THURSDAY, APRIL 14, 1881

THE NEW MUSEUM OF NATURAL HISTORY

THE great terra-cotta building facing Cromwell Road, South Kensington, and occupying the site of the old 1862 Exhibition, about which for the past twelve months public curiosity has been raised, is about to draw up its blinds, and to offer a part of its extensive galleries for inspection on Easter Monday.

It is no secret that for thirty years past the accommodation in the British Museum, Great Russell Street, Bloomsbury, "both for man and beast," had become too restricted, and the necessity for a larger building was keenly felt. As usually happens in such cases, the most adventurous and energetic officer was the first to obtain for his department what he required, namely, *more room*.

Sir A. Panizzi (then Keeper of Printed Books) projected, shortly after the 1851 Exhibition, his scheme for a great central Reading-room and Library, and some five years after witnessed its completion. Some years later on, the Department of Antiquities, represented by Mr. C. T. Newton, C.B., also obtained an addition to its galleries on the western side, and still more recently on the southern side, next the great Entrance Hall.

Great praise is due to Mr. Bond, the present Principal Librarian, for putting an end to the use made of the fine colonnade in front of the British Museum, which for twenty-five years was blocked by antiquities covered in with a row of extremely unsightly and incongruous wood and glass sheds. These are now happily removed. The Department of Prints and Drawings lacking a gallery, obtained possession of the "King's Library" floor on the east side for an exhibition space; and even the conservative Coin Department likewise laid out for the public a few show-cases here of coins and medals.

But, like the clothes of the rising son, in the old caricature, the collections everywhere had outgrown their receptacle, and none more so than the departments of Natural History. Scientific men were however not unanimous, and a fierce controversy was carried on in 1858–59 as to the relative merits of enlargement on the old site, or dismemberment. Finally, after a Committee of the House of Commons had taken evidence upon the subject, the removal of the Natural History Collections was decided upon by Government.

But the death of the Prince Consort, the delay of the House of Commons to vote the necessary funds, the retirement of Sir A. Panizzi from the post of Principal Librarian, the discussion of rival plans, the inevitable delays about the completion of any Government building, caused twenty years to pass before the plans of the chosen architect, Mr. Alfred Waterhouse, were realised in a solid and material form.

Midsummer, 1880, barely sufficed to enable the Office of Works to certify to the fulfilment of the Contractor's work and to hand over the building to the Trustees ere collections began to be moved in.

Nine months only have elapsed, and already three Departments, viz. Botany, Mineralogy, and Geology, have transferred their entire collections from the old to the new building. But less than half the cases for the entire building have yet been supplied, and everywhere the labour of completing the structure as well as fixing cases and fittings is being busily carried on. Under these circumstances it seems not improbable that two years may elapse before the Zoological Collections will be removed and housed in their new quarters.

Let us now take a glance at what Mr. Sala styles "this Temple of Nature." The architectural character of the new building may be termed "Decorated Norman," but it is in many respects unique, especially as regards the treatment of its details. The first, or "ground-floor," is above the road, and the entrance is approached by a broad flight of steps and by a sloping carriage-drive. The entire structure is of brick cased with terra cotta, the doorways and the windows being ornamented with columns designed from natural history objects, chiefly from plants. Reproductions of various animals are also introduced. The main part of the building has a tower at each end, and there are also two central towers rising on either side of the entrance. The south front of the building is about 650 feet in length, running due east and west, and is three storeys high, in addition to the basement, which is above the level of the garden in which the building stands.

