THURSDAY, JUNE 8, 1882

## ANTS, BEES, AND WASPS

*Ants, Bees, and Wasps; a Record of Observations on the Social Hymenoptera.* By Sir John Lubbock, Bart., M.P., F.R.S., D.C.L., LL.D., Pres. B.A. and L.S., &c. International Scientific Series, Vol. XL. (London: Kegan Paul, Trench, and Co., 1882.)

SIR JOHN LUBBOCK has done well to gather all the results of his serially published observations on the social hymenoptera in one treatise, and to bring out the treatise in the International Scientific Series. On the one hand the extensive and important research on which he has for so many years been engaged is thus presented to the naturalist no longer in the form of scattered papers, and on the other hand the International Scientific Series, both on account of its popularity at home, and of its well-organised machinery for securing rapid translations abroad, is the most suitable place for publishing results which are in so eminent a degree of interest to general readers.

Looking to the investigations as a whole, or in the connected form in which they are now presented, we think that they deserve to be considered the most scientifically methodical, as well as in many respects the most scientifically fruitful, which have hitherto been prosecuted in the region of comparative psychology. In saying this we do not forget the investigations of Reaumur, Huber, Forel, Darwin, Moggridge, McCook, Morgan, or Spalding—all of whom we regard as holding more substantial claims to recognition in this respect than many others who might be mentioned in the same connection. But when we compare the researches of Sir John Lubbock with those of any other comparative psychologist, we find that he has the merit of showing, if not the greatest appreciation of scientific method, at least the greatest determination in applying such method to the questions with which comparative psychology has to deal. Darwin and Spalding are the only other men who in this department of science have shown an adequate estimate of the importance of experiment as distinguished from observation; but neither Darwin nor Spalding had time to experiment in psychology on a large scale—the former having had so many other lines of inductive and deductive research to attend to, and the latter having died so young. Thus it is that when we compare the investigations of Sir John Lubbock with those of other workers in the field of animal psychology, we must assign to him the first place among these workers as a scientific observer.

For the most part the volume before us is a reprint of the papers read before the Linnean Society, with only as much re-casting as is rendered necessary to give a systematic form to the book. A few coloured plates, however, are added, as well as a brief account of some of the chief facts recorded by other observers of ants. The latter, indeed, is slender, and is not even attempted in the case of bees; so that the essay is strictly, as its title proclaims, "A record of observations on the social hymenoptera"; it is not an account of all that we know concerning the psychology of these animals. As the essay is sure to attain a wide popularity, it is perhaps to be regretted that its author did not take the opportunity of disseminating complete information upon so interesting a subject, together with the "record" of his own "observations." But this is a matter on which opinions are likely to differ, and there can be no doubt that within the scope laid down by its title, the work is admirably arranged.

We shall now proceed briefly to enumerate the principal results which this record of observations sets forth.

The longevity of ants has been found to be much greater than was formerly supposed, for while previous observers were for the most part of the opinion that these insects die off every year, Sir John says:—

"I have now (December, 1881) two queens which have lived with me since the year 1874. They must therefore be at least seven years old, and seem still quite strong and well. I have also some workers which I have had in my nests since 1875."

The following facts and opinions on questions of morphology may be quoted;—

"I must regard the ancestral ant as having possessed a sting, and consider that the rudimentary condition of that of Formica is due to atrophy, perhaps through disuse."

Some species have the power of ejecting their poison to a considerable distance—as much as eighteen inches—and this power might have led to the sting falling into disuse, especially if the poison is, as it appears to be, "so intensified in virulence as to act through the skin."

"The question arises whether the different kinds of workers are produced from different eggs. I am disposed to agree with Westwood in the opinion 'that the inhabitants of the nest have the instinct so to modify the circumstances producing this state of imperfection, that some neuters shall exhibit characters at variance with those of the common kind.'"

"Among bees and wasps the workers are occasionally fertile; but so far as our observations go, it is a curious fact that their eggs never produce females, either queens or workers, but always males. . . . It became therefore an interesting question whether the same is the case among ants, and my nests have supplied me with some facts bearing on the question."

These facts consist of numerous cases of fertile eggs having been laid by workers, and in every case with the result of producing a male insect.

With regard to psychology, we have only space to allude briefly to the more important results.

Experiments showed that certain individual ants in a community "are told off as foragers, and that during winter, when little food is required, two or three are sufficient to provide it."

Observations concerning sympathy and affection went to show, that while in most cases such feelings seemed to be entirely absent, in some cases they seemed to be certainly present. This was so in an instance observed last year, of a "poor ant lying on her back, and quite unable to move." Her companions moved her tenderly, for whenever Sir John "tried uncovering the nest where she was, the other ants soon carried her into the shaded part," and when they left the nest for an airing, they carried the invalid with them.

It was previously known that all the ants in the same nest recognise one another as friends. Sir John tried chloroforming and intoxicating certain individuals, to see whether this would prevent their being so recognised.

The chloroformed ants were treated by their companions as dead, but the intoxicated ones were recognised and taken into the hive, while intoxicated strangers were rejected. The manner in which recognition is effected has long been a standing puzzle to observers, and although Sir John Lubbock has not shown "how it is done," he has at least shown very conclusively how it is *not* done. Previous hypotheses supposed the faculty to depend on recognising personal appearance, personal scent, or on there being some pass-signal understood by all the members of a hive, and not known to members of other hives. But Sir John has found that the recognition is effected when the pupæ are hatched out away from their native hive, and even when the eggs are developed in one half of a divided hive, and the matured insects then returned to the other half. He also found that the memory of companions or nest-mates extends over at least a year and nine months.

Regarding the power of communication, the experiments went to show a strange uncertainty, though they agree with previous observations in establishing the main fact that such a power exists. Thus, for instance, when a dead fly was pinned down so that the ant which found it could not drag it towards the nest, she returned to the nest and procured assistance. This experiment was repeated, with small variation, a great number of times, and certainly proves a power of communication at least to the extent of "follow me." Moreover, by an ingenious device with three parallel tape bridges extending from a nest to three similar glasses, one empty, another holding a few larvæ, and the third filled with many larvæ, Sir John was able to show the interesting fact that ants can give definite information to one another as to locality, without requiring merely to lead the way. For he took two ants and placed one of them to the glass with many larvæ, and the other to that with a few. Each of them took a larva, carried it to the nest along the respective tapes, returned for another, and so on. After each journey he put another larva in the glass with a few larvæ to replace the one which was taken away. Every new ant which came to either of the glasses was imprisoned till the end of the experiment. Such being the conditions, it was observed that no ants went along the tape bridge to the empty glass, 104 ants went to the glass with a few larvæ, and 304 to the glass with the many larvæ. Thus it seems that the two original (marked) ants were able to tell their companions, not only where larvæ were to be found, but even where the largest store was to be met with.

Concerning the powers of special sense, a large number of experiments proved that ants are able to appreciate colour, and when their nests are covered with slips of stained glass, analysis of some of these experiments showed that there had congregated "under the red 890, under the green 544, under the yellow 495, and under the violet only 5." Other experiments showed that red light was the same to them as darkness, or, at least, that about the same proportion of ants congregated under red glass as congregated under a slip of porcelain. With reference to the parts of the spectrum invisible to our eyes, other experiments proved "that the limits of vision of ants at the red end of the spectrum are approximately the same as ours, that they are not sensitive to the ultra-red rays; but, on the other hand, that they are very sensitive to the ultra-violet rays." A layer of sulphate of quinine or of bisulphide of carbon had the effect, as might be supposed from the latter statement, of rendering the ultra-violet rays invisible, or less obnoxious to the ants. Conversely, a saturated solution of chrome alum, and chromium chloride in a layer so thick that in the darkness beneath it the ants could not be seen, had the effect of inducing the ants to escape from its luminosity to their eyes, and to go beneath the bisulphide of carbon; so that, "though to our eyes the bisulphide of carbon is absolutely transparent, while the chrome alum and chromium chloride are very dark, to the ants, on the contrary, the former appears to intercept more light than a layer of the latter."

A number of elaborate experiments on the sense of hearing produced only negative results, though from other considerations (chiefly anatomical) Sir John concludes, "On the whole, though the subject is still involved in doubt, I am disposed to think that ants perceive sounds which we cannot hear." Experiments on the sense of smell showed that the estimate previously formed by naturalists of its excellence was not exaggerated.

A number of experiments on the general intelligence of ants in overcoming difficulties of various kinds which Sir John devised for them, went to indicate a poverty of resources scarcely to have been expected; but it must be remembered that this only shows that there are ants and ants, for other trustworthy observers give wonderful accounts of the high intelligence of certain foreign species. On the subject of way-finding, there are also many interesting observations, which show that sight is not of nearly so much service as smell, although it is of much use in giving them their general "sense of direction;" for they observe the direction in which light is shining, guide themselves accordingly, and lose themselves if turned partly round on a rotating table in the dark.

We must not leave these chapters on ants without referring to one on the relation of these insects to plants, and another on their relation to animals. It is of importance to many species of plants that they should not be visited by ants, as the presence of these insects would tend to keep away bees, &c., which are required to fertilise the flowers. Consequently, these species of plants present a great variety of contrivances to exclude the ants, such as water-traps, slippery surfaces, narrow passages, sharply-curved stalks, hairs, viscid secretions, &c. Instances of such contrivances are given, and the general conclusion is stated that "though ants have not influenced the present condition of the vegetable kingdom to the same extent as bees, they have also had a very considerable effect upon it in various ways." Concerning the relation of ants to other animals, the most interesting addition to our knowledge which Sir John has made is that of *Lasius flavus* farming the eggs of aphides. For "here are aphides, not living in the ants' nests, but outside, on the leaf-stalks of plants. The eggs are laid early in October on the food-plant of the insect. They are of no direct use to the ants, yet they are not left where they are laid, exposed to the severity of the weather and to innumerable dangers, but brought into their nests by the ants, and tended by them with the utmost care through the long winter months until the following March, when the young ones are brought out and again placed on the

young shoots of the daisy. . . . Our ants may not perhaps lay up food for the winter (like the harvesters), but they do more, for they keep during six months the eggs which will enable them to procure food during the following summer, a case of prudence unexampled in the animal kingdom."

Only one chapter of the book is devoted to bees, and one other to wasps. These, however, are very interesting, as the following *résumé* will show:—

Numerous observations went to prove "that bees do not bring their friends to share any treasure they have discovered so invariably as might be assumed from the statements of previous writers;" and also that in general bees are rather stupid in finding their way to honey out of rooms, &c. Their affection and sympathy is even less developed than in ants, so that Sir John doubts "whether they are in the least fond of one another." Their special senses are much the same as those of ants, hearing being to all appearance absent, while smell and sight are well developed, the latter enabling the insects to distinguish differences of colour on coloured surfaces. They prefer blue.

All these remarks apply to the experiments on wasps no less than to those on bees, except that they are somewhat more clever in finding their way, and show less preference for certain colours. One individual wasp was tamed, used to perch upon the hand, "apparently expecting to be fed," and even allowed herself to be stroked without any appearance of alarm.

We have now said as much as our space permits to recommend this work to all who take an interest in one of the most interesting branches of natural history. We can only find two points on which to offer criticism. Over a hundred pages are occupied with appendices, conveying minute details of the observations and experiments mentioned in the previous part of the work. These details appear to us unnecessary in a popular book, and we think that the space filled by them might have been more profitably devoted to a well compressed abstract of the observations of other naturalists upon the psychology of the hymenoptera.

The second point, which seems to us fairly open to criticism, is that concerning the author's views on the philosophy of vision. He discusses the theories of vision by simple and compound eyes of insects, and says, "The prevailing opinion of entomologists now is that each facet receives the impression of one pencil of rays; so that, in fact, the image formed by a compound eye is a sort of mosaic," and proceeds to observe that this theory "presents great difficulties," because "those ants which have very few facets must have an extremely imperfect vision," and also because the ants have simple eyes as well as compound, so that, according to the theory, the former cast reversed images, and the latter direct—a consideration which leads Sir John to remark, "that the same animal should see some things directly, and others reversed, and yet obtain definite conceptions of the outer world, would certainly be very remarkable."

Now, as regards the first objection, the perfection or imperfection of the vision would not necessarily be determined by the *number* of the facets any more than by their *size*. If a given area or eye-space is throughout a receptive surface, it need make no difference whether the area is composed of a few facets or of many; the perfection or imperfection of the apparatus as an eye would in either case depend on the distinctness or definition with which a pencil of rays is admitted into each facet, whether the pencil itself be wide or narrow.

And, as regards the second objection, we can see no real difficulty in supposing that the same animal should with some of its eyes see direct images and with others reversed images, without any confusion resulting to its mental perceptions. Let us first consider the case of reversed images. Sir John Lubbock says that we "see everything really reversed, though long practice has given us the right impression." But this statement is not quite correct. We do not really *see* things reversed, for the mind is not a perpendicular object in space standing behind the retina in the manner that a photographer stands behind his camera. To the mind there is no up or down in the retina, except in so far as the retina is in relation to the external world, and this relation can only be determined, not by sight, but by touch. And if only this relation is *constant*, it can make no difference to the mind whether the images are direct, reversed, or thrown at any angle with reference to the horizon; in any case the correlation between sight and touch would be equally easy to establish, and we should always *see* things, not in the position in which they are *thrown upon* the retina, but in that which they occupy *with reference to* the retina. Thus it really requires no more "practice" correctly to interpret inverted images than it does similarly to interpret upright images, and therefore the fact that some eyes of an ant are supposed to throw direct images, while others are supposed to throw reversed, is not any real objection to the theory which Sir John Lubbock is considering.

We give these criticisms as the only ones we have found it possible to make, and heartily wish so interesting a book the success which it deserves.

GEORGE J. ROMANES

## OUR BOOK SHELF

*The Great Giant Arithmos, a Most Elementary Arithmetic.* By Mary Steadman Aldis. (London: Macmillan, 1881.)

"THERE are still mothers who wish to retain some portion of that influence which nature intended them to have in the training of their children, and who refuse to abandon it wholly either to the schoolmaster or the state. To such as these this little book is offered as a help in laying the foundations of one of the most important branches of instruction." In fifty-eight chapters the tender student is led pleasantly, clearly, and thoroughly, from the very simplest notions which lie at the threshold of arithmetic till he (or she), having solved many of the giant's easy riddles, is in a very good position to find out for himself some of the harder ones. We should say that the child who has had this course carefully laid before it, will have had its interest maintained throughout without flagging, for the mode of presenting the subject is such as to excite attention without causing fatigue. The lessons are all short, the questions pointed, and such as to draw out what knowledge has been acquired. Very little more is done than to explain the elementary operations of numeration, addition, subtraction, multiplication, and division. Towards the close a glance is given at some of the giant's more recondite mysteries, as of parts

or fractions of things. Much useful, if elementary, information is conveyed in small doses as the child is able to receive it, but there is nothing childish in the matter or the manner. We should say that the best way to use the book would be for the parent (or governess) to master each lesson well beforehand, so that there should be little or no reference to the book during lesson-time, except, perhaps, for the purpose of looking at the illustrative drawings. We feel sure that when the "good bye" is reached there will be few to call Arithmos unkind names and say "he is a horrid, cross old thing," and that "they hate him, and wish such a giant had never been made."

*A Treatise on Elementary Trigonometry.* By the Rev. J. B. Lock. (Macmillan, 1882.)

*Introduction to Plane Trigonometry.* By the Rev. T. G. Vyvyan. (Deighton, Bell, and Co., 1882.)

BOTH these works are elementary: their scope is in the main limited by the requirements of the Previous Examination at Cambridge, and of the Entrance Examinations for the army. Mr. Lock's is by far the fuller work, and is well adapted for a student who has not constantly at hand the assistance of a private tutor; in fact, such a reader, if of fair intelligence, might be independent of extraneous aid, if he have previously grounded himself carefully in geometry and elementary algebra. The work contains a very large collection of good (and not too hard) examples. The only fault—if we must grumble—is that there is too much, we think, for ordinary school teaching. As Mr. Vyvyan remarks, "in all public schools but a few hours a week can be given to mathematics by the generality of boys," and trigonometry has to take, in general, a very small portion of that limited time. But Mr. Lock is to be congratulated, when so many "Trigonometries" are in the field, on having produced so good a book, for he has not merely availed himself of the labours of his predecessors, but by his treatment of a well-worn subject has invested the study of it with interest. The figures are numerous, and are drawn so that the salient features arrest the eye at once.

Mr. Vyvyan's work also is well adapted to the end he has in view. He aims at producing a book which may fairly be mastered by any schoolboy of average ability, whose sole desire in studying this branch (or any other branch of mathematics) is to satisfy the University examiners in an early stage of residence, that so he may be free to read other subjects, and bid farewell to mathematics.

The matter is clearly, though somewhat concisely put, and is sufficient in quantity for Mr. Vyvyan's purpose, which is not to bring out a book that will render a schoolboy or other junior student independent of the assistance of a master—this he considers to be an impossible task. We ourselves have found that very much explanation is required by the generality of pupils. There is a sufficient collection and variety of exercises.

We cannot say that either text-book will supersede all other text-books, but each merits, and will no doubt secure a very fair circulation in schools. Mr. Lock's being the fuller, is likely to be the more generally acceptable.

*An Elementary Treatise on Conic Sections.* By Charles Smith, M.A. (London: Macmillan, 1882.)

A THOROUGHLY excellent elementary treatise. For a long time we have been exercised in mind when asked to recommend a book on Conics. To all its predecessors, with their varying shades of goodness and badness, we had some objection or other to urge. Mr. Smith has just met our want; his book is right up to the time, and is admirably adapted for the preparation of pupils for college scholarships; for students at the university it is a fitting introduction to that as yet unapproached work, Salmon's treatise on these curves. The text is excellent, full in alternative proofs, and suggestive in its methods; the numerous worked-out exercises, in addition to those collected at the close of the several chapters, render the reader independent of any other work. We think the title-page should state that it is an "analytical" treatise on conics.

## 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 Darwin Memorial

THE note in NATURE, vol. xxvi. p. 87, on the Darwin memorial, says that there is to be a fund associated with the name of the great naturalist, which shall be devoted to the furtherance of biological science. Probably most biologists would agree that one of the best plans for effecting this object would be one, the idea of which originated with Mr. Sydney Hickson, of Downing College, Cambridge, who is at present on the staff of the Oxford Biological Laboratory. This plan is to establish out of the fund a marine zoological station somewhere on the English coast, that of Devonshire, for example. Mr. Hickson has advocated this course in a letter to the *Times*, where he pointed out that Italy, Austria, and France have zoological stations, while we have none, a fact which is one of the many signs that the teachings of Darwin have aroused more enthusiasm and activity abroad than at home. If you would give publicity to this suggestion it would be certain to come under the notice of the Memorial Committee and of biologists generally.

J. T. CUNNINGHAM

Cottons, Romford, May 27

### Comet *a* 1882

OWING to recent bad weather, the only opportunity we have had here of observing the spectrum of the comet was on June 4. Unfortunately our view was obstructed by clouds just as it grew dusk, but at 11.30 I managed to obtain a glimpse for a few moments. The nucleus gave a very bright continuous spectrum, with a marked increase of luminosity and widening of the spectrum in the yellow. I could see no lines or bands. I was not able to make any further observations, as the comet was on the point of disappearing behind a tree.

