters made some remarks on an interesting specimen of *Colletia cruciata* received from Sig. Fenzi, of Florence. In this case, from the same branch there proceeded shoots with broad, flattened, deltoid spines characteristic of *C. cruciata*, but also others with slender or cylindrical spines very similar to, but more cylindrical than, those of *C. spinosa*. It would thus seem this interesting specimen may tend to clear doubts which have arisen respecting the relation of these two species and that of *C. bictonensis*, Lindl. = *C. cruciata*, Hook.—Mr. Worthington G. Smith made some remarks on a fossil fungus, its zoospores being shown under the microscope. He also exhibited drawings, among others sections of *Boletus subtomentosus*, stating that in a specimen five inches in diameter there are 17,000 pores or tubes. Each pore, when cut across, shows 2,000 cells on the surface. The number of surface cells on the underside of a specimen is 36,000,000. The cells in an entire plant are calculated to be 61,500,000,000, and the number of spores produced by the same specimen, 5,000,000,000.—Mr. S. W. Silver exhibited a series of vegetable products, arrows, and other weapons, &c., from the Fiji Islands and New Caledonia, collected by Consul Edgar Layard. Among the specimens was a mass of the poison said to tip the native arrows with. The composition of this is supposed to be identical with that described by the Rev. Thomas Powell in the Society's *Journal* of last year.—A paper was read on the anatomy of the Elk (*Alces machlis*) by Prof. M. Watson and Dr. A. H. Young. In this a full account of the organs of digestion, generative system, myology, &c., was given, preceded by remarks on the literature, &c., of the subject.—An abstract of a communication, "Descriptions of new genera and species of phytophagous coleoptera," by Dr. J. S. Baly, was read by the secretary in the absence of the author.—The Algæ of the Arctic expedition, by Prof. Dickie, was a paper dealing with the collections made by Capt. Feilden, Dr. Moss, and Mr. Hart, who accompanied Capt. Sir G. Nares. It is noted that of fresh-water species there are representatives of fourteen genera, many of which are common to Europe. Of Diatomaceæ thirty-one genera and seventy species have been identified, most being marine. Seven species of olive-coloured Algæ are given, but it seems no marine examples belonging to the red series were obtained. The collection embraces an area between 78° and 83° north latitude. Then followed a memoir on the minute structure of *Stromatopora* and its allies, by Prof. A. Nicholson and Dr. J. Murie. This interesting form (or group) has long been a puzzle; different writers assigning it a place respectively among Corals, Hydrozoa, Foraminifera, Sponges, and Polyzoa. The authors treat the subject by discussing at length history and literature, the general and minute structure of a typical stromatoporoid, mode of occurrence and original constitution, classification, affinities, and systematic position. The following genera are defined:—*Stromatopora*, *Caunopora*, *Clathrodictyon*, *Stylodictyon*, *Stromatocerium*, *Pachystroma*, and *Dictyostroma*, and a number of new species described. They believe it (or them) to have been originally calcareous and not siliceous, as has been maintained by some, substantiating this by weighty facts and reasons. They discard the notion of its alliance with the Nullipores or belonging to the Corals, Hydrozoa, or Foraminifera, showing wherefore in absolute essentials it is deficient and therefore untenably associated with either. To certain of the Polyzoa some examples hold a striking resemblance in many respects (as likewise is specially the case with certain of the corals), and possibly further research may bridge difficulties in the way of classing it with the former group, but their researches do not completely justify this step. Neither, strictly, does it belong to the horny, siliceous, or calcareous sponges, as at present understood, though the tendency of the data point to the probability of sponge organisation predominating. In this case, however, by absence of spicules, &c., the existing group of *Calcispongiæ* could not contain the stromatoporoids which, under negative evidence, would form a new order of calcareous sponges—Stromatoporoidea.—Messrs. A. S. Bicknell, E. A. Floyer, and Capt. Legge were elected Fellows of the Society.