The Central Hall or "Index Museum" runs from south to north; it is 150 feet long, 97 feet wide, and about 60 feet high; along its two sides are twelve arched recesses. At the north end is a wide and handsome staircase which branches off right and left to the open corridors or side aisles on either hand upon the first floor. This Central Hall is more richly decorated than any part of the building. The floor of mosaic work, where Italian marble is employed, has been skilfully laid by Italian workmen. The side aisles or corridors look out into the Central Hall by an open balustrade surmounted by large arches, each containing three smaller ones, the centre one being much higher than the others. The pillars supporting these are ornamented with a nearly natural treatment of *Lepidodendron*; in some few cases animals, monkeys, birds, &c., are introduced. The decoration of the ceiling is very effective. A double row of panels runs along the central line, and on either side of this, between the iron girders and following the curve of the roof, are panels in groups of six; these are ornamented with representations of different species of trees, shrubs, and flowering-plants treated somewhat conventionally. That portion of the ceiling over the main body of the hall is decorated with trees, each of which occupies six panels, as they can be most easily seen from the floor and need bold treatment. At the south end, where the ceiling is over a staircase and landing leading from the first to the second floor, each panel contains but one species: the eye being nearer to the ceiling greater detail has been introduced. The effect of the whole is very fine, and as the hall is at present without any cases or specimens, it has the general appearance of a cathedral. This idea is further heightened by the introduction of a triforium, though this has been added merely for effect, the passages being interrupted.

Beyond the Index Museum is a smaller and less lofty hall quite divided from it, save by two arched entrances, 97 feet by 70 feet, intended to hold the British Zoological Collection. It is surrounded by arched recesses similar to those in the Index Museum. In this hall the decoration of the ceiling is also botanical, but all the species selected are of British plants. Underneath the staircases and in the recesses a plain light colour is introduced, relieved with gilding. The decorations of the saloons or galleries are much simpler. The columns throughout are of terra cotta, ornamented with natural history objects.

The other parts of the building consist of series of galleries running north from the front or main building, but only one storey above the basement. The rooms on each floor, at the end of the long front galleries and under the two end towers, are called pavilions. The main or front galleries facing Cromwell Road are lighted by windows north and south. The Central Hall or Index Museum, the Hall for British Zoology, and all the other galleries of one storey high running north, are lighted by skylights. The Index Museum has however, in addition to its roof-lights, windows in the corridors on either side.

The distribution of the space available is as follows :—The long galleries to east of the entrance on the ground-floor, and all the galleries from it, running north, are devoted to Geology and Palæontology. The first floor above the Geological Gallery is devoted to Mineralogy, and the floor above this to Botany. The whole of the galleries on the west side of the building are given to Zoology. The Index Museum, according to Prof. Owen, is designed to present to the public, in a series of twelve recesses, typical examples of all the collections—in fact, an epitome of the whole animal, vegetable, and mineral kingdoms. Prof. Owen further desires to show the marvels of nature and objects of special interest, as exemplifying size, &c., such as whales, basking sharks, &c. These are to occupy the centre of this great hall. Passing to the right from the Index Museum (on the ground floor) we enter the South-East Gallery of the Geological Department (233 feet in length by 50 feet in width, and lighted by windows on either side), at the east end of which is the Pavilion, a room 60 feet by 40 feet. These two galleries are entirely devoted to the exhibition of the fossil Mammalia and Birds, and are provided with pier-cases and table-cases. The larger objects are arranged down the centre of the floor.

The cases on the left hand are nearly all occupied with the remains of *Proboscidea*. Commencing with the *Deinotherium* from Eppelsheim, with its tusk-like incisors in the lower jaw, we pass to the *Mastodons*, in which, as a rule, the tusks are developed in the upper jaw and not in the lower. But to this there are exceptions ; one American Mastodon having immature tusks in the lower jaw, and the *Mastodon augustidens*, from Sansau in France, having tusks in both the upper and the lower jaw.