A. PERCY SMITH

Temple Observatory, Rugby, June 6

THIS comet was distinctly visible to the naked eye, at 11 p.m. on Sunday, June 4, in the north-west, about 5° to 10° above the horizon (being in a hilly country, I could not estimate it correctly), with a bright nucleus, and a tail about 1½° in length. The sky had been overcast and stormy all day, but cleared up before midnight. I observed it from a hill-side about 400 feet above sea-level.

F. T. MOTT

Leicester

### Meteors

ABSENCE from home on business connected with the Transit of Venus Expeditions prevented me sending you earlier notice of a very brilliant meteor, which was seen here and at several distant stations.

On May 4, at 9h. 31m. p.m., Mr. Rooney, one of the assistants of the Observatory, saw a large fire-ball of a light purple tint. It was first observed near the star Arcturus, and then it moved towards the Great Bear, passing between δ and ε Ursæ. It burst just under α Ursæ, when its train changed in colour from a purple tint into a brilliant red. It was visible for about five seconds, and lit up the whole garden.

Another assistant, Mr. Cullen, saw the same body from a place not far distant, and his account agreed well with the above.

A note from a friend at Clitheroe informs me that the meteor was seen in that town by several persons, and was as brilliant as the full moon.

Another observer, writing from Prestwich to the *Manchester Examiner and Times*, describes it as having moved from S.S.E. to N.N.W., passing a few degrees to the east of the zenith, and exploding and then vanishing at an angle (altitude) of 40° to 45°.

At Tarporley it was visible for thirty seconds, moving from E. to N.N.W.

The same fire-ball was also seen in Cheshire.

Stonyhurst Observatory, Whalley, May 31 S. J. PERRY

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ON May 16, about 11 p.m., I saw a meteor that was, I think, the most terrific, as well as the grandest, I have ever happened to see. I reached my house about ten minutes afterwards, and at once wrote down, substantially, the following unvarnished account of the phenomenon. It may have been witnessed and recorded by some one elsewhere. If so, the observer may like to compare my record of it with his own :—I was walking westward, and I was about two miles south-west of Woodstock (as the crow flies). Suddenly my attention was drawn upward by a brilliant light. I then saw a meteor high up in the western sky, and a little south of the Great Bear. It was descending at an angle of 50°. Its speed was so moderate, that I got a good observation of it. Its seeming size was, I think, quite half that of the full moon. It appearance was such as I never saw before: it struck me as being like a transparent lantern, or, rather, pail, full of burning matter. Its base was a sharply-defined broad cone. It looked as though let down from above by an unseen string, rather than falling. It seemed to be very near me. A flickering reddish flame rose, fitfully, straight up from the horizontal surface of its yellow-hued fiery mass. It vanished, without my seeing any scattering of sparks, when it was about half way between the Pointers and the horizon.

JOHN HOSKYNS-ABRAHALL

Combe Vicarage, near Woodstock, May 27

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## Earth-Tremors in Japan

AN article on earth-tremors, which appeared in the *Times* last November, seems to have attracted considerable attention in Japan, and a few facts respecting the work which has been attempted in the investigation of microseismic disturbances in this country, may possibly be of interest. In the *Transactions* of the Seismological Society of Japan we have already had three communications on this subject. Prof. H. M. Paul told us how, when searching for a site for the United States Naval Observatory at Washington, by watching the reflection of the image of a star in a vessel of mercury with a telescope, he was easily enabled to detect earth-tremors produced by a railway train at the distance of a mile.

Major H. S. Palmer, R.E., of Hong Kong, gave us an account of how, by digging a trench large enough to contain himself and his instruments when seeking for a station from which to make observations on the Transit of Venus, he practically escaped from earth-tremors which emanated from a railway line about 400 yards distant. As there are strong reasons for believing that many of the earthquakes which are felt in Yedo are produced by the faulting of the rocks, it was natural to assume that before the actual breakage took place there might be a crackling or gradual giving way which would be indicated to us by preceding earth-tremors.

In order to determine the presence of these earth-tremors, at the end of 1879 I commenced a series of experiments with a variety of apparatus, amongst which were microphones and sets of pendulum apparatus, very similar in general arrangement, but, unfortunately, not in refinement of construction, to the arrangements now being used in the Cavendish Laboratory.

The microphones were screwed on to the heads of stakes driven in the ground, at the bottom of boxed-in pits. In order to be certain that the records which these microphones gave were not due to local actions, such as birds or insects, two distinct sets of apparatus were used, one being in the middle of the lawn in the front of my house, and the other in a pit at the back of the house. The sensitiveness of these may be learnt from the fact that if a small pebble was dropped on the grass within six feet of the pit, a distinct sound was heard in the telephone, and a swing produced in the needle of the galvanometer placed in connection with these microphones. A person running or walking in the neighbourhood of the pits, had each of his steps so definitely recorded, that a Japanese neighbour, Mr. Masato, who assisted me in the experiments, caused the swinging needle of his galvanometer to close an electric circuit and ring a bell, which, it is needless to say, would alarm a household. In this contrivance we have a hint as to how earth-tremors may be employed as thief-detectors.

The pendulum apparatus, one of which consisted of a 20 lb. bob of lead at the end of 20 feet of pianoforte wire provided with small galvanometer mirrors, and bifilar suspensions were also used in pairs. With this apparatus a motion of the bob relatively to the earth was magnified 1000 times, that is to say, if the spot of light which was reflected from the mirror moved a distance equal to the thickness of a sixpence, this indicated there had been a relative motion of the bob to the extent of 1000th part of that amount.

The great evil which every one has to contend with in Japan when working with delicate apparatus are the actual earthquakes, which stop or alter the rate of ordinary clocks.

Another evil which had to be contended with was the wind, which shook the house in which my pendulums were supported, and I imagine the ground by the motion of some neighbouring trees. A shower of rain also was not without its effects upon the microphones. After many months of tiresome observation, and eliminating all motions which by any possibility have been produced by local influence, the general result obtained was that there were movements to be detected every day and sometimes many times per day.

Although these observations, which I found required more attention than a private observer was enabled to give to them, have been discontinued, I sincerely hope they may be again taken up. My reason for this is that in a country like Japan, where earthquakes are in some part or other phenomena of everyday occurrence, we have excellent opportunities of determining whether any connection exists between earthquakes and earth-tremors. The idea that earth-tremors may be the forerunners of earthquakes is by no means novel, and that earth-tremors actually exist was demonstrated some years ago in Florence by Timoleo Bartelli, who made microscopic observations of the pointer of a pendulum, which, to free from local surface action, he suspended in a cell. The localities which I should recommend for the observations of earth-tremors would be as near as possible to some earthquake centre. The localisation of these centres, however, is a matter of some difficulty. The difficulty arises from the fact that *good* time observations on earthquakes have, so far as I am aware, never yet been obtained; and farther, although we are able with our seismographs to write down the direction in which the earthquakes shake us backwards and forwards, these directions by no means always tell us the direction in which an earthquake came, an east and west motion having sometimes been proved to have travelled broadside on up from the south.

A great assistance to the interpretation of the various records which an earthquake gives us on our seismographs is what I may call a barricade of post-cards. At the present moment Yedo is barricaded, all the towns around for a distance of one hundred miles being provided with post-cards. Every one of them is posted with a statement of the shocks which have been felt.

For the months of October and November it was found from the records of the post cards that nearly all the shocks came from the north and passed Yedo to the south-west. When coming in contact with a high range of mountains, they were suddenly stopped, as was inferred from the fact that the towns beyond this range did not perceive that an earthquake had occurred. This fact having been obtained, the barricade of post-cards has been extended to towns lying still farther north. The result of this has been that several earthquake origins have, so to speak, been surrounded or coralled, whilst others have been traced as far as the seashore. For the latter shocks earthquake hunting with post-cards has had to cease, and we have solely to rely upon our instruments. Having obtained our earthquake centres, at one or more of these our tremor instruments might be erected, and it would soon be known whether an observation of earth-tremors would tell us about the coming of an earthquake as the cracklings of a bending do about its approaching breakage. To render these experiments more complete, and to determine the existence of a terrain tide, a gravitimeter might be established. I mention this because if terrain tides exist, and they are sufficiently great from a geological point of view, it would seem that they might be more pronounced and therefore easier to measure in a country like Japan, resting in a heated and perhaps plastic bed, than in a country like England, where volcanic activity has so long ceased, and the rocks are, comparatively speaking, cold and rigid, if an instrument sufficiently

delicate to detect differences in the force of gravity in consequence of our being lifted farther from the centre of the earth every time by the terrain tide as it passed between our feet, could be established in conjunction with the experiments on earth-tremors.

JOHN MILNE

Imperial College of Engineering, Tokio, Japan

### Limulus

CONCERNING the systematic place of Limulus, I should like to draw attention to a habit which has, as far as I know, never been alluded to in discussions, viz. the manner of casting its skin, mentioned by me in Deformation of Insects (*Mem. Compar. Zoology*). Limulus splits the skin exactly around the front margin of the head. Among Crustacea the Decapods at least split the skin around the hind margin of the carapace. Insects split the skin in the longitudinal middle line of the occiput and thorax, with the later addition of a transversal split on the head. I have seen cast skins of Scorpio, Pseudoscorpions, Hydrachna, and Arachnids, but they are not now at hand for a sure verification. As far as I remember all of them split the skin in the middle line of the anterior parts. At least I do not remember to have seen any transversal anterior split.

H. A. HAGEN

Cambridge, Mass.

### The Utilisation of Ants in Horticulture

DR. C. J. MACGOWAN has sent me from Han Chow, Province of Hainan, China, a little paper on the "Utilisation of Ants as Insect Destroyers in China." It seems that in many parts of the province of Canton the orange trees are injured by certain worms, and to rid themselves from these pests, the inhabitants import ants from the neighbouring hills. The hill-people throughout the summer and winter find the nests of two species of ants, red and yellow, suspended from the branches of various trees. The "orange ant breeders" are provided with pig or goat bladders baited inside with lard. The orifices of these they apply to the entrance of the bag-like nests, when the ants enter the bladders, and, as Dr. Macgowan expresses it, "become a marketable commodity at the orangeries." The trees are colonised by placing the ants on their upper branches, and bamboo rods are stretched between the different trees, so as to give the ants easy access to the whole orchard. This remedy has been in constant use at least since 1640, and probably dates from a much earlier period. This is certainly a new way of utilising ants, which as a rule are deservedly considered a nuisance by the horticulturist. I should like to learn from any entomological reader of NATURE whether the facts communicated have before been known in Europe, and, if so, whether the species of ant has been determined.

C. V. RILEY

Washington, D.C.

### Aurora Australis

APRIL 17.—Evening very dark; air close and sultry; thermometer at 65. About 6.35 p.m. noticed a broad sheath of dull rosy red in the south, stretching upwards towards the zenith; from south-east to south was spread a bright greenish-yellow glare, sufficiently luminous to enable us to read the figures of a lady's small watch. Shortly afterwards, the sky from east-by-south to south-south-west was illumined with a ruddy glow deepening to dark red; at the most easterly point of the auroral light were broad pulsating streamers of great brilliancy; these extended to south-east-by-east. Could not detect the slightest sound from aurora. Weather continued fine. April 20.—This evening there was a wide-spread glare of auroral light, with greater range, but of far less brilliancy than marked the grand display on the 17th. Weather fine and clear.

T. H. POTTS

Ohinitaki, N.Z., April 21

### "Cuprous Chloride Cell"

As the account given of my cuprous chloride cell in your report (NATURE, vol. xxvi. p. 96) of the Proceedings of the Royal Society of Edinburgh is rather misleading, I hope I may be excused if I make a few remarks on the subject. It is there stated that my cells suffered greatly from loss. This is not a correct statement. There are two ways in which the work expended in charging a secondary battery is lost. When a secondary battery is being charged, the E.M.F. between the terminals of the battery is higher than the normal E.M.F. of the battery with open terminals, work being expended in heating the cells. When the charged cells are used to supply a current, the E.M.F. between the terminals is lower than the normal E.M.F. with open terminals, work being again spent in heating the cells. This source of loss is unavoidable, and is in practice very serious. I need only refer to the recent experiments in Paris with Faure accumulators, which were, I think, reported in NATURE. The second source of loss is the local action in the cell. This depends upon the chemistry of the cell. I have found the estimation of loss from this cause a difficult matter, but I think I am justified in saying that the loss from this cause in my cell is very small, when it is properly constructed. In fact, when used as a primary, its advantage is that it does not suffer from diffusion and consequent local action as all double-fluid cells do. I think it deserves a trial as a primary battery on this account. It is necessary to protect the cuprous chloride from air, covering it with water being quite sufficient. If this is done it should be a very durable form of cell

A. P. LAURIE

King's College, Cambridge

[The statement that the cells suffered greatly from loss is in our report coupled with an additional statement which implies that other secondary cells have the same fault; so that Mr. Laurie is in no worse predicament than other inventors of secondary batteries. Unless Mr. Laurie's cell is in this respect superior to others, the report can hardly be regarded as misleading.—ED.]

### Physico-chemical Lecture Experiments

A VERY striking lecture experiment, which I have never seen performed or described, and which illustrates the reaction, by double elective affinity, of *dry solids*, is the trituration together in a mortar of corrosive sublimate and iodide of potassium. The result is a brilliant scarlet coloration of iodide of mercury. If a large crystal of the one is rubbed on a crystal of the other, a scarlet precipitate (if the word may be so applied) is formed at every point of contact. From the brilliancy of the colour the experiment may be readily seen by a large number of spectators.

June 5

LEIGH CLIFFORD

## *CUPS AND CIRCLES*

AN important addition to the literature of "Cups and Circles" and Cup-marked Stones,[1] has just been issued as part of the fifth volume of "Contributions to North American Ethnology," printed by the Department of the Interior in their series of the publications of the U.S. Geographical and Geological Survey of the Rocky Mountain Region. The literature of the subject as regards the Old World is already extensive, and the object of Mr. Rau's work is to collect and systematise the existing information regarding the "cup and ring cuttings" that have been observed on rocks and boulders in Europe and India, and to add to this systematised knowledge an account of those that are now known in America.

The first monograph on these archaic forms of sculpturings on rocks and stones was that of A. E. Holmberg, on the Lapidary Sculpturings of Scandinavia ("Skandinavien's Hällristningar," Stockholm, 1848), but though copiously illustrated, it remained in a great measure a sealed book, from its being written in Swedish; and it was not till the publication of Mr. Tate's memoir on "The Ancient British Sculptured Rocks of Northumberland and the Eastern Border" (Alnwick, 1865); the exhaustive essay on the same subject by the late Prof. Sir James Y. Simpson, entitled "Archaic Sculpturings of Cups, Circles, &c., upon Stones and Rocks in Scotland, England, and other Countries" (Edinburgh, 1867); and the larger work, prepared under the direction of the late Algernon Duke of Northumberland, entitled "Incised Markings on Stone found in the County of Northumberland, Argyle, and other Places, from Drawings made in the Years 1863 and 1864" (London, 1869) that the attention of archæologists generally was awakened to the

[1] "Observations on Cup-shaped and other Lapidarian Sculptures in the Old World, and in America." By Charles Rau. (Washington, 1881.)

subject. Since that time a host of enthusiastic observers has arisen over Europe, and innumerable examples of "cups and circles" have been discovered and described. It is difficult to account for the fascination that allures men to the study and pursuit of these "pitted stones." They are neither beautiful, nor intrinsically valuable. They are often earth-fast boulders, too large for transport, and unsuitable for "collections." But there is an element of mystery about them, and the mysterious is often more attractive than the beautiful or the useful. They piqne the curiosity of the ordinary observer by the obvious suggestion that they have a story to tell if they could be made to speak; and they whet the ardour of the scientific investigator by the equally obvious suggestions that they are the products of a definite human purpose, which may be discoverable from an examination and comparison of their special characteristics. Probably no series of archæological remains has been more carefully examined, more minutely described, or more copiously illustrated, and if the accumulation of such a mass of detailed information regarding their typical forms and characteristics over wide areas should ultimately fail in determining the nature of the purpose or purposes for which they were produced it cannot fail to add largely to the extent and precision of our knowledge of an essentially obscure subject.

It is certainly a matter of great interest, whatever may prove to be its general significance, that "cup-stones" and "pitted stones," which are in many cases analogous to those in the Eastern Hemisphere, are found in the United States and other parts of the Western Continent. Perhaps the most remarkakable of those found in the United States is one at Ironton, in Lawrence County, Ohio, which was first brought to the notice of European archæologists by Prof. Daniel Wilson, in the *Proceedings* of the Society of Antiquaries of Scotland for June, 1875. It is a boulder of grey sandstone 3 feet long, 2 feet 7 inches wide, and a foot and a half high, weighing between 1000 and 1200 pounds. The surface of the stone is pitted all over by about 116 cups, whose average diameter is 1½ inches and their depth about ½ inch, and on one side of the block there are several grooves 4 or 5 inches long, shallow and circularly hollowed in the bottom, so that "a cylindrical stone applied in the direction of its length would have produced the grooves, and its end by rotation the cup-shaped cavities." Another cupped boulder of granite occurs at Niantic, in New London County, Connecticut. It has only six cups, varying from about 2 inches to 3⅛ inches diameter, and from ¼ inch to almost 1 inch in depth. Mr. Rau does not notice a still more remarkable boulder of granite in Forsyth County, Georgia, 9 feet long, 4½ feet high, and 3 feet wide, of which Prof. Wilson has given a figure. Along one side of the boulder is a row of cups, eighteen in number, connected by an incised line or gutter, while the face of the boulder is covered with markings of single or double concentric circles, surrounding small cups in the centre. In some cases two of these circles are connected by a straight gutter. Two very large boulders on the bank of the Ohio, a few miles below Manchester, in Adams County, have been seen by Dr. Hill, but are not more precisely described than that they are of sandstone, the one having twenty-nine and the other thirty-seven cups. A large cupped boulder at Orizaba, in Mexico, has been figured in Lord Kingsborough's "Mexican Antiquities." Two boulders of sandstone in an old Indian town in Santa Barbara County, California, are covered with conical-shaped excavations and cup-shaped depressions. The largest is 25 feet long and 10 feet wide, and shows twenty-five excavations from 6 inches to 26 inches diameter at the surface, and 5 to 16 inches deep. In one instance a groove is cut between two of the basins.

"Cup-stones" or "pitted stones" of small size are also frequently found in the United States. The first of these that has been noticed as obtained from the Indian Mounds in Ohio, was described and figured in "The Ancient Mounds of the Mississippi Valley," by Squier and Davis (Washington, 1848), and is now in the Blackmore Museum, Salisbury. It is a small block of sandstone, 6 inches by 8 inches, weighing between thirty and forty pounds, and presenting on its surface three detached cups—two confluent, one half-finished, and several which are apparently just commenced. They are slightly oval in shape, about 1½ inches in greatest diameter, and seven-eighths of an inch in depth. Still smaller stones, often water-rolled greywacke pebbles, with one or more cup-shaped indentations on their flattish sides are extremely common. The cavities are rough and irregular, and the explanation given of their purpose is that they were probably used by the Indians for cracking hickory nuts. Another variety of "cup-stone" with regularly rounded and well-smoothed cups is regarded as paint-mortars. But while some of the larger boulders with basin-like cavities, such as those from Santa Barbara County, California, may have been used as mortars for triturating grain, it is obvious that such an explanation cannot apply to the boulders with smaller cups, or to those cases in which the cups are hollowed in the perpendicular surfaces of stones and rocks.