Meteorological Society, December 19, 1877.—Mr. S. H. Eaton, M.A., president, in the chair.—Commander E. G. Bourke, R.N., J. A. Douglas, W. H. La Touche, B.A., G. J. Pearse, W. S. Rogers, and W. Tyrer were elected Fellows.—The following papers were read:—Notes on the meteorology and physical geography of the West Coast of Africa from Cape Verd to the Cape of Good Hope, by Commander E. G. Bourke, R.N. This paper gives the results of the observations which the author made during the five years he was stationed on the above coast.—On the meteorological observations made by the Norwegian Deep Sea Exploring Expedition in the North Atlantic in 1876 and 1877, by Prof. H. Mohn. This expedition has been organised in order to carry out for the North Atlantic and the Arctic Ocean an inquiry similar to that conducted by the *Challenger* Expedition. The vessel employed was the *Vöringen*, of 400 tons burthen, and the period the summer months of 1876 and 1877. The barometrical observations were taken at first with a mercurial barometer and afterwards with an aneroid which was compared daily with the mercurial barometer on board. The temperature was obtained by a special screen hoisted up on the fore-stay. It was found that this gave very satisfactory results. The experiments conducted with a screen similar to that used by our Meteorological Office on ship-board gave readings too high when the sun shone on it. The sling thermometer was also tried, and gave a temperature on the mean a shade below the screen in the rigging. The wind observations were taken with an anemometer, and Prof. Mohn describes his own anemometer at length, and deals with its corrections in detail. The speed of the ship was determined by a special logging machine, and by this means and the anemometrical observations, the true motion of the wind was ascertained. The part of the paper which presented most novelty was that referring to the evaporation of the sea-water. Two different forms of atmometers were described, both of them devised by Prof. Mohn, and the theory of their action and of the errors to which the experiments were exposed are carefully considered. The paper concluded with tables of the diurnal range of the various meteorological elements for the period of observation.—Report on the phenological observations during 1877, by the Rev. T. A. Preston, M.A. As a rule, the same order of flowering of plants is observed this year as in 1876, viz., that plants came into flower first in the south-west of England and then in regular order to the north of Lincolnshire, where plants were latest in coming into flower. From the tables accompanying the report may be deduced the general state of the weather as regards temperature, and to a certain extent moisture. There is no doubt but that damp acts more powerfully than cold in retarding the flowering of some plants and this has been particularly evident this year. The year, as a whole, has been very unfavourable to vegetation; the bitter cold of May checked the growth of plants, and by the autumn there was comparatively little new wood, and that not properly ripened.—Note on a peculiar fog observed at Kew on October 18, by G. M. Whipple, B.Sc., F.R.A.S.

Royal Microscopical Society, January 2.—Dr. J. Millar in the chair. A paper was read by Dr. Bartlett on the detection of toxic matter connected with typhoid and other enteric diseases, in the course of which he gave an account of his attempts to trace to its ultimate source the cause of a recent outbreak of typhoid fever, and showed that whilst chemical analysis had failed to discover any impurity either in the water or milk, he had been able, by means of microscopical examination, to detect in the water certain bodies, presumably of a fungoid character, which were identical with those found in the bowels of persons who had succumbed to the disease.—Mr. Slack brought before the notice of the meeting a section of bone of *Megalosaurus bucklandii* and its remarkable resemblance to the structure now identified as peculiar to birds, was pointed out by Mr. Charles Stewart.