Such cups, often surrounded by concentric rings, or by broken rings with a gutter passing from the central cup outwards through the part where the rings are interrupted, are found abundantly in the British Islands, and in France, Switzerland, Germany, and Scandinavia. They are sculptured on rocks, boulders, on monolithic and on megalithic monuments, on the stones of dolmens and cists, and on stones built into the walls of underground dwellings. Thus they occur in close connection with the habitations and the graves of prehistoric man in central and north-western Europe. In a few cases in Scandinavia they occur on sepulchral structures that are assigned to the Stone Age, but their associations, so far as these are determinable, are chiefly with the Bronze Age. In Britain, and especially in Scotland, their associations are largely with the Iron Age, and the Age of Bronze; but few, if any well-authenticated instances of their occurrence in association with the typical objects of the Age of Stone are upon record. On the other hand small, portable cupped stones have been found in cists and grave-mounds which are attributed to the Stone and Bronze Ages, both in Great Britain and Ireland. In Brittany the large stones of the dolmens are frequently sculptured with a variety of rude figures, among which cups and circles not unfrequently occur.

Perhaps the most remarkable examples in Scotland are the rock-sculptures at Achnabreac in Argyleshire, described and figured in Prof. Simpson's work, and a rock-surface on the shore of Loch Tay, recently described by Mr. J. Romilly Allen. Prof. Simpson described nearly a hundred examples of rock and stone surfaces thus sculptured, but this number has been more than doubled during the last year by two observers, Mr. William Jolly and Mr. Romilly Allen, the former working in the northern, and the latter in the central, districts of Scotland. In England the most curious examples are those on the moor at Ilkley, in Yorkshire, described in the *Journal* of the British Archæological Association (1879), by Mr. Romilly Allen. In Ireland the most striking groups are those on the stones of the great chambered cairn at New Grange, in the valley of the Boyne, and those associated with the remarkable cairns in the Lough Crew Hills, described by the late Eugene Conwell.

Many theories have been advanced with reference to the presumable purpose of such "cups and circles." It has been suggested that their purpose was useful, that it was ornamental, that it was commemorative, and that it was religious. The utilitarian theory is disposed of by their position in situations where use of any kind is

almost impossible. The ornamental theory is negatived by the fact that they occur so often in situations in which they cannot be seen, as for instance on the under sides of cist-covers. The commemorative theory admits of much being said in its favour, but fails to suit all the circumstances of the case. The theory that they fulfilled some purpose in relation to the religious observances of prehistoric man is perhaps the most plausible that has yet been suggested, and has the following arguments in its favour.

If this early system of sculpturing these enigmatic markings on rocks and stones originally had reference to a common idea connected with the religious observances of prehistoric times, the existence of some traces of this connection might reasonably be looked for in the superstitions of the area in which it was formerly prevalent. This, in point of fact, is found to be the case. In many parts of Sweden, these cup-marked boulders are known as *elf-stenar*, and are still believed by the common people to possess curative powers. They say prayers, and make vows at them, anoint the cups with fat (usually hog's lard), place offerings of pins and small copper coins in them, and when they are sick, they make small dolls or images of rags, to be laid in them. These facts are stated in the *Manadsblad* of the Swedish Academy of Science. Miss Mestorf, as quoted by Mr. Rau, is more explicit :—

"The elfs are the souls of the dead; they frequently dwell in or below stones, and stand in various relations to the living. If their quiet is disturbed, or their dwelling-place desecrated, or if due respect is not paid to them, they will revenge themselves by afflicting the perpetrators with diseases or other misfortunes. For this reason, people take care to secure the favour of the 'little ones' by sacrifices, or to pacify them when offended. Their claims are very modest: a little butter or grease, a copper coin, a flower, or ribbon, will satisfy them. If they have inflicted disease, some object worn by the sick person, such as a pin, or button, will reconcile them. A Swedish proprietor of an estate in Uppland, who had caused an elf-stone to be transported to his park, found, a few days afterwards, small sacrificial gifts lying in the cups. In the Stockholm Museum are preserved rag dolls, which had been found upon an elf-stone."

These superstitious practices are connected with actual cup-stones of prehistoric times, but there are others, for the practice of which cups have been made in modern times. In the *Proceedings* of the Berlin Anthropological Society for June, 1875, Dr. Veckenstedt called attention to the existence of cup-markings on the walls of the church of Cottbus, in Brandenburg. Since then, they have been discovered on the walls of churches in more than twenty different localities in Prussia, and also in Germany and Switzerland, and even in Sweden. They are usually on the southern side of the churches, near an entrance, and not beyond the height of a man's arm. According to some accounts, in Germany at least, the cups were believed to possess healing virtues, chiefly for charming away fevers, and in some instances these modern cups in the church walls have been anointed with grease, like the cups in the prehistoric *elf-stenar* of Sweden. In Posen a tradition refers to the cups on the church-walls as the work of damned souls who ground them out in the night-time.

The existence of this superstitious veneration for prehistoric cup-stones, and the continuance of the custom of forming cups (on the walls of Christian churches) for curative purposes, pre-supposes the religious character of the original system of which these twin superstitions are apparently direct survivals. No evidence exists within the area occupied by the prehistoric cup-stones of Europe by which the precise form of the natural religion with which they were connected can be determined. But a religion exists in whose observances cups and circles are still made on rocks and stones. It does not exist in Europe, and there is no direct evidence that it ever existed within the European area, but it exists in the area which was the home of the Aryan race.

In the district of Nagpur, in India, Mr. Rivett-Carnac found a group of grave-mounds surrounded by stone-circles. The mounds contained burials after cremation, accompanied by urns and implements of iron. The circles round the mound are from 20 to 56 feet in diameter, are mostly formed of trap-boulders, but each circle has a few stones larger and more regularly-shaped than the rest, and on these stones he found sculpturings of cups and circles, which he recognises as analogous to the cups and circles of the European area. He has also found in Kumaon, close to the temple of Chandeshwar, a rock-surface, on which, in a space 14 feet by 12 he counted more than 200 cups, varying from an inch and a half to six inches diameter, and from half an inch to an inch in depth. These cups are occasionally surrounded by rings and connected by grooves, but the usual form is that of a simple cup. All these markings, whether on the rocks or on the stones of sepulchral circles, are old, so old that the natives attribute them to the giants. But in the temple itself the conventional symbols of Siva, as Mahadeva (The Generator), were in some cases represented by rough slabs with a cup and circle, or concentric circles with a radiating gutter rudely incised. The resemblance of these symbols to the European cup and ring cuttings is not so close as their resemblance to some of the sculpturings on Bald Friar Rock, on the Lower Susquehana in Maryland. Mere resemblance of form, however important it may be in a tentative classification of things whose relations are unknown, is quite insufficient if not irrelevant as evidence of identity of purpose or significance. Symbols that are absolutely similar in form may have had widely different meanings and applications in different places, at different times. Mr. Rau observes that no one who has examined Mr. Rivett-Carnac's papers in the *Journal* of the Asiatic Society of Bengal (1879) can help admitting the striking resemblance between the cup and ring cuttings of India and Great Britain; and he is probably right in his inference that the close connection between cups and rings implies that both belong to one system of primitive sculpture, the single cup being merely the simpler form. The argument in favour of both forms being symbols of the *cultus* of the reciprocal principles of nature rests solely on the ground of a similarity of form which does not amount to identity. Even though an absolute identity had been established between the ancient and modern sculpturings, their identity of significance would still remain to be proved.

It appears from this extended survey of the phenomena of cup and ring cuttings on rocks and boulders that more progress towards the elucidation of the subject is to be made by the study of their differences and diversities than by the mere observation of general similarities of form and circumstances. It seems probable that there are some, such as the portable varieties, which had a utilitarian purpose. It is not improbable that others of larger size on boulders, such as the block under the entrance to the tumulus of New Grange, may have been merely ornamental; and there are considerations which forbid the absolute exclusion of the supposition that others may have been commemorative, or in some sense possessed of a religious connection and significance. But none of these conclusions can be reached by mere force of argument. If the problem is ever to be solved, its solution will be reached by research, by comparison of the phenomena of different areas, and investigation of the inferences deducible from them. With regard to the American forms, Mr. Rau observes that as the cups on the Cincinnati boulder are perfectly similar to those on many stones in the Old World, it is probable that they owe their origin to the same motives. If these motives arose from

some religious conception, we might feel inclined to trace the origin of American cup-cutting to Asia. But if, on the other hand, the cups were designed for a practical purpose, the custom of excavating them may have sprung up in America, as well as elsewhere.

## THE ECLIPSE EXPEDITION

THE following letter from its Special Correspondent with the English Eclipse Expedition, appeared in the *Daily News* of Tuesday :—

*Sohag, May* 19

Still at Sohag! but how different is the place now from what it was when I first sighted it—as it seems, years ago. Then the solitary steamer and the tents of the French party were hardly sufficient to break the shore line as we looked at it, alas for too long a time, from the place of our last *ensablement*. But now the steamer is lost in a fleet of dahabeeahs, and the line of tents and shelters has been extended for some distance towards the town; but tents are coming down, the hot sand is being strewed with boxes, and in 24 hours nothing will be left but some brick piers, which the next high tide will make short work with. Yes, something will be left. Sohag will have taken its place in scientific history by the side of many other out-of-the-world places, which seem to be chiefly affected by eclipses, and its memory may still puzzle the dryasdusts of the future.

As the 17th approached the excitement of almost everybody visibly increased, and as the energy waned the tension waxed. A little wind eddy of fearful violence, which produced a small sand-storm on the land, and almost a waterspout as it tore its way out of sight across the Nile, after hurling down one of the French tents and driving the dahabeeah occupied by the English party from its moorings, was almost a relief; and a further variety was introduced into the monotony of heat and work by the arrival of the dahabeeahs and the final visit of the Governor-General to the astronomers and his new visitors, Aly Pacha Cherif (son of Cherif Pacha, Minister of Mohamet Aly); Osman Pacha Galeb, Governor-General of Assiout; Mahmoud Pacha, director of the Cairo Observatory; Mohamed Bey-el-Kakim, and others being among them. On this occasion the Governor-General Aly Pacha Riza was accompanied by Teidrous Effendi, chief judge, and Mohamet Effendi Kamil, one of the judges of his province, and his aide-de-camp Moustafa Effendi Sirry. The commandant of the garrison of Sohag was also in attendance. Moktah Bey, as usual, acted as interpreter, and the final arrangements for the eventful day were made. First among these the military guard had to be largely strengthened, for not only is a very pardonable curiosity a thing to be utterly suppressed during eclipses, but a whisper had gone abroad that the False Prophet of the Soudan had included the eclipsers in his anathemas, and even one fanatic in the camp at Sohag might give a deal of trouble. And at last the 17th came, ushered in by the finest morning we had had—(clouds had been terribly persistent for several previous days at the time the eclipse was to happen)—and when the observers turned out at dawn to put the final touches to their preparations the local excitement had begun to show itself. On the hill, under palm trees, between us and Sohag there was already a great crowd, which rapidly increased; but a cordon of sentries round the camp kept everything quiet within.

And now for the actual work. In an eclipse there are four critical points: the first, second, third, and fourth contacts, so called—the first when the moon makes its appearance on the sun, the second when its first totality obscures it, the third when the sun again reappears, and the fourth when the sun is quite clear of the moon again. It is of course with the totality—that is, the time that the sun as we know it is invisible between the second and third contacts—that the physical astronomer has almost exclusively to do, but as some of the phenomena are visible slightly before totality the time has to be carefully watched. During totality this has to be done in the most steady manner, and the observer upon whom this duty falls has a most responsible task. In the English Observatory, to which I shall now confine myself, this fell upon Mr. Buchanan; and as the arrangement adopted this time was new, I will describe it. It was devised by Mr. Lockyer as the result of his Indian experience, when the timekeeper found it so difficult to keep the time and to observe the eclipse, which he had come 600 miles to see, that he resolutely turned his back upon the sun lest he should fail in his self-imposed task and so disturb the work of others. What one wants to know at any moment during an eclipse is for how many seconds the phenomenon is yet to be visible and when each ten seconds of the totality have flown away, as each observer has generally more than one thing to do, and the announcement of the timekeeper is the signal for changing his instrument. On this occasion a clock used for testing gas meters was employed, with a seconds pendulum set going at the moment of totality, and with a large dial marked 65, 60, 50, 40, and so on to 0; 65 being the number of seconds which it was thought would leave a safe interval for covering the lenses of all the cameras before the actual termination of the eclipse. The plan answered admirably. Mr. Buchanan sang out the times shown on the dial, and sketched the eclipse with perfect ease.

While the land was darkening and the sky and the Nile were beginning to put on those indescribable hues round which so much of the terror of eclipses is centred, and while the whispers on the hill at Sohag were beginning to surge into a sound—half roar, half moan—some eight minutes before totality, Mr. Lockyer announced the appearance of bright lines, indicating that our atmosphere was already dimly illuminated enough to permit of the atmosphere of the sun being seen through it, and it was easy to see by the rapid pencilling on a copy of Angström's map, which was arranged on a stand under the eye-piece of his spectroscope that observations in earnest had commenced. This went on, the image of the retreating cusp of the sun being carefully kept on the slit of the spectroscope, by Mr. Lawrence until Dr. Schuster, as had been arranged, announced the instant of totality. At this signal Mr. Buchanan said, "65 seconds," Mr. Lockyer left the spectroscope to study the structure of the corona with the telescope, and Dr. Schuster uncovered all the lenses of his camera—all four of them arranged on a single stand—and to all, except the observers, the sun's atmosphere shone out in all its splendour and majesty, and the roar increased on the hill. In the telescope the verdict was that the solar conditions of 1871 were again present; and at the signal "40 seconds more," the information to be gathered by the naked eye and the gratfng was to be sought by one observer, while the photographic plates had to be changed by another. At this moment the silence in the observatory was broken by shouts calling attention to a strange object among the fainter exterior details of the corona itself, which were more suspected than seen. There, one solar diameter to the right and one solar diameter long, was an exquisitely formed comet, complete with nucleus and tail, sweeping in a beautiful curve, in brilliancy almost, if not quite, equalling that of the very corona itself—a real photometer, in fact, of which we have not yet heard the last. As in the naked eye view there was a struggle with the comet, so with the grating there was a struggle of another kind. A prism or a diffraction grating used without lenses forms what is called a slitless spectroscope. The coronal ring is really used as a circular slit, and according to the substances present in the solar atmosphere we shall have rings or no rings; and if rings are seen, then their presence in

certain definite positions will tell us what substances are present. Now, in 1871 rings were seen, and they were very bright. In 1878 no ring whatever was seen. The question to be decided, then, was, Did this year's eclipse resemble in this respect the eclipse of 1871 or 1878? The result of the inquiry was that there were rings, but that they took time to see. This indicated a solar condition more resembling that presented in 1871 than in 1878, but stopping short of it.

Owing to these difficulties, hardly had Mr. Lockyer time to pass back to the telescope by means of which the spectrum of the corona was to be studied, when the clock showed that sixty-five seconds had elapsed, and Mr. Buchanan's "over" filled all with regret that the phenomenon, so rare and beautiful, and full of such precious knowledge, which each was doing his "level best" to secure, should be so ephemeral. So the caps were put on the cameras by Dr. Schuster and his assistant, Mr. Woods, lest the precious records which it was hoped might have been secured thould be spoiled by the first beam of the reappearing sun. It turned out, however, that so admirably had the eclipse been calculated, and so exactly had the French party hit upon the central line, that the totality really lasted 7 seconds more, that is, the full 72 seconds. The spectrum of the corona, therefore, was studied for a second or two under, perhaps, better conditions than had ever been present before, excepting during the memorable observation of Janssen in 1871. There were the red and green and blue lines stretching right across a wide field of view, and although no obvious dark lines were seen in the momentary glimpse, it was obvious that the spectrum was not truly a continuous one. There were variations of intensity here and there, and not the equal toning generally observed. So then ended the totality in one of the observatories. Dr. Schuster and his assistants at once proceeded to the extemporised dark room on board the steamer to develop the photographs, while those members of all the parties who had made telescopic or spectroscopic observations retired to the solitude of their tents to write down their results while they were still fresh in their minds.

Later on in the day there was a conference, at which the collective note, which I have already telegraphed to you, was drawn up and signed on behalf of the several expeditions. The observations were thought then, and are thought now, to have been a splendid success. The photographic results obtained by Capt. Abney's rapid plates have secured permanent records of the highest value, which largely increase our knowledge of the sun's atmosphere. They connect the spectrum of the sun with that of the stars in a most unmistakable manner; and, taken in connection with the observations of Lockyer and Trépied on the bright lines visible before totality—observations predicted a year ago in the teeth of received opinion—show that those who would explain solar phenomena in the light of terrestrial chemistry have their work cut out for them. But on this and on some other matters I may have something to say in a subsequent letter.

The Cairo Correspondent of the *Daily News* telegraphs on Monday:—

By order of the British Government, Sir E. Malet has officially thanked the Khedive for the great attention and services rendered to the Eclipse Expedition. The Khedive has returned a complimentary answer. No other Consul has yet thanked his Highness.

## *AURORÆ IN GREENLAND*[1]

SINCE the publication of the researches on Auroræ by Baron Nordenskjöld, the study of this enigmatical phenomenon has acquired still more attraction for the student of the physics of the globe. We are glad, therefore, to notice the appearance of a new work on "Auroræ," published by the Danish Meteorological Institute, being a discussion, by M. Sophus Tromholt, of the fifteen years' observations (1865-1880) made by M. S. Kleinschmidt at Godthaab in Greenland.

The auroræ at Godthaab are seen, of course, almost exclusively in the southern part of the sky. "I do not remember," M. Kleinschmidt says, "to have seen during these last twenty-five years, more than a few times, any aurora in the north; the middle point of the aurora-arc is usually situated between due south and south-south-east, with small oscillations on both sides of this middle point. In all colonised parts of the western coast of Greenland, the auroræ are always seen towards the south; but it seems to me that at the southern extremity of this country, I have observed more intense auroræ extending throughout the whole of the sky." This observation fully confirms the conclusions of Baron Nordenskjöld, as will be seen from his map, which we reproduced (NATURE, vol. xxv. p. 371). Godthaab being situated in 64° 11′ N. lat., that is, in the third region of Nordenskjöld, the exterior circle of the glory must appear as a bow in the south, and the common, or interior one, as a luminous arc in the magnetic north, or, rather, as a light spread throughout the sky. Indeed, northern auroræ were seen at Godthaab only during twenty-five days, out of fifteen years, and their number was but forty in the morning hours, and sixteen in the evening. At Jacobshavn (69° 13′ N. lat.) 50 per cent. of all auroræ are seen towards the south east, 26 per cent. towards the east, and only 9·5 per cent. appear in that part of the sky which is comprised between north-west and north-east. At Upernivik (72° 47′ N. lat.) the disproportion is still greater, 74 per cent. of auroræ appearing between south-east and south, 14·5 towards the east, and only 4·8 per cent. between north and west. As to the frequency of the quiet arc-aurora (the "glory" of Nordenskjöld), as compared with that of the brilliant ray-auroræ, it is difficult to judge by the abstracts of observations published by M. Tromholt, inasmuch as the observer seems not to have attached great importance to this difference; but it results from what he says that the most frequent shape is that of a luminous arc "whose rays are diffused so that the luminous mass seems to be homogenous." The rays are often only pulsations in the arc itself. As to the fascinating and brilliant ray-auroræ, they are by far less frequent than the former; however—in accordance with Nordenskjöld's theory—they are not uncommon in this latitude. The height of the middle point of the arc is usually from 5° to 10° above the horizon. Feeble light, very much like twilight, is not uncommon, as well as a similar light spread throughout the sky. M. Kleinschmidt has also observed auroræ in the shape of "an immense column of smoke," consisting of more or less defined rays: "it nearly always appears in the same position, starting from a point between north-east and east-north-east, whence it crosses the zenith and reaches an opposite point of the horizon." The same was observed in the "common arc" by Nordenskjöld (NATURE, vol. xxv. p. 369, Fig. 5).

The number of auroræ extending beyond the zenith, or appearing in the northern part of the sky being anything but numerous, it is only with caution that we may admit the conclusion arrived at by M. Tromholt as to a periodicity in the oscillations of the "auroral belt;" but it is worthy of notice that his conclusion is the same as that arrived at by Weyprecht, namely, that "the auroral belt advances towards the south about the autumnal equinox, then moves towards the north, and reaches its most northern position about the winter solstice; thence it again moves towards the south, and occupies its most southern position about the spring equinox; after that it again returns towards the north." If confirmed by more extensive observations, this result would imply an

[1] "Om Nordlysets Perioder, efter Iakttagelser fra Godthaab i Grönland." Af Sophus Tromholt. (Publication of the Danish Meteorological Institute.) Copenhagen, 1882.

oscillation of Nordenskjöld's "glory" in dependence on the seasons. Another, diurnal oscillation, according to which the auroral belt would slowly advance towards the north (for Godthaab) during the night, seems very probable. It would explain—M. Tromholt says—the greater intensity of auroræ towards midnight, as well as the greater frequency of northern auroræ among those which were observed at Godthaab during the morning; but this last phenomenon, of course, might depend also upon some diurnal variation of the intensity of the "common arc." In any case, these conclusions are to be considered as provisory ones, and must be submitted to the further test of observations carried on at points more favourably situated than Godthaab for the study of these oscillations. Such is also the opinion of M. Tromholt himself.

Of course, the fifteen years' observations at Godthaab do not include a period of time sufficiently long for enabling us to deduce from them the laws of periodicity of auroræ. But still they allow of several interesting conclusions which may serve as a guidance for further researches. Thus, it appears from them—contrary to what was said as to the auroræ being more frequent during the most cloudy days—that the number of observed auroræ is directly proportionate to the brightness of the sky. This dependence appears not only for different years or months, but also for separate days. If all the days when auroræ were observed are classified according to their brightness, which is expressed by the figures 1 to 4, and the brightness compared with the average number of auroræ observed during the days thus classified, we see that while the quantity of clouds was 1·6, 1·7, 1·8, 1·8 ... 3·2, 3·3, 3·4, and 3·5, the average corresponding number of auroræ was 7·0, 7·0, 5·0, 5·0 ... 2·9, 2·7, 3·5, and 1·5, the decrease being altogether very regular, so as to leave little doubt as to the accuracy of the law.

The following data have some bearing on the 11½ years' period of auroræ which was deduced from observations in more southern latitudes, and which is considered as depending upon the amount of solar spots. Reckoning the years from August to May, so as to comprise in each year all autumn, winter, and spring auroræ (during the bright nights of the summer they are not observable), the yearly number of auroræ during the years 1865-66 to 1879-80 is given by M. Tromholt as follows:—97, 112, 65, 84, 45, 61, 32, 47, 73, 97, 97, 104, 69, 100, and 75, that is, rather irregular. Nevertheless, it is easy to perceive in these figures a certain periodicity with three maxima corresponding to the years 1866-67, 1876-77, and 1878-79. By introducing a correction which depends upon the brightness of the sky, and reducing the observed number of auroræ to an average cloudiness, M. Tromholt finds another series which is more in accordance with the number of solar spots as given by Wolf. Both series for the years 1865-66 to 1879-80 (August to May), appear as follows:—

*Number of auroræ, with correction for brightness of sky*

86·2, 91·3, 67·4, 80·9, 51·7, 56·5, 32·0, 46·0, 78·4, 97·0, 95·0, 102·0, 73·0, 85·2, 83·3

*Number of solar spots*

23·5, 6·1, 18·3, 60·1, 107·0, 133·5, 98·6, 89·4, 51·7, 32·1, 11·6, 13·5, 6·8, 2·2, 16·3

It would seem from these two series, that instead of being proportionate to the number of solar spots, the number of auroræ is rather *inversely* proportionate to this number, the two maxima of auroræ corresponding with the two minima of solar spots, and the minimum of auroræ arriving one year later than the maximum of solar spots. The same appears still better from the observations at Stykkisholm in Iceland, which run through the years 1846-47 to 1872-73. Both curves for this place (auroræ and solar spots), although showing several irregularities, nevertheless display a marked connection between the two phenomena; both inflexions of the auroræ curve towards a maximum correspond very well with the minima of solar spots, and *vice versâ*. The result for Godthaab and Stykkisholm is thus the inverse of what was found in more southern latitudes; and, to explain this contradiction, the author admits that the "auroral belt" is subject in its oscillations to a period of about eleven years, during which it advances more towards the north at the time when the number of solar spots reaches a minimum, and returns back towards the south during the maximum period of solar spots.

As to the number of auroræ observed respectively during the evening and during the morning, the observations at Godthaab fully confirm the fact already noticed at other places, namely, that auroræ are more frequent during evening hours. But it still remains to investigate in how far this difference depends upon the hours of observation, the observer usually taking notice of nearly all auroræ which appear before midnight, and not noticing those which appear during the first six hours after midnight.

Such are the questions discussed in M. Tromholt's memoir. As will be seen, they are rather indicated than definitely solved; but we must be thankful to the author for having raised them, and express a hope that the observations of auroræ which are now made to such an extent in Norway and Greenland, may be extended to the polar parts of Siberia and North America; we earnestly hope that the Meteorological Commission of the Russian Geographical Society, which already has done so much useful work, will soon extend its network of observations over this new field, which becomes every day more and more important. P. K.

## *ILLUSTRATIONS OF NEW OR RARE ANIMALS IN THE ZOOLOGICAL SOCIETY'S LIVING COLLECTION*[1]

### VIII.

20. THE MULE DEER (*Cariacus macrotis*).—While the Virginian Deer (*Cariacus virginianus*) is widely distributed all over the continent of North America, it is necessary to go far to the west before we arrive within the limits of the range of the two other species of the same group—the Mule Deer (*C. macrotis*), and the Black-tail (*C. columbianus*). Of these western deer, the latter, of which the Zoological Society had living specimens some years ago,[2] is confined to a narrow strip of land along the Pacific coast. But the Mule Deer has a larger distribution, being found on both sides of the Rocky Mountains, and extending eastwards of the main range, far into the prairies of Missouri.

The Mule Deer was discovered by Lewis and Clarke during their expedition to the Rocky Mountains in 1804, on the Missouri River, in about 42° N.L., and was so named from the excessive development of the ears, which at once distinguishes it from its fellows. Its most natural home is the mountainous region which flanks the main range of North America on both sides, though, as already stated, it extends hundreds of miles into the great plains drained by the Mississippi and its affluents. It is also met with in Oregon and British Columbia, though rather superseded in numbers in this quarter by the Black-tailed Deer.

The antlers of the Mule Deer, which, as in most other deer, are borne only by the male, are of the same peculiar type as those of the Virginian Deer. All the normal tines have a posterior projection, and the beam, after casting off the basal snagg, curves gradually forward and inward, until the extremities remotely approach one another. The tines thus stand mostly upright when the head is carried in its usual position, but when the head

[1] Continued from vol. xxv. p. 610.

[2] See Wolf and Sclater "Zoological Sketches," vol. i. pl. 20, for figures of the Deer.

is bowed in battle, the tines become nearly horizontal, and offer formidable weapons of offence. Five points is about the usual number carried by the adult male, though six or seven are not uncommon, and heads are said to have been obtained with even eleven and twelve tines.

The size of the Mule Deer is rather larger than that of the Virginian, and it is also more strongly built. Individuals are said to attain a weight of 250 pounds, but this is the extreme size. The most marked characteristic of the species, however, is certainly the long, broad, and thick ears, which are well covered with hair on both sides, and somewhat resemble those of a donkey or mule.

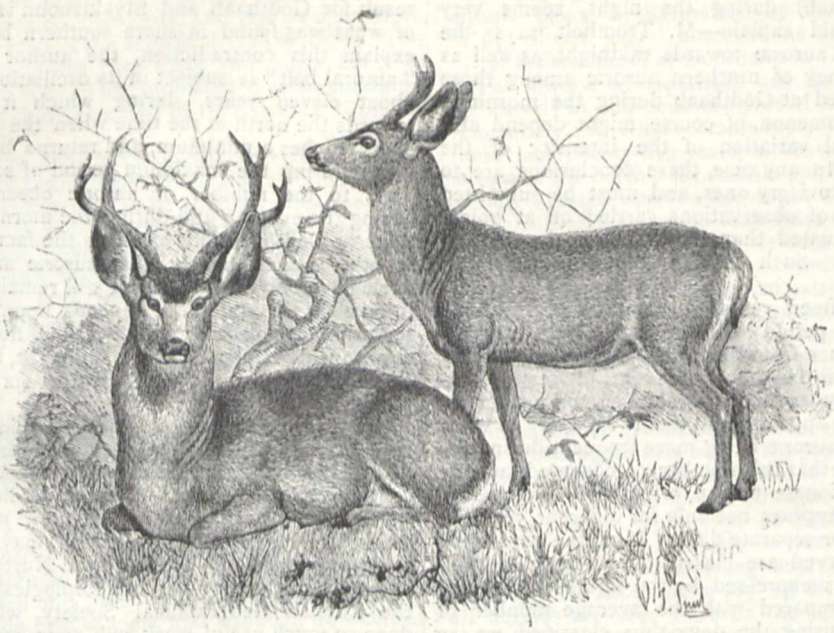

FIG. 20.—The Mule Deer.

For their living examples of this fine animal, Fig. 20 (the first, it is believed, ever received in Europe), the Zoological Society are indebted to one of their Corresponding Members, Dr. John Dean Caton, of Ottawa, Illinois, U.S.A., author of an excellent volume on the Antelope and deer of North America.[1] Males of the species were

FIG. 21.—The Chilian Deer.

[1] "The Antelope and Deer of North America." by John Dean Caton, LL.D. New York: Hurd and Houghton, 1877 1 vol. 8vo.

safely imported some years ago, but it is only a few months since that Dr. Caton, after several previous unsuccessful attempts, succeeded in supplementing his gift by transmitting to England an adult female. There is now therefore for the first time some prospect that the Mule Deer may be added to the list of acclimatised species propagating its young in this country.

21. The Chilian Deer (*Furcifer chilensis*).—The Chilian Deer also belongs to the American group of the Cervidæ, but has some special peculiarities, and together with an allied form—the Andean Deer (*Furcifer antisiensis*)—constitutes a small and distinct section of the American Deer, remarkable for the simple character of the bifurcated antlers.

The Chilian Deer is generally known to the natives of Chili as the "Guemul," and, though but slightly deviating from the ordinary deer in general appearance, has been strangely misunderstood by some of the older authors. Molina, in his work on the Natural History of Chili, classed it as a horse (!) under the name *Equus bisuleus*, while Hamilton Smith has referred it to the Llamas, and other authors to the Camels! Gay, in his "Fauna Chilena," published in 1847, first gave a clear account of this animal, and figured the female in the accompanying "Atlas," from a specimen in the Museum of Santiago. Gay tells us it is rare in Chili, being only met with in the Cordilleras of the southern provinces. Mr. E. C. Reed, who sent a skin and skull of the "Huemul" for exhibition before the Zoological Society in 1875,[1] tells us that several specimens of it have of late years been procured by the Chilian vessels engaged in exploring the Chonos Archipelago, and that it extends throughout Patagonia down to Sandy Point, in the Straits of Magellan.

The Chilian Deer is of about the size of a large roe-deer, but much stouter and thicker in its limbs. The antlers of the male, as will be seen by the illustration (Fig. 21), are very simple in character, consisting of a well-developed beam provided with a single anterior snag or brow antler, which curves rapidly upwards, and attains nearly an equal length with the beam itself.

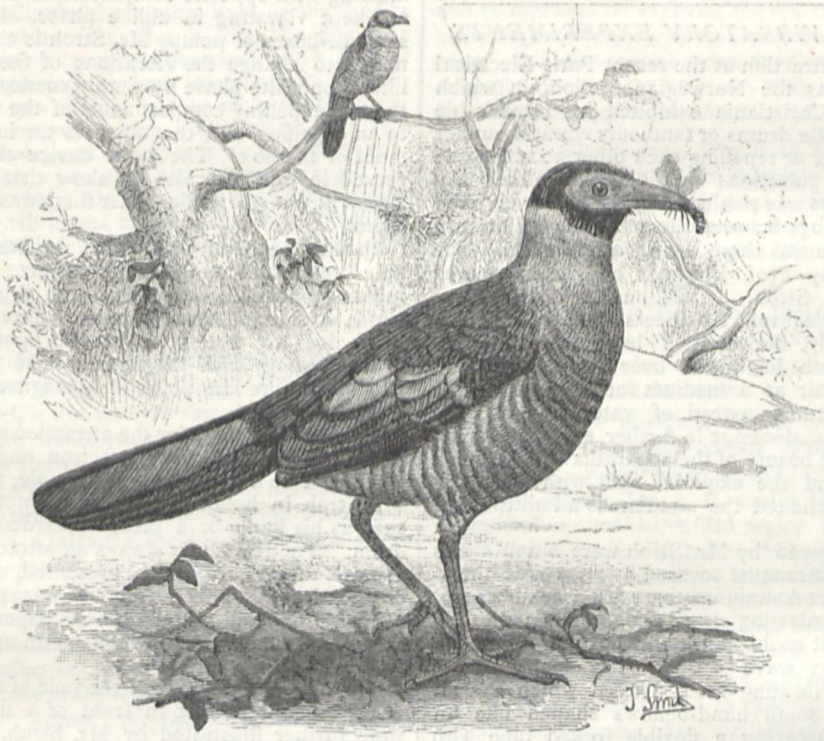

FIG. 22.—The Radiated Ground-Cuckoo.

The example of this rare deer in the Zoological Society's collection was received from the Jardin d'Acclimatation of Paris in December last, and is believed to be the only individual of the species ever brought alive to Europe.

22. The Radiated Ground-Cuckoo (*Carpococcyx radiatus*).—To the minds of most people the name cuckoo conveys only the idea of a tree-loving bird of strong flight, that utters a well-known cry and drops its eggs in other birds' nests. But the Cuckoo family (Cuculidæ) of naturalists is an extensive group, containing many birds which not only have neither cuckoo-like call nor parasitic habits, but differ greatly from our familiar summer visitor both in structure and in manner of life. No better instance can be given of this truth than the very remarkable bird which we now figure (Fig. 23) from an example living in the Zoological Society's "Insect House." Though a "cuckoo" in all the essential points of its conformation, it is a purely terrestrial bird with a pair of long and strong legs, and in its general gait and actions much more nearly resembles a pheasant or a rail than the ordinary cuckoo of this country, with which it claims relationship.

The Radiated Ground-Cuckoo was first made known to science in 1832, by Temminck, who described and figured it in one of the *livraisons* of his "Planches Coloriées," published in that year from a specimen in the Leyden Museum. This, he tells us, was received from M. Diard, a well-known Dutch collector, who had obtained it at the settlement of Pontianak, in Western Borneo. A ticket attached to the foot of the bird called attention to its singular structure and habits, and contained the remark that it differs from the Malkoha Cuckoos (*Phænicophai*) also found in the same district, in keeping constantly on the ground in search of worms, and in avoiding danger by rapid running, whereas the Malkohas are always met with flying about amongst the trees in search of insects.

[1] See *Proc. Zool. Soc.*, 1875, p. 44.

Our great countryman, Mr. Wallace, who, we believe, met with this ground-cuckoo in Sarawak, also speaks of its terrestrial habits, and states that its mode of life resembles that of the pheasants of the genus *Euplocamus*. Little else appears to have been recorded respecting this cuckoo, which is certainly one of the most peculiar forms of bird-life that have of late years been exhibited in the Zoological Society's aviaries.

On examining the specimen in question, which, when it first arrived, had only a half-grown tail, but is now in excellent plumage, it will be at once observed that the naked space round the eye has been incorrectly coloured in Temminck's figure of this species. Instead of being of a red colour as there represented, it is of a nearly uniform pale green, as is likewise the bill. Few non-professional ornithologists, indeed, would recognise a cuckoo in the pheasant-like ground-loving bird with large bright bill, which is labelled in the Zoological Society's Gardens "The Radiated Ground-Cuckoo."

## *MR. STROH'S VIBRATORY EXPERIMENTS*

A CENTRE of attraction at the recent Paris Electrical Exhibition was the Norwegian section, in which Prof. Bjerknes of Christiania exhibited his remarkable experiments with little drums or tambours vibrating under water, and attracting or repelling each other according as the phase of the pulsations was like or unlike. An account of his results was published in NATURE, vol. xxiv. p. 361, and the analogy between them and the well-known effects of magnetism was there drawn attention to. The field opened up by Prof. Bjerknes has been entered by Mr. Augustus Stroh, a well-known member of the Society of Telegraph Engineers and of Electricians, who recently delivered a lecture on his researches. Mr. Stroh has gone over the experiments of Dr. Bjerknes in air as a medium for propagating the pulsations of the drums instead of water, and has advanced beyond his predecessor in further experiments on the same line. The beauty of the apparatus and methods devised by him, and the exquisite skill with which he manipulated them, elicited the unanimous admiration of his hearers.

The drums employed by Mr. Stroh were small shells of wood having their mouths covered by an elastic membrane and their rears communicating with a flexible pipe, through which the pulsating air was communicated to the membrane, so that it could cause the latter to bulge out or collapse at every wave of air. The source of the vibrations was a vibrating reed, against which the air was forced by a small hand-bellows shaped like an accordion. By employing a flexible forked tube with arms of equal length, each fitted with a drum at the end, the vibratory air-blast from the reed could be conveyed to the drums so as to set them vibrating in like phase; and when one of the drums was mounted on a vertical axis, and free to rotate round it like the pole of a balanced magnetic needle, the approach of the other drum to it resulted in an attraction between them which was very pronounced. In this case the drums were vibrating in like phase, that is to say, they both bulged out and bulged in simultaneously. The mechanical explanation of the attraction is that there is a rarefaction of the air between the drums produced by the simultaneous advance and recession of the membranes toward each other. This rarefaction occasions a difference of pressure between the front and backs of the drums, causing them to move towards each other.