Paris

Academy of Sciences, January 7.—M. Fizeau in the chair.—M. Daubrée was elected vice-president, from the Section of Physical Sciences (the other candidates being MM. Wurtz, Chevreul, and Blanchard).—M. Peligot reported on volumes just published, or being published, by the Academy. Vol. xxxix. of the *Mémoires* is devoted chiefly to researches by M. Chevreul, vol. xli. to researches by MM. Becquerel; a second volume on the transit observations, relating those at Pekin and St. Paul's Island, has been published; a memoir on *Phylloxera vastatrix*, by M. Cornu, appears in vol. xxvi. of the *Mémoires des Savants Étrangers.* The Academy lost by death, in 1877, one member, M. Leverrier, and five correspondents, MM. Santini, Hofmeister, Braun, Weddell, and Gintroc.—M. Faye presented, in the name of the Bureau des Longitudes, the first volume of its *Annales.* In these *Annales* will be inserted, with additions, the memoirs which the Bureau formerly published in the *Connaissance des Temps*, its circle of activity having been enlarged.—On persulphuric acid, a new oxygenated acid of sulphur, by M. Berthelot. This is obtained pure and anhydrous, by making the electric *effluve* act, with strong tension, on a mixture of equal volumes of dry sulphurous acid and oxygen; it is got in the dissolved state by electrolysis of concentrated solutions of sulphuric acid, or by mixing with care a solution of oxygenated water with sulphuric acid, concentrated, or diluted with less than one equivalent of water. At a temperature near zero, it crystallises, and resembles, in its general aspect, anhydrous sulphuric acid, only it has longer, and thinner, and transparent needles. The formula, determined variously, is S_2O_7. Heated in a flame, the substance is immediately decomposed into oxygen and anhydrous sulphuric acid. In air it gives off thick fumes. In concentrated sulphuric acid it dissolves without liberating oxygen. In water it dissolves, giving thick fumes and effervescence, &c.—On a new flat regulating spiral for chronometers and watches, by M. Phillips. The theory of this is explained.—On some new modifications in the telephone, by M. Breguet. According to indications by MM. Garnier and Pollard, a thin plate of sheet iron is arranged with the end of a blacklead pencil pressing slightly on the central part; plate and pencil are connected by wires of ordinary lines with the two ends of the bobbin wire of a Bell telephone, which has, instead of the magnetic bar, a bar of soft iron. A battery of two Laclanché elements is placed in the circuit. The plate, vibrated by the voice, causes variations in the blacklead, and so in the resistance of the circuit and the intensity of the permanent current, which produces alternative attractions and non-attractions in the electromagnet of the receiving telephone; thus the voice is reproduced. M. Breguet is hopeful of an increased intensity of effect by such a method.—On the production and properties of a new suction-ram without air-reservoir, capable of drawing water from all depths, by M. de Caligny.—Density of liquid oxygen, by M. Pictet. The author experimentally confirms M. Dumas' view, who obtained the expression $\frac{16}{16} = 1 = \delta$, for the solid, and probably the liquid state also. The jet of oxygen showed a strong polarisation of the electric light, indicating the presence of solid dust, probably small crystals of solid oxygen.—On the quartic of Steiner, by M. Amigues.—On a single principle containing the whole theory of curves and of surfaces of any order or class, by M. Serret.—On a theorem of M. Villarceau; remarks and consequences, by M. Gilbert.—On phenomena of dispersion in metallic reflection of polarised luminous or calorific rays, by M. Mouton. The greater the wave-length the longer is the interval during which mirrors act like glass on light, simply impressing a certain rotation in the original plane of polarisation, and the shorter therefore is that in which the original rectilinear polarisation of the incident ray is changed by the fact of reflection into elliptic polarisation.—On normal ethyloxybutyric acid and its derivatives, by M. Duvillier.—Researches on the intracellular alcoholic fermentation of plants, by M. Muntz. Plants kept in air give no trace of alcohol; those kept in nitrogen give a quite appreciable quantity, and they continue to live and grow. These facts are a confirmation of M. Pasteur's views.—On the inversion and alcoholic fermentation of cane-sugar by mouldiness, by M. Gayon.—Some remarks on the origin of alcoholic yeast, by M. Trécul.—Verbal response of M. Pasteur.—On a new gorilla from Congo, by MM. Alix and Bouvier. This seems, like chimpanzees, to have more arboricolar habits than the *Gorilla gena.* The name of *G. Mayema* is given it from that of the negro chief of the village near which it was killed.—On the formation of fibrine of the blood studied with the microscope, by M. Hayem.—On a process for obtaining recomposition of the light of the solar spectrum, by M. Lavand de Lestrade.

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