When, however, the vibrations are in opposite phase, that is to say, when one drum bulges out while the other bulges in, there is a repulsion between the drums corresponding to a condensation of air in the space between them. This condition of things is ingeniously obtained by means of an electromagnetic air-pump or bellows devised by Mr. Stroh. It consists of an iron armature placed between the poles of two double electromagnets, and free to move alternately towards either electromagnet. This to-and-fro motion of the armature is kept up by making and breaking the battery circuit in the coils of the electromagnets alternately. The armature carries a cross-arm or lever-rod fixed at right angles to its axis, and the ends of the rod are attached to two leather diaphragms, which act as partitions across the interior of two boxes. Each of these two boxes communicates with the external air by two pipes or orifices, one on each side of the leather partition. Now when this diaphragm or partition stretching across the box oscillates, air is expelled from one compartment of the box, and at the same time air rushes into the other through the orifices provided. It follows that if the orifices communicate with two drums one drum will collapse whilst the other is inflated. Now the oscillations of the armature keep the diaphragm oscillating, and hence the two drums communicating with opposite compartments of the air-chamber are kept vibrating in unlike phase. By employing two such air-boxes or pumps Mr. Stroh is able at a moment's notice to change the vibrations of the two drums from like to opposite phase by simply connecting the drums to the two expelling compartments of the two boxes, or one to an expelling and the other to an indrawing compartment of the box. The same device of a pivoted drum served in this case also to show that when the drums were vibrating in unlike phase there was repulsion between them.

In the science of magnetism we are taught that like poles repel and unlike poles attract; but in the experiments we are considering it is the drums in like phase which attract and those in unlike phase which repel. Mr. Stroh does not attempt to theorise upon his results; but if the analogy with magnetism hold good our ideas of what constitute like poles in a magnet will suffer a considerable change.

The aërial analogy for the attraction which always takes place between a piece of soft iron and a magnetic pole, whether it be a north or a south pole, was illustrated by Mr. Stroh in holding quiescent or non-vibrating bodies, such as his hand, or a piece of cardboard, near to either drum. The result was always an attraction of the drum towards the passive surface presented, whatever the phase of the drum. This attraction was prettily shown by means of a small round disk of paper attached to the end of a delicate lever pivoted on an upright stand like a magnetic needle.

The dying oscillations of the pole of a magnetic needle, when brought to rest in front of a disturbing magnet, were further illustrated by Mr. Stroh, in presenting the free drum a little apart from the pivoted one, and observing the latter shift round and oscillate before the other, until it came to rest face to face with it. This of course happened when the two drums were vibrating in like phase. When they vibrated in opposite phase, the pivoted drum moved away from the free one, and came to rest further off.

Until this point Mr. Stroh had been occupied with repeating Dr. Bjerknes' experiments in air; but beyond this he makes a new departure on his own account. The object of his further experiments was to ascertain what goes on in the air between the vibrating drums; and by inclosing a pair of the drums in an air chamber communicating wiih a capillary tube containing a column of spirits of wine to act on a pressure guage he showed that when the vibrations were of like phase, the spirit fell, indicating that the air was expelled from between the drums, and on the contrary, when the vibrations were of unlike phase, the spirit rose in the tube, indicating that air had been drawn into the space between the drums, and the pressure thereby raised.

The most valuable part of Mr. Stroh's results was now

arrived at. By a series of test experiments he demonstrated that the lines of pressure in the air between the two drums are practically identical in direction with those which Faraday revealed to us in the magnetic field by means of iron filings. These were investigated by exploring the field between the drums with a small taper flame and noting the direction of the blast, as well as with a small windmill mounted on a stand, but the action of both these explorers requires a still atmosphere, and therefore could not be shown to a large audience. Mr. Stroh however, had devised a means of showing the movements of the air by models of the drums vibrating in glycerine traversed by the electric light which threw an image of the drums upon a screen. The membranes of the drums were oscillated in this case by working a crank and pulley, and four star-like water-wheels were pivoted between them in such a manner that when the drums were vibrated the wheels revolved under the streaming of the glycerine caused by the vibrations of the drums. Aniline blue placed in the glycerine at the middle of the surfaces of the drums also indicates the stream lines of the fluid to an audience. Starting from the middle, the glycerine separating into two trails, curved outwards into a kind of volute. This happened at both membranes, so that the space between was filled up by four such curves having a diamond space between them. This effect was produced by unlike phase, and closely resembled the arrangement of lines seen when two like magnetic poles are opposed to each other. On the other hand, the stream lines produced by vibrations in like phase were much less complex, and resembled the lines of force crossing over between two unlike magnetic poles.

## NOTES

AT a meeting of the subscribers to the Memorial to the late Prof. Rolleston, held at the Royal College of Physicians on Thursday, June 1 last, it was resolved that the fund subscribed for the above object, which amounts to a little over 1100*l.*, should be paid to the University of Oxford, as trustees, for the purpose of founding a prize, to be known as the Rolleston Prize, to be awarded every two years to the author of the best memoir embodying the results of original research on any branch of the following subjects:—Animal and Vegetable Morphology, Physiology and Pathology, and Anthropology. The prize, which will amount to about 70*l.* on each occasion, is to be open to all members of the Universities of Oxford and Cambridge who have not exceeded in standing ten years from the date of their matriculation. The adoption of the report of the executive committee was moved by Prof. Acland. Sir James Paget, Mr. Douglas Galton, and other distinguished men of science were present. A vote of thanks to the chairman, Dr. A. B. Shepherd, who has been most active in the furtherance of the objects of the Memorial, and also to the secretaries, Messrs. W. M. Moullin, M.D., C. T. Acland, M.A., A. P. Thomas, M.A., and E. B. Poulton, M.A., was carried.

CAPT. DOUGLAS GALTON, R.E., C.B., F.R.S., has accepted the Presidentship of the forthcoming Congress at Newcastle of the Sanitary Institute of Great Britain.

M. DUMAS, Perpetual Secretary of the Academy of Sciences, Paris, has, we understand, requested Dr. Siemens to allow a translation of his paper on the Conservation of Solar Energy to appear under M. Dumas' authority in the *Annales de Chimie et Physique*.

THE Committee for the arrangement of the Electric Exhibition in Vienna have resolved to delay the opening of the Exhibition till 1883.

THE fifth annual meeting of the Midland Union of Natural History Societies takes place at Nottingham on June 15. The programme includes a *conversazione* on the 15th and various excursions on the 16th.

THE Jubilee Exhibition of the Royal Cornwall Polytechnic Society and the Fine and Industrial Arts, will be opened at the Polytechnic Hall, Falmouth, on Tuesday, September 5, 1882. The Exhibition will be on an extensive scale, and the Committee have determined to make it representative of the progress of the past half century in science and art, mining enterprise, naval architecture, and fishing, meteorology, photography, natural history, and statistics, as well as the fine arts pure and applied, more especially in connection with the county of Cornwall. The Exhibition will be attended by men eminent in science, who will come to Falmouth after the British Association Meeting at Southampton, several of whom will deliver lectures at the jubilee. Electricity and the electric light will be a special feature of the Exhibition. The Exhibition itself will occupy the Polytechnic Hall and the Volunteer Drill Hall, and will be open for double the ordinary period. Excursions on a large scale will also be organised for exploring the sea coast, the scientific and archæological interests, and the natural beauties of the neighbourhood. In order to ensure success the Committee with confidence solicit the aid of all Cornishmen. They estimate that 600*l.* will be required to carry out the object in view.

A YOUNG Finnish lady, Miss Irene Åström, passed the examination for a candidate of philosophy at the University of Helsingfors, on May 24, with great honours. The young lady was subsequently, through a deputation of ladies, presented with a gold watch and chain, at a festive meeting given in her honour at the Æsthetic Club, Hesperia.

AT the expense of Herr Oscar Dickson, of Gothenburg, a promising young Swedish entomologist, Herr A. S. Mortenson, will, during the summer, study the entomology of the islands of Gotland and Öland in the Baltic.

IT ought to be mentioned, to the credit of our namesake, *Naturen*, that its recent numbers contain an unusually large proportion of original matter of more than local interest. To the April number, Hr. J. B. Barth, Director of Forests, has contributed an exhaustive and highly interesting memoir on forest economy generally, and on the biology of the Norwegian pine, *Abies excelsa*, specially. He treats at great length of the physical influence exerted by this tree, in rendering the earth around it more adaptable for its own rapid diffusion, as well as for that of other plants, and he regards it as of later development than the common fir, *Pinus sylvestris*, which, it appears, it is destined to some extent to supersede. The same number contains an amusing, but not uninstructive paper by Hr. Uhrbrand, on the appearance of will-o'-the-wisps (Norw. *Lygtemænd*) and their chemical or meteorological character, and a short notice by Hr. Reusch, of the conglomerates near Christiania. The May number gives a summary of Vogt's recent reports of the mines and minerals of Norway, from which it would appear, that while no sanguine hopes can be entertained of the continued yields of the once prolific Norwegian silver mines, the newly opened copper, nickel, and apatite works promise to become the most remunerative of the otherwise unimportant sources of national industry. The same number records the most interesting results of Hr. Tromholt's comparisons of the various meteorological observations made in Greenland, chiefly by officers of the Danish navy. From these it is shown, that while the auroral manifestations exhibit in Greenland the same periodicity of intensity as elsewhere, their minima and maxima do not correspond with those of the solar spots, the minima of the aurora coinciding with the maxima of the spots, and *vice versâ*. It also appears, that the arch of the aurora is most frequently seen at the south of the magnetic pole, and only in exceptional cases in the north, and that mostly at the winter

solstice, when the southern manifestations generally are of rare occurrence, their greatest frequency coinciding with the equinoxes.

THE tide of travel, with insects, as with men, seems naturally to be from east to west. With the noted exception of the grape phylloxera and the Colorado potato beetle (as Miss Murthly points out in a paper to the St. Louis Academy), Europe has not received from America any considerable pest, while innumerable noxious species have crossed the Atlantic from Europe. There is a comparative scarcity, too, of Asiatic insect species on the western seaboard of America, notwithstanding frequent ocean traffic. Spite of great arid plains and lofty mountains, nearly all the insects of Eastern American States, including those from Europe, have found their way to the fields, orchards, and vineyards of the Pacific States. One of the latest insect-invaders from Europe is the cabbage or rape-butterfly (*Pieris rapæ*, Schrank). It appeared about twelve years ago in some northern seaports, and its range now extends from far north in Canada to the south of Georgia. It attacks every cruciferous garden vegetable, but in the flower garden curiously rejects plants of that family in favour of mignonette. Miss Murthly has noted a large amount of premature emergence from the chrysalis, and consequent death; indicating imperfect adjustment of the insect to the climate of its new habitat. In Europe the insect is mainly kept in check by numerous parasites. For several years in America none such came to the aid of the disheartened gardener, but some have now appeared, the most important being a small, metallic green fly, which, though identical with the most destructive European parasite, is proved to be indigenous on both sides of the Atlantic. It lays its eggs in or upon the skin of the mature caterpillar, and from these come small maggots, which live on the fatty tissues of their victim, but do not touch its vital organs till the chrysalis state is reached.

THE mines opened a short time since in China in the province of Chihli, with the special support and patronage of Li Hung Chang, have recently become the subject of much adventitious interest in Europe. The working of these mines was wholly a native enterprise; foreign machinery was imported in large quantities, and up to a month or two ago all seemed going on well. A canal between the mines and Tientsin was nearly completed, and it was calculated that 250 tons of fine coal could be forwarded daily to the latter port. Five thousand tons were, it was said, ready at the pit's mouth for conveyance as soon as the canal was opened. It was believed that, with sufficient transport, one thousand tons a day could be raised for many years from the present pits, while it was said that fifty collieries of an equal size to the present one could be opened in or near Kaiping. The information, therefore, telegraphed by Reuter's agent in Shanghai that the further working of the mines had been peremptorily stopped by the Government, came with a shock to many interested in progress in China. It was stated that a censor in a memorial to the throne complained that the long galleries in the mines, and the smoke of the foreign machinery, disturbed the earth dragon, who in his turn disturbed the spirit of the Empress, who died some months ago, and who was buried about a hundred miles off. The irate spirit of the departed lady promptly took vengeance by afflicting the denizens of the palace in Peking with measles. The latter were, the censor is reported to have said, distinctly traceable to the Kaiping mines, which interfered with the *fêng-shui*. The conclusion was obvious: the mines must be stopped. Such was the story told by the Tientsin correspondent of a Shanghai newspaper. The process by which a suggestion that the mines should be stopped grew in the excited minds of the residents of Shanghai into the certainty that they were actually stopped—and thus to Reuter's telegram—is not an unfamiliar one. The latest information from the East enables us to say that the mines are still working as usual, and there is not the slightest evidence that there is or has been any intention of interfering with them. It is even denied that such a memorial as that mentioned above has had any existence except in the imagination of a *gobemouche* at Tientsin. However this may be, it must be confessed that the petition has a Chinese ring about it, and that the method of argument is one sufficiently familiar to readers of the *Peking Gazette*. The mines are fortunately within Li Hung Chang's jurisdiction, and while they enjoy his encouragement it is unlikely that *fêng-shui* or other superstition will be allowed to interfere with them.

THE Chinese Customs authorities have, we observed, declined to assist the Chamber of Commerce of Shanghai in making a series of meteorological observations along the coast of China. We have already described the project in these columns. The reason of this refusal is unknown; but it is generally believed that Sir Robert Hart, the Inspector-General of Chinese Customs, intends establishing a special meteorological bureau in connection with his department. If Sir Robert can obtain the assistance of one of the very few men in the East competent for such a task, he may add one more to the many good services which the organisation over which he presides has done to China.

A SHARP earthquake shock, at first undulatory, then vertical, lasting seven seconds, was felt at Naples on Tuesday Morning at 6·47. The instruments on Mount Vesuvius gave warning. The centre of the disturbance proves to have been at Isernia, in the Abruzzi, according to the telegrams received since.

A *conversazione* in connection with the Royal Colonial Institute will be held at the South Kensington Museum on the evening of June 23.

THE Scientific Publishing Company announce that they have in the press "Photometry and Gas Analysis," by J. T. Brown, F.C.S., divided into three sections—Standards, in two chapters, Photometers, in eight chapters, and Gas Analysis, in two chapters. The Company also announce the publishing in handy form of the "Minutes of Evidence on Electric Lighting Bill, 1882," with text of the bill and a commentary upon the whole.

WE have received a sensible and interesting lecture on the Relations of Science to Modern Life, by the Rev. Dr. H. C. Potter, delivered before the New York Academy of Sciences; it is published by Putnam and Sons of New York.

WE have on our table the following books:—British Freshwater Algæ, II., Mr. C. Cooke (Williams and Norgate); Transactions of the Brighton Health Congress (J. Beal and Co., Brighton); Capital and Population, Fredk. B. Hawley (Appleton, New York); Hydrographical Surveying, Capt. W. G. L. Wharton (Murray); Logic for Children, A. J. Ellis, F.R.S. (C. F. Hodgson); First Lessons in Geology, A. S. Packard (Providence, U.S.); Diagrams to First Lessons in Geology, A. S. Packard (Providence, U.S.); Anales de la Officina Meteorologica, vol. ii., B. A. Gould (Buenos Aires); Scientific Transactions of the Royal Dublin Society, vol. ii. series ii.; The Great Diamond Fields of the World, Edw. W. Streeter (Bell and Sons); A Flight to Mexico, J. J. Aubertin (Kegan Paul); Geological Survey of Canada, Report of Progress for 1879–80 (Dawson Brothers, Montreal); New Indian Lepidopterous Insects, F. Moore (Asiatic Society); Regenwaarkemingen in Nederlandsch Indie, 1881 (Batavia); Lohrmann's Mondcharten, J. A. Barth of Leipzig; The Land of the Bey, T. Wemyss Reid (Low and Co.); Catalogue of Fossil Foraminifera in the British Museum; Die Seefischerei an der Westkisten Schwedens, Gerhards. Yhlen (Norstedt und Soner, Stockholm); Botanicon Sinicum, E. Bretschneider (M. D. Trubner and Co.); Tabular View of the Geological Systems, Dr. Clement (Swan Sonnenschein); Report on Injurious Insects, E. A. Omerod (Swan Sonnenschein); Bibliographie Generale de l'Astronomie, vol. ii. (Brussels); Proceedings American Association, 2 parts; Col-

liery Ventilation, Alan Bagot (Kegan Paul); Report U.S. Geographical Surveys, vol. vii. Archæology (Washington); Report of the Metropolitan Board of Works, 1881; Botanical Atlas, parts 1 and 2, D. M'Alpine (W. and A. K. Johnston); Ancient Water Lines, D. Milne Home (Edinburgh, Douglas); Laboratory Guide, A. H. Church (Van Voorst); Wolf's Naturwissenschaftlich-Mathematisches Vade-Mecum; Madeira, its Scenery and how to see it, Ellen M. Taylor (Stanford); The Foundations of Mechanics, W. F. Browne (Griffin and Co.); Land Nationalisation, A. R. Wallace (Trübner and Co.).

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus erythræus*) from India, presented by Capt. E. B. Stephens, R.N.; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Miss R. M. Stanley; two Striped Hyænas (*Hyæna striata*) from India, presented by Mr. N. H. Beyts; a Cape Zorilla (*Ictonyx zorilla*) from Cape Colony, presented by Capt. Farmer, s.s. *Pretoria*; a Three-striped Paradoxure (*Paradoxurus trivirgatus*) from India, presented by Mr. R. A. Sterndale; a Puma (*Felis concolor*) from America, presented by Capt. J. Jellicoe, R.M. s.s. *Moselle*; an American Tantalus (*Tantalus loculator*) from Columbia, presented by Mr. H. B. Whitmarsh, R.M. s.s. *Moselle*; a Java Sparrow (*Padda oryzivora*) from Java, presented by Miss M. North; a Landrail (*Crex pratensis*), British, presented by Mr. A. Battiscombe; a White Pelican (*Pelecanus onocrotalus*) from North Africa, presented by Mr. C. G. Bolau; a Lesser White-nosed Monkey (*Cercopithecus petaurista*) from West Africa, an Emu (*Dromæus novæhollandiæ*) from Australia, four Summer Ducks (*Aix sponsa*) from North America, three Brant Geese (*Bernicla brenta*), two Common Wigeons (*Mareca penelope*), a Common Buzzard (*Buteo vulgaris*), European, deposited; two Great Anteaters (*Myrmecophaga jubata*) from South America, a Negro Tamarin (*Midas ursulus*) from Guiana, a Purple Heron (*Ardea purpurea*) from Java, a Blue-crowned Hanging Parrakeet (*Loriculus galgulus*) from Malacca, two Rose-breasted Grosbeaks (*Hedymeles ludovicianus*) from North America, a Bell's Cinixys (*Cinixys belliana*) from Angola, purchased; a Red Deer (*Cervus elaphus*), born in the Gardens; two Herring Gulls (*Larus argentatus*), two Impeyan Pheasants (*Lophophorus impeyanus*), four Horned Tragopans (*Ceriornis satyra*), two Peacock Pheasants (*Polyplectron chinquis*), bred in the Gardens. The following species of insects have emerged in the Insect House during the past week—Silk Moths: *Actias selene, Attacus mylitta, Attacus cynthia, Telea polyphemus*; Butterflies: *Limenitis sibylla, Argynnis paphia, Lycæna iolas*; Moths: *Chærocampa elpenor, Sphinx pinastri, Sesia spheciformis, Sciapteron tabaniforme, Callimorpha dominula.*

## OUR ASTRONOMICAL COLUMN

THE COMET (1882 *a*).—In a circular issued from Lord Crawford's Observatory on May 29, Dr. Copeland remarks that the spectrum of the nucleus of the present comet deserved the closest attention, as it showed "a sharp bright line coincident with D, as well as strong traces of other bright lines, resembling in appearance those seen in the spectra of $\gamma$ Cassiopeiæ and allied stars." For some weeks the head had exhibited white light, which might be inherent in the comet or the reflected light of the sun; on May 28 the nucleus began to throw out yellow rays, which on June 1 were also given out by parts of the tail immediately behind the head. Of $\gamma$ Cassiopeiæ, Secchi writing in 1877, says: "Le plus remarquable de ces étoiles exceptionelles est $\gamma$ de Cassiopée, qui présente les raies spectrales de l'hydrogène, non pas noires, par renversement, mais directement brillantes, curiosité unique jusqu'ici dans tout le ciel. Il n'y a que $\beta$ de la Lyre qui ait quelquefois les raies brillantes, et encore pas toujours, parce qu'elle est variable"; and he further writes of $\beta$ Lyræ, "Elle nous a montré une fois, an maximum d'éclat, les raies brillantes de l'hydrogène, comme $\gamma$ de Cassiopée, chose que nous n'avons plus vue ensuite, bien que nous l'ayons souvent cherchée."

The Radcliffe meridian observation of the comet on May 20, communicated by Mr. Stone last week, shows that the place calculated from the orbit we then published required only the following small corrections:—$\Delta\alpha \cdot \cos\delta = -1''\cdot8$ $\Delta\delta = +4''\cdot0$.

The Kiel observation on May 31 indicates corrections of $+4''$ in R.A., and $-19''$ in declination.

The positions given last week for June 10 and 11 are not likely to require material correction. In seeking for the comet in daylight on those dates, care should be taken to focus accurately (for this purpose Mercury or Venus may be available), and a pretty long "dew-cap" or a cardboard tube should be fitted to take off the direct sunlight from the object-glass. At so short a distance from the sun, it will of course be necessary to use a dark glass, but it may be well that the illumination of the field should not be diminished much beyond that which the eye will readily bear. More than one astronomer considered he had missed seeing the first comet of 1847 in daylight on March 30, by using too dark a glass; this was the opinion of Dawes, who could not otherwise explain his want of success.

On August 9 the comet situated near the star 16 Virginis will have the same theoretical intensity of light as at the first Harvard College observations on March 19, setting in London about 1h. 50m. after the sun. On July 5, when not far from Regulus, the intensity of light is equal to that on May 6.

THE TRANSIT OF MERCURY, 1881, NOVEMBER 8.—This phenomenon was fully observed at Sydney, by Mr. H. C. Russell and seven assistants. The mean results are as follows, in Sydney, M.T.:—

| | h. | m. | s. | |
|---|---|---|---|---|
| First contact—external ... ... .. | 8 | 21 | 57·53 | a.m. |
| ,, —internal ... ... ... | 8 | 23 | 40·65 | a.m. |
| Last contact—internal ... ... ... | 1 | 40 | 25·16 | p.m. |
| ,, —external ... ... ... | 1 | 42 | 9·22 | p.m. |

If we calculate with Leverrier's Tables of the Sun and Mercury, and adopt his diameters, the above observations show differences for the internal contacts of +22·9s. and +26·2s. respectively.

THE SMALL PLANETS.—The number of known members in this group is now 225, the last one having been discovered by Palisa at Vienna on April 19. It appears to belong to the more distant division of the group, the period of revolution exceeding six years.

THE CORDOBA ZONES.—We have received vol. ii. of "Resultados del Observatorio Nacional Argentino en Córdoba," containing the observations of stars in zones, made during the year 1872, and shall give an early account of this important work, for which astronomy is indebted to Dr. Gould's untiring energy and zeal, and the enlightened liberality of the Argentine Government in promoting the interests of science.

## CHEMICAL NOTES

IN the Chemical Section of the Meeting of Bohemian Naturalists in Prague, on May 27, B. Brauner (Fellow of The Owens College) communicated a paper on the atomic weight of didymium. The author's former determinations gave the number 146·6, but after further purification he finds now didymium to be 145·4. Both samples were entirely free from any known earth metal. Assuming that both numbers are true, the author remarks that the only explanation which can be given, is that "didymium" is a mixture of two (or more) bodies, one, whose atomic weight is *smaller* than 145·4, and a second, whose atomic weight is greater than 146·6. Thus it is clear that the chemistry of didymium becomes as complicated as that of "erbium," which was thought to be a simple earth, and later on was split up into the following earths, viz. real (1) erbia, (2) terbia, (3) scandia, (4) ytterbia, (4) thullia, and (6) holmia. The evidence, that the mineral cerite contains other earth metals besides cerium, lanthanum, and didymium, has been given by the author some time ago (*Monatshefte* iii. 1) when he found that the *spark-spectrum* of the portions *intermediate* between lanthanum and didymium, as well as of those between didymium and cerium, contains *new lines*, not belonging to any known cerite metal. The author is pursuing his researches in the laboratories of the Owens College.

ZIMMERMAN, who recently determined the densities of gaseous uranium tetrachloride, and bromide, has obtained pure metallic uranium, and made measurements of its specific heat, which completely confirm the number 240 as the atomic weight of this metal (*Berichte*, 15, 847).

J. W. BRÜHL, from the results of determinations of molecular refractions of many carbon compounds, concluded that the atomic refraction of carbon varies according as the atoms of carbon are tetravalent, divalent, or monovalent (singly, doubly, or trebly "linked"), in the molecule under consideration. In calculating molecular refractions, Brühl used the empirical expression $\frac{n-1}{d}\cdot M$; Landolt has recently re-calculated the ratios of many molecular refractions by the use of the formula $\frac{n^2-1}{(n^2+2)d}\cdot M$, deduced by Lorenz from the theory of light; his results entirely confirm those arrived at by Brühl by the use of the empirical expression stated above

IN their researches on ozone, MM. Chappuis and Hautefeuille have made use of the spectroscope to trace the progress of the chemical change which occurs when oxygen, or a mixture of oxygen and nitrogen, is subjected to the action of the electric discharge. They find that ozone is characterised by a distinct absorptive spectrum, the prominent bands in which are two in number situated in the neighbourhood of D. The same bands are prominent in the absorptive spectrum of liquid ozone.

MM. CHAPPUIS AND HAUTEFEUILLE also find that the amount of ozone produced by the action of the electric discharge on a mixture of oxygen and nitrogen increases to a maximum, then decreases to a minimum, then again increases, and so on; by the aid of the spectroscopic method they trace this oscillation to the formation and decomposition of an oxide of nitrogen not hitherto observed, which they propose to call pernitric oxide (*acide pernitrique*) (*Compt. rend.*, xciv. 858 and 1111).

THE *Journal* of the Society of Chemical Industry, the fourth number of which is now before us, promises to be of very great service to all who are interested in chemical manufactures. The present number of the journal contains papers read before the Society on "Smoke Abatement," "The Chemical Technology of Jute Fibre," "The loss of Sulphuric Acid in the Manufacture of Salt Cake," &c. Notes on the more important recent technical applications of chemistry and chemical physics, and very useful classified abstracts of recent patents complete the number.

IN the last number of the *Berichte* of the German Chemical Society (xv. 1161) HH. v. Meyer and H. Goldschmidt describe an apparatus by means of which the specific gravities of gases may be determined at very high temperatures. The apparatus concists of a cylindrical porcelain tube 500 or 600 mm. in length, capacity about 100 c.c., furnished with a capillary tube of about 200 c.c. long at each end. The apparatus is heated, the air is driven out by an inert gas, *e.g.* by nitrogen, the gas whose specific gravity is required is allowed to enter the apparatus, and the weight of this gas is determined by driving it out, by means of an inert gas, into some liquid by which it is completely absorbed. The temperature may be calculated from the ratio between the volume of air contained in the apparatus under the conditions of the experiment and the volume contained at the ordinary temperature of the room. By the use of this apparatus the authors have determined that the density of cyanogen is normal (*i.e.* corresponds with the formula $C_2N_2$) between 100° and 800°, but that at 1200° this gas is decomposed with evolution of nitrogen.

## PHYSICAL NOTES

A NEW method of comparing the brightness of different coloured lights has been proposed by Herr Brücke (*Wien. Ber.*, 84). He finds that objects cease to be visible at a greater visual angle, the more they differ from the background on which they are seen, only in colour and not in brightness. If a board be set up, which is black at one end and white at the other, with successive shades of grey between (a brightness-table), one may determine the brightness, *e.g.* of a coloured paper, by placing a piece of it before different parts of the board, and noting the place where, with shortest interval, it becomes invisible. This relation of brightness, in red and blue, varies much with the strength of illumination, so that each determination becomes invalid, where the illumination is considerably altered. Herr Brücke believes such a table might be useful in the colourless reproduction of paintings (drawings, copper-plate engravings, &c.). Further, he constructs a photometer, in which, instead of the brightness-table, he employs a variable illumination of the object to be distinguished from it.

THE specific gravity of liquid steel has been determined by Herr Alexjeff, by a method proposed by Herr Petruschewsky (*J. d. Russ. Chem. Phys. Ber.*, 12). A porcelain tube, open at both ends, was connected at one end with a forcing pump and a manometer, while the other end was immersed in liquid steel to a given depth (the tube vertical). On pumping, bubbles appeared at the latter end; and the indication of the manometer at that moment, compared with the depth of immersion, served for determination of the relative density of the steel and the liquid (naphtha) used in the manometer. The specific gravity of liquid steel was thus found to be 8·05, and so, greater than that of solid steel.

ACCORDING to Herr Antolik (*Wied. Ann.*, 3) very regular and pure Lichtenberg figures are obtained on spherical glass vessels filled with warm water at about 60° C. The surface can be made at will electrically positive or negative (which is not the case with ebonite or resin). Wires are inserted which are furnished with balls at their upper end. If positive electricity be introduced, electricity of that kind becomes free at the surface, and on dusting with Villarsy's mixture, a quite homogeneous sulphur layer is produced. Very regular discs appear on drawing sparks with the knuckles. A number of interesting effects are described by the author.

PROF. H. M. PAUL has communicated to the Seismological Society of Japan some notes on the effect of railway trains in transmitting vibrations through the ground. A box holding about twenty pounds of mercury thickened by amalgamation with tin, was placed upon a heavy plank screwed to the top of a post sunk 4½ feet into the ground. Images reflected in the surface of the mercury were observed by a telescope, as in meridian observations. An express train passing at a distance of one-third of a mile, set the surface of the mercury in confused vibration for two or three minutes. Other observations were made at stations at somewhat greater distances. The experimenter also found that a one-horse vehicle passing along a gravelled road 400 or 500 feet distant, caused a temporary agitation of the mercury whenever the wheels struck a small stone.

AN extremely valuable series of notes on physiological optics, from the pen of W. Le Conte Stevens, has lately appeared in the *American Journal of Science:* most of these relate to stereoscopic vision and the theory of the stereoscope. They are both too valuable and too full of matter to render full justice possible in a brief note.

A NEW form of refractometer, producing interference-bands and rings between two pencils of light which have traversed paths at right angles to each other, is described by Mr. A. A. Michelson in the *American Journal of Science.* In the path of a ray from a lamp, a piece of plane-parallel glass is interposed at 45°. The two pencils respectively reflected and refracted are then returned along their own paths by mirrors normal to each; and these returning rays unite at the point whence they parted, giving a resultant ray at right angles to the former path. The theory of this refractometer is deduced by Mr. Michelson, who devised this apparatus for use in his experiments to test the hypothesis of a relative velocity between the earth and the luminiferous æther.

M. VIOLLE finds the temperature of fusion of zinc free from lead, cadmium, arsenic, and other impurities to be 929·6° (C.); the value previously found by Edm. Becquerel was 932°; that given by Sainte-Claire Deville and Troost being 1040°.

THE rapidly-reversed currents generated in an ordinary Bell telephone do not sensibly affect the needle of a galvanometer even when the loudest tones are being sung into the instrument. Nevertheless M. Chardonnet has made the curious and interesting observation that during the short period while the note is increasing or diminishing in intensity, a deviation of the needle is observed. The explanation advanced is that during the rise or fall in intensity the alternate currents are no longer of equal strength, the odd semi-oscillations being either greater or less in amplitude than the even semi-oscillations during the period of rise or fall.

SOME interesting new pieces of acoustical apparatus have been recently described by Herr Hartmann (*Wied. Beibl.* No. 3). The *motorophone* shows the change of rotatory motion into

sounding motion, and the dependence of the qualities of the tone on the nature of the motion. A rapidly-rotated shaft has an adjustable eccentric with jointed rod, which at each rotation pulls a large drum-skin to and fro. A bell-mouth strengthens and concentrates the tones. The velocity of rotation determines the pitch; the eccentricity the strength of the tones. The *phonomotor* acts on the opposite principle, rotatory motion being got from vibration. In the *electromagnetophone* a piece of sheet-iron under an electromagnet has a point dipping in mercury; a current passing through the coils and the point becomes readily intermittent, and the membrane sounds. The *electromagnetic membrane-siren* is similar, but a solid sliding contact takes the place of the mercury, and a driving-wheel gives rapid interruption. Again, a tuning-fork is supported so as to be capable of rotation before a resonance-case. According to position it gives a strong resonance or a weak interference tone, the latter slightly higher. On rotating, the former becomes lower, the latter higher, and the dissonance ever greater. A *resonance-interference-pipe* is formed by connecting a caoutchouc tube with the nodes of an open pipe. If the tube be shortened by pressure at different parts, the tone of the pipe is raised or lowered through resonance-interference, is extinguished, or lets only the first overtone be heard. These instruments are made by G. F. Weigle, in Stuttgart.

CONTINUING his researches on "adsorption," or condensation of gases on surfaces of solids, Herr Kayser (*Wied. Ann.* No. 4) has studied the influence of the adsorbing material. The pressure was determined, which occurred in the glass vessel when given volumes of gas had been in contact with the solid material. The gases were carbonic acid, sulphurous acid, and ammonia, and these were adsorbed in the empty glass vessel, by coarse glass powder, and by turnings of brass and wrought iron. The metal-turnings were quite clean and unoxidised, and before each experiment they were heated *in vacuo* to about 300°, to remove gas. It was found that pressure was greatest, and so adsorption least, in the empty vessel. The order of increasing adsorption was, in general: empty vessel, iron, brass, and glass powder. By the empty vessel, $SO_2$ was least condensed, $CO_2$ and $NH_3$ about equally. Also, on the metallic surfaces, $SO_2$ always gave greater pressure than $NH_3$; between $CO_2$ and $SO_2$ there was hardly any difference. By the glass surfaces, on the other hand, $CO_2$ was comparatively little condensed, $NH_3$ considerably, and $SO_2$ to a large extent.

THE behaviour of mercury when polarised in contact with dilute sulphuric acid (as in Lippmann's well-known experiments), and with other acids and salt solutions, has been studied by Herr König at the instance of Prof. Helmholtz (*Wied. Ann.*, No. 5). The surface-tension, it is shown, reaches a maximum at a mean state of polarisation different for different liquids; the values diminishing on either side, as one removes from this, and both with positive and negative charges. Prof. Helmholtz offers some comments by way of theory on the phenomena.

FROM experiments at Würzburg (*Wied. Ann.*, No. 5), Mr. William Hallock infers the correctness of the view that the changes of electromotive force of the Smee element are due to action of polarisation. The electromotive force of polarisation is by no means independent (he affirms) of the nature of the electrodes, and it considerably exceeds that necessary for visible decomposition. The polarisation cannot be calculated from the heat phenomena.

TO find whether the two coefficients used in equations of motion of incompressible liquids—one of viscosity, the other of variable adherence of the liquid to the walls—are independent of velocity, M. Elie (*Journ. de Phys.*, May) rotates a solid sphere within another filled with liquid, and hung bifilarly. The smaller sphere (0·04 m. diameter) is supported by a metallic wire passing through an aperture in the larger (0·12 m.) between the suspending wires to the vertical axis of an electric rotatory apparatus. During rotation (2 to 10 turns in a second) the hollow sphere is displaced to an amount indicated by a reflected light spot, and stops when the moment of the bifilar suspension balances that due to friction. In all the experiments with water, the reactions due to friction were found to increase more rapidly than the velocity; the ratio increased a third when the velocity was doubled; hence it appears that the viscosity or adherence, or both together, increase with the velocity.

THE name of *rheolyser* has been given by Prof. Wartmann to an apparatus (described in the *Archives des Sciences* for May) whereby the intensity of a derived electric current may be rapidly varied from zero to a maximum, and which indicates exactly the relation of those variations. A graduated metallic ring round a tripod-supported column encloses a thick disc of glass or ebonite, resting on the six radii of the ring. In the upper surface of the disc is a circular trough of mercury receiving two copper electrodes at the bottom, at a semicircle of interval. A cross-bar on the top of the column, on which it turns as axis, acts as a movable Wheatstone-bridge; it has two terminal verniers, and two screws dipping in the mercury; these latter are insulated, but communicate, through central binding screws, with a mirror galvanometer. The intensity of the derived current varies according as the bridge is displaced.

## GEOGRAPHICAL NOTES

THE last work by Dr. E. Regel, on the Flora of Central Asia, which has recently appeared in the "Acta Horti Petropolitani" (vol. vii.), gives to Prof. Rehring, of Berlin, the opportunity of discussing the relations between the present flora and fauna of the North-eastern Asiatic Steppes, and the Post-glacial flora and fauna of Middle Europe. Prof. Regel, on the ground of his researches in Asia, arrived at the conclusion that out of the species which inhabited Central Asia during post-glacial times, very few have migrated towards north-western Asia and to Europe, and that the species now inhabiting this part of Asia have probably immigrated from Europe. The same was the conclusion arrived at several years ago by Dr. Rehring, when he and Dr. Liebe discovered in the Diluvium of Germany (at Westregeln and at Gera), a steppe-fauna much akin to the West Siberian (*Dipus jaculus*, *Arctomys bobac*, *Spermophilus altaicus*, *Lagomys pusillus*, *Equus caballus*, &c.), which facts led him to the inference that in post-glacial times middle Germany enjoyed a steppe vegetation and climate. The same steppe fauna has since been discovered at many other places in Germany, so that it may be said that the German diluvium encloses an unmistakable steppe fauna. Dr. Rehring discovers in Dr. Regel's work new proofs in favour of his theory of migration of the diluvial fauna from Europe to Asia, in opposition to the theory of the late Dr. Brandt, who considered North-western Asia as the true fatherland of the European diluvial fauna. We may observe that Dr. Rehring's theory would imply the migration of the German steppe fauna, not only to North-western Siberia, but also to Eastern Siberia, during the post-glacial period, which would involve several important difficulties. We believe that a true theory of the migrations of post-glacial faunas can be established only by taking into account the history of the glacial period in Asia, which history has never investigated.

DISCUSSING the character of the Glacial period on the Caucasus, M. Moushketoff points out (*Izvestia*, vol. xviii. fasc. 2), those features which are common to the former glaciers of the Caucasus, and those of the Zerafshan in Central Asia. He observes the present comparatively small extent of glaciers and snow-fields in both countries. The area now covered with perpetual snow on the Caucasus is very small (250 square kilometres) compared with the extent of the same regions in the Alps (more than 3000 square kilometres). The same relations—M. Moushketoff says—must have existed to some extent between both countries during the Glacial period, because of the greater dryness of climate on the Caucasus, and still more in Central Asia, in comparison with Western Europe. He concludes, in accordance with M. Abich and many others, that the ancient glaciers of the Caucasus had a far greater extension than the present ones (for instance, those of the Elbrouz reached, at least, down to 5200 feet, and the Baskan glacier united into one single mass all the present small glaciers which do not now descend lower than 6600 to 8600 feet). Nevertheless the glaciation was not so general as in Western Europe. This conclusion only must be provisional, the traces of the Glacial period having not yet been the subject of a thorough exploration, either on Caucasus or in Turkestan, whilst the obliteration of these traces has been far more complete in both these countries than in Europe. Taken in its widest sense, the supposition that the glaciation has been less intense in Middle Asia than in Europe seems very probable, and has been arrived at also by other explorers of Turkestan and Siberia.

BESIDES the Annual Address of the President, Lord Aberdare, reviewing the geographical progress of the year, the June number of the *Proceedings* of the Royal Geographical Society contains Mr. O'Donovan's paper on Merv; M. de Gorloff's account of

his journey in the Atlas and the Northern part of the Algerian Sahara; the Rev. Thos. Wakefield's fourth journey to the Southern Galla country; and Capt. Paiva de Andrada's Zambesi Expedition, 1881. We learn that the Search Expedition for Mr. Leigh Smith is now organised, and will be commanded by Sir Allen Young. The expedition will leave this month.

FROM a letter of Consul H. E. O'Neill in the June number of the Geographical Society's *Proceedings*, it would seem that the "snow-clad Irati" spoken of by Messrs. Maples and Goldfinch as reported to exist in the country south-east of Lake Nyassa, is probably a delusion. Mr. O'Neill was close to the mountain, which he estimates at not more than between 5000 to 6000 feet above the sea.

MISS ELLEN M. TAYLOR has compiled a very useful guide-book to Madeira, under the title of "Madeira: its Scenery, and How to See It" (Stanford). She gives the very kind of information intending visitors are likely to want, and the possession of which will save them much trouble. While Miss Taylor draws largely on existing authorities, she also gives the results of her own experience. Her list of trees, flowers, ferns, and seaweeds will be useful to the amateur naturalist.

THE first paper in the June number of *Petermann's Mittheilungen* is on M. Charnay's expedition to the ruins in Central America, by Herr Fred. Kofler. Dr. Hermann J. Klein has an article of much interest on "Some Volcanic Formations in the Moon," in which he suggests that the lunar surface ought to be carefully examined by geologists, in order to discover the exact condition of things as compared with terrestrial geology. There is a short account of Oschanin's exploration of Karategin in 1878, and a very useful paper by Herr B. Hassenstein, on the geographical and cartographical literature of the Indo-Chinese border-lands, with a map of the Tibetan and Indo-Chinese border-region.

THE last number of the *Izvestia* of the Russian Geographical Society (vol. xviii. fasc 2), contains a good many valuable papers. We notice among them the preliminary report on the geological exploration of the former beds of the Amu-daria, by A. E. Hedroitz; a paper by M. Mousketoff on his geological exploration of the Caucasus; a description of an excursion to Seraks, by P. M. Lessar, with a map of the route between Askabad and Seraks; a notice by A. Regel of his journey to the Karategin and Darvaz, dated Kala-i-Khumb, with a map; on the sands of Ferghana, by M. W. Malakhoff, and a variety of small notices. We are glad to learn that the *Izvestia* will have a special department, "Polar News," devoted to all that concerns the exploration of Polar regions; it will be under the direction of Baron Wrangel.

WE learn from the *Izvestia* of the Russian Geographical Society that Dr. A. E. Regel has returned from his journey to Karategin and Darvaz to Samarkand, and is preparing for a new journey to the Pamir.

PROF. NORDENSKJÖLD has telegraphed to the Mayors of Tromsö, Hammerfest, and Vardö, on behalf of Herr Oscar Dickson, of Gothenburg, asking them to acquaint skippers leaving for the Arctic Sea, with the rewards offered by Herr Dickson for the Discovery of the *Eira*, viz. 225*l*. to be paid to the one who may first relieve Mr. Leigh Smith or any of his companions; 140*l*. to the one who may first discover and give information in writing of the crew of the *Eira*, of a later date than November 1 last, 56*l*. for the first information, by telegraph, addressed to Herr Oscar Dickson, that any one of the crew of the *Eira* has been found, or a letter from either of a later date than that of November 1 last.

THE German Antarctic expedition, consisting of Dr. Schrader and six companions, have sailed by the Hamburg mail steamer for Monte Video, thence by Imperial corvette to the island of South Georgia, to establish a scientific station for meteorological observations. They will remain twelve months.

AT the last meeting (May 30) of the Russian Geographical Society, the Secretary said that a telegram received from Irkutsk announces the possibility of establishing seven new meteorological stations in the far north, namely, at Verkhoyansk, Orlensk, Witimsk, Olekminsk, Kirensk, Nokhtuisk, and Preobrajensk, besides the station already established at the mouth of the Lena. The necessary instruments will be forwarded immediately by the Central Meteorological Observatory. At the same meeting, M. Rykatcheff made a communication on tides in the atmosphere. He proved the correctness of the theory of Laplace with regard to atmospherical tides by the discussion of a very great number of anemometrical observations.

PROF. LENSTRÖM, Secretary of the Meteorological Commission of the Society of Science in Finland, anxious that Finland may participate in the Circumpolar observations, has offered to erect a station at Sodankylä (67° 20′ N., 26° 40′ E.), which proposition has been accepted by the President of the International Congress, Dr. H. Wild, of St. Petersburg.

## THE ROYAL OBSERVATORY

THE annual visitation of the Royal Observatory took place on Saturday, when the Astronomer-Royal, Mr. W. H. M. Christie, presented his report.

"The Report," Mr. Christie states, "here presented, refers to the period of twelve months, ending May 20, 1882, a fixed date being taken, conveniently near to the visitation day. Sir G. B. Airy resigned his office on August 15, 1880, and a portion of the observations here referred to were made under his superintendence. There seems to be no occasion to separate these from the remainder, as the course of observation which Sir G. B. Airy has carried out for so many years has been continued without essential alteration in its main features."

Of the Transit of Venus instruments the Report states, two transits, three altazimuths, five 6-inch equatoreals, two photoheliograph mountings, nine clocks, and one Transit of Venus model have been sent to Mr. Stone at Oxford for use in the forthcoming Transit of Venus, and three transits, an altazimuth, a photoheliograph, and two clocks are at the Cape of Good Hope, where they will be available for the Transit of Venus.

A series of pendulum observations was made in the record room last autumn by Major Herschel, R.E.

After giving details as to the usual astronomical observations, the altazimuth, and other matters, Mr. Christie goes on to speak of the spectroscopic and photographic observations:—

"During the twelve months ending May 20, 1882, the sun's chromosphere has been examined with the half-prism spectroscope on 36 days, and on every occasion prominences were seen. On one day a detailed examination of the whole spectrum of the chromosphere was made at 24 points on the sun's limb. Several prominences have shown great changes in the course of two or three minutes, and large displacements or contortions of the bright lines, indicating very rapid motions of approach or recession have been noted. In particular, a prominence examined on May 13, 1882, was observed to rise through a space of about 30″ in less than two minutes, being at the rate of about 110 miles a second, whilst the C line showed a displacement towards the red gradually increasing from $1\frac{1}{2}$ to 11·4 tenth metres, corresponding to a motion of recession increasing in two minutes from 36 to 330 miles a second. Thirteen sun-spots have been examined on 20 days with reference to the broadening of the lines in their spectra. The strong black lines or bands in the part of the spectrum between *b* and F, first noticed in the spectrum of a spot on November 27, 1880, have been generally observed to be present in the spectra of spots during the last twelve months, besides several fine lines in the same region of the spectrum to which there is nothing corresponding in the solar spectrum. For the determination of motions of stars in the line of sight, 177 measures have been made of the displacement of the F line in the spectra of 41 stars, 68 of the $b_1$ line in 19 stars, and 9 of the $b_4$ line in 5 stars. Of the 61 stars observed, 15 had not previously been examined, and the total number of stars of which the motions have been spectroscopically determined, is now 106. In the case of three of the stars observed in the last year, a dispersive power equivalent to that given by sixteen prisms of 60° has been used. A comparison of the successive determinations of the motion of Sirius indicates a progressive diminution from about 22 miles a second in 1877 and 1878, to about 7 miles a second or less this year, and as other stars do not show anything similar, it appears likely that the change is due to the orbital motion of Sirius. Further observations will, however, be required to settle the point. The spectrum of Comet *b* 1881, was examined on six nights, that of Comet *c* 1881, on three nights, and that of Comet *a* 1882, on three nights. The spectra of the first two objects showed the usual cometary bands corresponding to those of the first spectrum of carbon, and a continuous spectrum from the nucleus and brighter portions of the head. Comet

a 1882, has hitherto shown only a continuous spectrum with two irregular ill-defined maxima of light. The observations of this comet are being continued."

In the year ending May 20, 1882, photographs of the sun have been taken on 200 days, and of these 352 have been selected for preservation. Since the end of last August photographs have been taken on Sundays as well as on week days. There were only 2 days out of 200 on which the sun's disk was observed to be free from spots. There has been a large increase in the number and size of spots and faculæ, the mean of the daily areas for each in 1881 being nearly double of the corresponding quantities for 1880, and the increase is still continuing, though with well-marked fluctuations. A very remarkable outbreak of spots occurred in April last.

With regard to magnetical observations the report states that no important change has been made in the three magnetometers with which the changes in the magnetic declination, horizontal force, and vertical force are continuously recorded by photography.

"The large temperature correction for the vertical force magnet has made it impracticable to discuss satisfactorily the diurnal inequality of vertical force and its dependence on solar activity, notwithstanding the great care taken to keep the magnetic basement at as nearly uniform a temperature as possible. After giving details as to rearrangements of the earth-current apparatus, the report states that "on four days during the year, viz., September 12 and 13 and April 16 and 19, magnetic storms have occurred. Those of April were of more marked character than any that have taken place since the great storms of the year 1872, and it is a significant fact that exceptionally large spots made their appearance on the sun shortly before, viz., on April 11 and 17. Smaller magnetic movements are now also much more frequent, the traces exhibiting a marked contrast to their general appearance some two or three years ago. In regard to the long period variation of about 11 years, we are able now to say definitely that the minimum as regards diurnal range of declination occurred at the commencement of 1879, whilst as regards diurnal range of horizontal force, it occurred unmistakeably earlier, about August, 1878. Since the epochs mentioned, each element has, with small fluctuations, continued regularly to increase again in magnitude, the daily range of declination having increased from 6'·59 at the beginning of 1879 to 9'·15 in 1881, and that of horizontal force from ·00110 (in parts of the whole H.F.) in 1878 to ·00181 in 1881. We have frequent applications from mining surveyors for the values of the magnetic elements, and recently the wish has been expressed that information as to the diurnal inequality and particulars of magnetic storms observed here should be communicated from time to time to the *Colliery Guardian* newspaper, in order that mining surveys may be carried out with due allowance for the diurnal and other motions of the magnetic needle."

Under the heading of Meteorology, the Report states that "the mean temperature of the year 1881 was 48°·7, being 0°·6 lower than the average of the preceding 40 years. The highest air temperature was 97°·1 on July 15, and the lowest 12°·7 on January 17. The mean temperature was below the average, 6°·7 in January and 4°·8 in October, and above the average, 5°·9 in November. In other months the temperature in general differed little from the average. On four days in July the temperature rose above 90°. The mean daily motion of the air in 1881 was 291 miles, being 12 miles greater than the average. In January and September the mean daily motion was 70 miles and 72 miles below the average respectively. In April, August, and November it was 70 miles, 60 miles, and 71 miles above the average respectively. The greatest daily motion was 999 miles on October 14, the day of the great storm, and the least, 59 miles on May 25. A velocity of 61 miles an hour was recorded on October 14, and one of 58 miles an hour on April 29, these being both greater than any recorded in previous years. The greatest pressure was 53 lbs. on the square foot on October 14; pressures of 46, 47, and 48 lbs. were also registered during the same gale. On April 29 a pressure of 49½ lbs. was recorded at a time when the hourly velocity was 50 miles; the pressures corresponding to the maximum velocity of 58 miles an hour were not registered, the cord of the pressure pencil having slipped off the pulley."

"The volume of Greenwich Observations for 1879 was printed and distributed last autumn, and the volume for 1880 was passed for press in the middle of April. The copies are now in the binder's hands. As regards the volume for 1881, the transits are printed to May 19, meridian zenith distances to April 27, azimuths with the altazimuth to March 31, and zenith distances to June 2."

"The number of chronometers now being tested at the Observatory is 214, 168 of which (120 box-chronometers, 23 pocket-chronometers, and 25 deck-watches) belong to the Government, and are being rated after repair previous to being issued to the navy. The remaining 46 are placed here for the annual competitive trial, and of these 18 are fitted with Airy's supplementary compensation. In addition to the above, 6 chronometers have been placed on trial for the Mauritius Observatory, and 5 chronometers have been tested for the Japanese Government.

"There has been only one case of accidental failure in the automatic drop of the Greenwich time-ball. On four days the ball was not raised, on account of the violence of the wind. The Deal ball has been dropped automatically at 1h. on every day throughout the year, with the exception of 15 days, on which there was either failure in the telegraphic connection, or interruption from telegraph signals continuing up to 1h., and of one day when the current was too weak to release the trigger without the attendant's assistance. On 3 days, high winds made it imprudent to raise the ball. The Westminster clock has continued to perform well, its errors having been under 1s. on 40 per cent. of the days of observation, between 1s. and 2s. on 44 per cent., between 2s. and 3s. on 14 per cent., and between 3s. and 4s. on 2 per cent. Time-signals, originating in the Observatory, are distributed at 10 a.m. and 1 p.m. to all parts of the country by the Post Office telegraphs."

Mr. Christie concludes his Report by referring to some new arrangements for calculations and observations, which will greatly economise the time and labour of the staff. The staff, indeed, seems inadequate to the constantly increasing work. With reference to spectroscopic observation, for example, Mr. Christie says:—"With only one assistant available for observations, we can barely do half of the work which we have undertaken in deference to a widely-expressed wish, and we are continually forced to make a choice between observations with conflicting claims on our attention. As regards solar photography, the value of our results would be very greatly increased if the gaps in the Greenwich series were filled up by the help of the photographs taken in India and elsewhere under the auspices of the Solar Physics Committee, so that the areas and positions of sun-spots and faculæ should be given for every day. I am in communication with the Committee on this matter, and am in hopes that the saving of labour recently effected in our photographic reductions will enable us to undertake the work with our existing staff."

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The honorary degree of D.C.L. will be conferred at the approaching Encænia upon the following among other distinguished persons:—Baron Nordenskjöld, Dr. Allen Thomson, and M. Pasteur.

CAMBRIDGE.—The election of a Professor of Animal Morphology took place on May 31, when Mr. Francis Maitland Balfour, M.A., F.R.S., Fellow of Trinity College, was by an unanimous vote of the members of the electoral roll selected to fill the newly-established chair. The professorship was established by a grace of the Senate passed on May 11 by virtue of the provisions of the University Statute for the establishment of additional professors. The stipend attached to the chair is 300*l.* per annum, and it is provided the professorship shall terminate with the tenure of office of the professor first elected unless the University shall decide that the professorship shall be continued. The Council of the Senate in their report recommending the foundation of the professorship laid stress on the fact that the teaching of biology in Cambridge had lately been most successful and had rapidly developed. The classes are now so large that the accommodation provided a few years ago had already become insufficient. It was well known that one branch of this teaching—viz. that of animal morphology, had been created in Cambridge by the efforts of Mr. F. M. Balfour, and that it had grown to its present importance through his ability as a teacher and his scientific reputation. The service to the interests of Natural Science thus rendered by Mr. Balfour having been so far generously given without any adequate academical recognition, the benefit of its continuance was en-

tirely unsecured to the University, and the progress of the department under Mr. Balfour's direction remained liable to sudden check. Upon this representation the Senate unanimously concurred in the report of the Council and established the professorship.

EDINBURGH.—Dr. James Geikie, F.R.S., has been appointed to the Murchison Chair of Geology and Mineralogy in succession to Prof. Archibald Geikie, Director of the Geological Survey. Dr. Geikie will not enter upon the duties of his class till November next.

DR. P. PHILLIPS BEDSON, F.C.S., Demonstrator and assistant Lecturer on Chemistry in the Victoria University, Owens College, has been elected to the Professorship of Chemistry in the Durham University College of Physical Science, Newcastle-on-Tyne.

## SOCIETIES AND ACADEMIES

### LONDON

Royal Society, May 25.—"On the Cause of the Light Border frequently noticed in Photographs just outside the Outline of a Dark Body seen against the Sky; with some Introductory Remarks on Phosphorescence." By Prof. G. G. Stokes, Sec. R.S.

An observation I made the other day with solar phosphori, though not involving anything new in principle, suggested to me an explanation of the above phenomenon which seems to me very likely to be the true one. On inquiring from Capt. Abney whether it had already been explained, he wrote: "The usual explanation of the phenomenon you describe is that the silver solution on the part of the plate on which the dark objects fall has nowhere to deposit, and hence the metallic silver is deposited to the nearest part strongly acted upon by light." As this explanation seems to me to involve some difficulties, I venture to offer another.

1. I will first mention the suggestive experiment, which is not wholly uninteresting on its own account, as affording a pretty illustration of what is already known, and furnishing an easy and rapid mode of determining in a rough way the character of the absorption of media for rays of low refrangibility.

The sun's light is reflected horizontally into a darkened room, and passed through a lens,[1] of considerable aperture for its focal length. A phosphorus is taken, suppose sulphide of calcium giving out a deep blue light,[2] and a position chosen for it which may be varied at pleasure, but which I will suppose to be nearer to the lens than its principal focus, at a place where a section of the pencil passing through the lens by a plane perpendicular to its axis shows the caustic surface well developed. A screen is then placed to intercept the pencil passing through the lens, and the phosphorus is exposed to sunlight or diffuse daylight, so as to be uniformly luminous, and is then placed in position; the screen is then removed for a very short time and then replaced, and the effect on the phosphorus is observed.

Under the circumstances described there is seen a circular disk of blue light, much brighter than the general ground, where the excitement of the phosphorus has been refreshed. This is separated by a dark halo from the general ground, which shines by virtue of the original excitement, not having been touched by the rays which came through the lens.

2. The halo is due to the action of the less refrangible rays, which, as is well known, discharge the phosphorescence. Their first effect, as is also known, is, however, to cause the phosphorus to give out light; and if the exposure were very brief, or else the intensity of the discharging rays were sufficiently reduced, the part where they acted was seen to glow with a greenish light, which faded much more rapidly than the deep blue, so that after a short time it became relatively dark.

3. This change of colour of the phosphorescent light can hardly fail to have been noticed, but I have not seen mention of it. In this respect the effect of the admission of the discharging rays is quite different from that of warming the phosphorus, which, as is known, causes the phosphorus to be brighter for a time, and then to cease phosphorescing till it is excited afresh. The difference is one which it seems important to bear in mind in relation to theory. Warming the phosphorus seems to set the molecules more free to execute vibrations of the same character as those produced by the action of the rays of high refrangibility. But the action of the discharging rays changes the character of the molecular vibrations, converting them into others having on the whole a lower refrangibility, and being much less lasting.

4. Accordingly when the phosphorus is acted on simultaneously by light containing rays of various refrangibilities, the tint of the resulting phosphorescence, and its more or less lasting character, depend materially upon the proportion between the exciting and discharging rays emanating from the source of light. Thus daylight gives a bluer and more lasting phosphorescence than gaslight or lamplight. I took a tablet which had been exposed to the evening light, and had got rather faint, and, covering half of it with a book, I exposed the other half to gaslight. On carrying it into the dark, the freshly exposed half was seen to be much the brighter, the light being, however, whitish, but after some considerable time the unexposed half was the brighter of the two.

Again, on exposing a tablet, in one part covered with a glass vessel containing a solution of ammonio-sulphate of copper, to the radiation from a gas flame, the covered part was seen to be decidedly bluer than the rest, the phosphorescence of which was whitish. The former part, usually brighter at first than the rest, was sure to be so after a very little time. The reason of this is plain after what precedes.

A solution of chromate of potash is particularly well suited for a ray filter when the object is to discharge the phosphorescence of sulphide of calcium. When it stops the exciting rays, it is transparent for nearly the whole of the discharging rays. The phosphorescence is accordingly a good deal more quickly discharged under such a solution than under red glass, which, along with the exciting rays, absorbs also a much larger proportion than the chromate of the discharging rays.

5. I will mention only one instance of the application of this arrangement to the study of absorption. On placing before excited sulphide of calcium a plate of ebonite given me by Mr. Preece as a specimen of the transparent kind for certain rays of low refrangibility, and then removing the intercepting screen from the lens, the transmission of a radiation through the ebonite was immediately shown by the production of the greenish light above-mentioned. Of course, after a sufficient time the part acted on became dark.

6. I will mention two more observations, as leading on to the explanation of the photographic phenomenon which I have to suggest.

In a dark room, an image of the flame of a paraffin lamp was thrown by a lens on to a phosphorescent tablet. On intercepting the incident rays after no great exposure of the tablet, the place of the image was naturally seen to be luminous, with a bluish light. On forming in a similar manner an image of an aperture in the window shutter, illuminated by the light of an overcast sky reflected horizontally by a looking-glass outside, this image of course was luminous; it was brighter than the other. On now allowing both lights to act simultaneously on the tablet, the image of the flame being arranged to fall in the middle of the larger image of the aperture, and after a suitable exposure cutting off both lights simultaneously, the place of the image of the aperture on which the image of the lamp had fallen was seen to be *less* luminous than the remainder, which had been excited by daylight alone. The reason is plain. The proportion of rays of lower to rays of higher refrangibility is much greater in lamplight than in the light of the sky; so that the addition of the lamplight did more harm by the action of the discharging rays which it contained on the phosphorescence produced by the daylight, than it could do good by its own contribution to the phosphorescence.

7. The other observation was as follows:—The same tablet was laid horizontally on a lawn on a bright day towards evening, when the sun was moderately low, and a pole was stuck in the grass in front of it, so as to cast a shadow on the tablet. After a brief exposure, the tablet was covered with a dark cloth, and carried into a dark room for examination.

It was found that the place of the *shadow* was *brighter* than the general ground, and also a deeper blue. For a short distance on both sides of the shadow the phosphorescence was a little feebler than at a greater distance.

This shows that, though the direct rays of the sun by themselves alone would have strongly excited the phosphorus, yet

[1] The lens actually used was one of crown glass which I happened to have; a lens of flint glass would have been better, as giving more separation of the caustic surfaces for the different colours.

[2] The experiments were actually made, partly with a tablet painted with Balmain's luminous paint, partly with sulphide of calcium and other phosphori in powder.

acting along with the diffused light from all parts of the sky, they did more harm than good. They behaved, in fact, like the rays from the lamp in the experiment of Section 6. The slightly inferior luminosity of the parts to some little distance on both sides of that on which the shadow fell, shows that the loss of the diffuse light corresponding to the portion of the sky cut off by the pole was quite sensible when that portion lay very near the sun.

All this falls in very well with what we know of the nature of the direct sunlight and the light from the sky. In passing through the atmosphere, the direct rays of the sun get obstructed by very minute particles of dust, globules of water forming a haze too tenuous to be noticed, &c. The veil is virtually coarser for blue than for red light, so that in the unimpeded light the proportion of the rays of low to those of high refrangibility goes on continually increasing, the effect by the time the rays reach the earth increasing as the sun gets lower, and has accordingly a greater stretch of air to get through. Of the light falling upon the obstructing particles, a portion might be absorbed in the case of particles of very opaque substances, but usually there would be little loss this way, and the greater part would be diffused by reflection and diffraction. This diffused light, in which there is a predominance of the rays of higher refrangibility, would naturally be strongest in directions not very far from that of the direct light; and the loss accordingly of a portion of it where it is strongest, in consequence of interception by the pole in front of the tablet, accounts for the fact that the borders of the place of the shadow were seen to be a little less luminous that the parts at a distance.

8. The observations on phosphorescence just described have now prepared the way for the explanation I have to suggest of the photographic phenomenon.

It is known, that with certain preparations, if a plate be exposed for a very short time to diffuse daylight, and be then exposed to a pure spectrum in a dark room, on subsequently developing the image it is found, that while the more refrangible rays have acted positively, that is, in the manner of light in general, a certain portion of the less refrangible have acted in an opposite way, having undone the action of the diffuse daylight to which the plate was exposed in the first instance.

It appears then that in photography, as in phosphorescence, there may in certain cases be an antagonistic action between the more and less refrangible rays, so that it stands to reason that the withdrawal of the latter might promote the effect of the former.

Now the objective of a photographic camera is ordinarily chemically corrected; that is to say, the minimnm focal length is made to lie, not in the brightest part of the spectrum, as in a telescope, but in the part which has strongest chemical action. What this is, depends more or less on the particular substance acted on; but taking the preparations most usually employed, it may be said to lie about the indigo or violet. Such an objective would be much under-corrected for the red, which accordingly would be much out of focus, and the ultra-red still more so.

When such a camera is directed to a uniform bright object, such as a portion of overcast sky, the proportion of the rays of different refrangibilities to one another is just the same as if all the colours were in focus together; but it is otherwise near the edge of a dark object on a light ground. As regards the rays in focus, there is a sharp transition from light to dark; but as regards rays out of focus, the transition from light to dark, though rapid, is continuous. It is, of course, more nearly abrupt the more nearly the rays are in focus. Just at the outline of the object there would be half illumination as regards the rays out of focus. On receding from the outline on the bright side, the illumination would go on increasing, until on getting to a distance equal to the radius of the circle of diffusion (from being out of focus) of the particular colour under consideration, the full intensity would be reached. Suppose, now, that on the sensitive plate the rays of low refrangibility tend to oppose the action of those of high refrangibility, or say act negatively, then just outside the outline the active rays, being sharply in focus, are in full force, but the negative rays have not yet acquired their full intensity. At an equal distance from the outline on the dark side, the positive rays are absent, and the negative rays have nothing to oppose, and therefore simply do nothing.

9. I am well aware that this explanation has need of being confronted with experiment. But not being myself used to photographic manipulation, I was unwilling to spend time in attempting to do what could so much better be done by others. I will, therefore, merely indicate briefly what the theory would lead us to expect.

We might expect, therefore, that the formation of the fringe of extra brightness would depend:—

(1) Very materially upon the chemical preparation employed. Those which most strongly exhibit the negative effect on exposure to a spectrum after a brief exposure to diffuse light might be expected to show it most strongly.

(2) Upon the character of the light. If the light of the bright ground be somewhat yellowish, indicating a deficiency in the more refrangible rays, the antagonistic effect would seem likely to be more strongly developed, and, therefore, the phenomenon might be expected to be more pronounced.

(3) To a certain extent on the correction of the objective of the camera. An objective which was strictly chemically corrected might be expected to show the effect better thaa one in which the chemical and optical foci were made to coincide, and much better than one which was corrected for the visual rays.

It is needless to say that on any theory the light must not be too bright, or the exposure too long; for we cannot haye the exhibition (in the positive) of a brighter border to a ground which is white already.

P.S.—Before presenting the above paper to the Royal Society I submitted it to Capt. Abney, as one of the highest authorities in scientific photography, asking whether he knew of anything to disprove the suggested explanation. He replied that he thought the explanation a possible one, encouraged me to present the paper, and kindly expressed the intention of submitting the question to the test of experiment.

**Linnean Society**, May 24.—Anniversary Meeting.—Sir John Lubbock, Bart., F.R.S., president, in the chair.—Mr. H. T. Stainton, on behalf of the Audit Committee, read the statement of receipts and payments for the year, and the Treasurer, Mr. Frank Crisp, followed with a detailed explanation of the various items, showing that the Society was in a very sound financial condition; besides investments of about 4000*l.*, the balance at bankers' being 649*l.* 2*s.* 5*d.* Afterwards the secretary, Mr. B. D. Jackson, read his annual report. Since the last anniversary, fifteen Fellows of the Society, 2 Foreign Members, and 1 Associate, had died, and 7 Fellows had withdrawn; while 40 new Fellows had been elected. Between purchase, exchange, and donations, 383 vols. and 348 separate parts had been added to the Library.—The President then delivered his anniversary address, commenting generally on the events of the past year with especial reference to their bearing upon the Society; he also made allusions to the removal of the Botanical Department of the British Museum to South Kensington, and to the additions of Miss North's oil paintings, &c., to Kew Gardens; this was followed by reports on the various botanical and zoological publications published during the last twelvemonth. The obituary notices of deceased Fellows was read by the Secretary, the Society having to deplore the loss of Charles Darwin, Professor Rolleston, Sir C. Wyville Thomson, and their late treasurer, Mr. Frederick Currey, who had been in office above twenty years. The scrutineers having examined the ballot, then reported that Mr. H. W. Bates. T. S. Cobbold, Prof. P. M. Duncan, E. M. Holmes, and Sir J. D. Hooker had been elected into the Council, in the room of Prof. Allman, Rev. J. M. Crombie, W. S. Dallas, A. Grote, and Prof. Lankester, who retired; and for officers, Sir J. Lubbock as president, Frank Crisp as treasurer, and B. D. Jackson and G. J. Romanes.

MANCHESTER

**Literary and Philosophical Society**, March 13.—Alfred Brothers, F.R.A.S., in the chair.—Mr. Marcus M. Hartog, F.L.S., made a communication upon water-fleas.—On *Cypræa guttata* (Gmel.), by J. Cosmo Melvill, F.L.S.—Lepidoptera of the Shetland Islands, by Hastings C. Dent, C.E.—Notes on the Giant Dragon's-blood tree at Orotava, by Mr. John Plant, F.G.S.—Mr. R. D. Darbishire, B.A., F.G.S., exhibited a fine series of Ceylonese land and freshwater shells, procured through the instrumentality of Mr. M. M. Hartog, F.L.S.

April 17.—Annual Meeting.—Mr. Boyd remarked upon the discovery of the egg-cases of *Pediculis capitis* in the crevices in an African chief's head stool in the possession of a friend of his.—Mr. Plant stated that he had endeavoured to obtain larger specimens of the Dreissena noted at the last meeting, but without success.—Dr. Alcock concluded his notes on

frog tadpoles by describing the three remaining periods into which their life-history may be divided.

### BERLIN

**Physical Society**, May 12.—Prof. Du Bois-Reymond in the chair.—Dr. Herz spoke on hardness. The methods hitherto used to determine the hardness of bodies have all been merely comparative estimates, *e.g.* in mineralogy it has been stated by what other substances the material in question is scratched, and what it can scratch, and so its position in the scale of hardness is shown to be between these others. Or it has been ascertained by some physicists to what depth in the substance a steel cone is pressed by a given force, and this depth gives a measure of the hardness. Herr Herz has sought a more absolute method; and he has confined himself, on account of the complexity of the question, to consideration of isotropic elastic substances. In these the hardness may be determined by the pressure which must be exerted on a round surface, to exceed, by the deformation produced, the limit of elasticity. In the case of plate-glass, *e.g.* it was found by experiment, that at a pressure of 136 kg. per square mm., the limit was passed, and a circular crack was produced; 136, accordingly, expresses the degree of hardness of the glass. Every isotropic body which has exceeded its limit of elasticity under greater or less pressure, is, respectively, harder or less hard. The advantage of this method lies in the fact that no second substance is needed, but only two balls or lenses of the substance examined.—Prof. Christiani then showed, as samples of a new method of preservation a series of organic bodies coated galvanoplastically; a mulberry leaf, a crab, a butterfly, a beetle, the brain of a rabbit, a rosebud, and other objects, were silver-, gold-, or copper-plated, and showed all details of their outer form, down to the finest shadings, very well preserved. As to the process (which is patented by the inventor), it was stated that the objects to be preserved, being put, living or dead, into a solution of silver nitrate in alcohol, then dried, and treated with sulphuretted and phosphuretted hydrogen, form good conductors, which, brought in the usual way into the galvanoplastic bath, can be coated with any desired thickness of a metallic deposit.

### GOTTINGEN

**Royal Society of Sciences**, January 7.—Contribution to the theory of surfaces, with special reference to minimal surfaces, by A. Enneper.

February 4.—Report on the Polyclinic for ear diseases, by K. Burkner.—Completion of Steiner's elementary geometrical proofs of the proposition that the circle has a greater surface-content than any other plane figure of equal circumference, by F. Edler.

March 4.—On functions which remain unchanged by linear substitutions, by L. Fuchs.—Measurement of the earth's magnetic horizontal intensity by means of bifilar suspension of a magnet, by F. Kohlrausch.—Contribution to the theory of surfaces, &c. (continued), by A. Enneper.—On cryolith, pachnolith, and thomsonolith, by C. Klein.—Communications on Giordano Bruno, by P. de Lagarde.—Report on Beneke prize.

### PARIS

**Academy of Sciences**, May 29.—M. Blanchard in the chair.—The following papers were read:—Separation of gallium, by M. Lecoq de Boisbaudran.—On the cycle of reasoning; its use for formulating and strengthening the fundamental hypotheses and propositions of all science; application to mechanics, by M. Ledieu. The cycle includes four operations: (1) observation and, if necessary, experimentation *a priori*; (2) induction; (3) deduction; (4) experimentation and, at least, observation *a posteriori*. A fundamental hypothesis or law is more or less rational when, on submitting it to the cycle, one can more or less close this cycle. The author illustrates this.—Report on a memoir of M. Bouquet de la Grye entitled, "Study on Waves of Long Period in the Phenomena of Tides." In this memoir the author extends the work of Laplace. It is also proved, *inter alia*, that the greatest elevation of the water at Brest occurs, not with west but with south winds. The density of the water is found to explain the unexpected fact revealed by Bourdaloue, that the mean level of the ocean at Brest is higher by 1·02 m. than that of the Mediterranean at Marseilles. From 1834 to 1878 the mean level of the ocean has sunk, at Brest, or the ground has risen (the fact subsists, after allowing for variation of temperature and saltness). The relative rise of ground has been about 1 mm. a year.—Measurement of the volume of blood contained in the system of a live mammal, by MM. Gréhant and Quinquaud. The method used depends on carbonic oxide giving an oxycarbonised hæmoglobin, a more fixed combination than oxygenated hæmoglobin (the carbonic oxide being substituted for the oxygen volume for volume). An animal is made to breathe gas containing a known amount of CO. The volume of CO remaining is noted, say, in a quarter of an hour, and this gives the amount fixed. On the other hand, the blood is analysed to find the CO fixed in a given volume. In this way it was found that the total weight of blood is between 1-12th and 1-13th of the body-weight. In the normal state there are no great variations.—Obervations to serve in the study of phylloxera, by M. Boiteau.—On a proposition relative to linear equations, by M. Darboux.—Demonstration of a theorem relative to the function E ($x$), by M. Bouniakowski.—Two means of having $\pi$ in the game of head or tail, by M. Barbier.—On a mode of transformation of figures in space, by M. Vanecek.—On a potential with four variables, which renders almost intuitive the integration of the equation of sound, and the demonstration of the formula of Poisson concerning the inverse potential with three variables, by M. Boussinesq.—On the actinic transparence of optical glasses, by M. de Chardonnet. A species of glass only allows passage (even with thin plates, and with long exposure) to wave-lengths exceeding a certain minimum, characteristic of the material. Another characteristic is the thickness beyond which elective absorption diminishes no further. With these limits, the shortening of the spectrum seems sensibly proportional to the thickness of the medium. The actinic absorption (measuring the shortening of the spectrum in the scale of wave-lengths) for a given optical system is comprised between the absorption of the least transparent glass and the sum of proportional shortenings due to all the glasses of the apparatus.—Action of sulphydrate of ammonia on sulphide of tin, by M. Ditte.—Influence of the tension of sulphuretted hydrogen in presence of a neutral solution of sulphate of nickel, by M. Baubigny.—On the transformations of cuproso-cupric sulphites, by M. Étard.—Determination of glycerine in fatty matters, by M. David. He saponifies 100 gr. of tallow with baryta.—On the ligneous formations produced in the pith of cuttings, by M. Prillieux.—On the true situation of the mouth of the Shiré, and on the canal of communication connecting this river with the Zambesi, by M. Guyot. Correcting the notion that the Shiré, after entering the lake of Lydia, resumes its course and joins the Zambesi near the foot of Chamouara, he represents that the lake is really connected with the Zambesi by a canal called Zio-Zio; running first W.S.W. to E.N.E., then nearly east, which conveys water *from* the Zambesi and is a larger feeder of the lake than the Shiré (the latter at its entrance into the lake is only about 670 feet wide and 3 to 4 feet deep, with little current).

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