Nearest the entrance door, in the centre of the gallery, is placed the entire skeleton of the great American mastodon from Ohio, which must have been considerably larger in bulk than that of any existing elephant ; on the same stand is placed the head of a young Mastodon from New Jersey, and in front of it the skull and lower jaw of the South American Mastodon from Chili. It is interesting to notice that both the mastodon and elephant had overspread the North and South American continents in Tertiary times, and they were equally widely distributed over the European and Asiatic continents ; their modern representatives however are confined, the one to the continent of Africa, the other to India, Ceylon, &c. The tusks of some of the old fossil elephants were of enormous proportions : witness the head of *Elephas ganesa* from the Siwalik Hills, India, and that of the mammoth (*Elephas primigenius*) from the valley of the Thames, near Ilford. Large numbers of elephant remains have been dredged up year by year for the past sixty years off the Dogger Bank and the Norfolk coast, affording good evidence that in comparatively modern times the North Sea was a great valley watered by the Rhine, Moselle, &c., giving pasturage to vast herds of deer, bison, oxen, and elephants ; where also the rhinoceros and the hippopotamus found a pleasant home. A goodly series of the remains of these animals from British and Continental localities may be seen in this gallery, and also abundant evidence of the old Siberian mammoth and rhinoceros, both of which have been met with "in the flesh," frozen solid in mud and ice. Here are also exhibited an interesting series of the "pigmy elephant" from Malta, brought home by Admiral Spratt, R.N., and Prof. Leith Adams. By far the larger collection of elephant remains are those from the Siwalik Hills, India, obtained by Col. Sir Proby T. Cautley and described by Dr. Hugh Falconer, F.R.S. The "gigantic Irish deer" (*Megaceros Hibernicus*) forms a prominent and striking object in the centre of the gallery, with its branching antlers 10 feet across, a noble prey for its contemporary, the "sabre-toothed tiger" (*Machairodus latidens*), remains of both animals having been found together in Kent's Cavern, Torquay.

Passing by the cases of carnivora, of thick-skinned animals, and of ruminants, our attention is next arrested by the great bandless armadillo from South America (*Glyptodon*), whose carapace is bigger than a hogshead, and which measured nearly 12 feet from its head to the tip of its armour-plated tail.

Another of these extinct Edentates from the La Plata, the *Megatherium Americanum*, stands in the centre of the floor of the Pavilion. This colossal "ground-sloth" measured 18 feet in length, its bones being more massive than those of an elephant. It displays in every part of its framework enormous strength and weight combined, sufficient to break down or uproot the trees, upon the leaves and succulent branches of which it fed, like its pigmy modern congener *Bradypus tridactylus*, which leads an arboreal existence, climbing from bough to bough in the Brazilian forests.

The extinct Marsupial fauna of the great island continent of Australia is here well represented by the huge *Diprotodon*, the *Nototherium*, and the anomalous *Thylacoleo*. Of the Wombat family only a small living representative is known, of burrowing habits, found in Tasmania ; formerly they were abundant on the continent of Australia, varying in size from a marmot to that of a tapir. The largest of these are called *Phascolomys magnus* and *P. gigas*.

The collection of remains of the great extinct wingless birds of New Zealand forms a very interesting feature of this gallery. The tallest skeleton measures 12 feet in height, and the smallest not more than 3 feet.

Madagascar had also its extinct wingless birds, similar to those of New Zealand. Eggs of both the *Dinornis* and the *Æpyornis* may here be seen, one of the latter having a capacity of two gallons.

The rarest of all avian fossils is still the *Archæopteryx* *macrura* from the lithographic stone quarries of Solenhofen. Fortunately for the incredulous a second specimen has recently been obtained, and is preserved in the Berlin Museum. Its lacertilian affinities are well shown in its long and rat-like tail of twenty vertebræ and its three-clawed digits in each fore-limb (or wing?). The head of the Berlin specimen is too obscure to give evidence of teeth, but its beaked jaws are clearly seen in the photograph. The original specimen described by Prof. Owen is headless.

Running parallel with the south-east gallery is the Reptilian Gallery, 225 feet in length and 21 feet wide, the south wall of which is entirely occupied with the grand series of sea-lizards, the *Ichthyosauria* and *Plesiosauria*, once so abundant in the old Liassic seas of Europe, and the fossil remains of which have even been brought home from the Arctic regions and from New Zealand. The largest of the long-necked Plesiosaurs measures 22 feet in length and 14 feet across its extended paddles. The largest Ichthyosaur was probably even bigger than this. On the north side are displayed the remains of the great land lizards, *Dinosauria*, of which the *Iguanodon* is perhaps the most familiar example. A more recent discovery is that of the *Omosaurus* from the Kimmeridge Clay of Swindon, Wilts, the femur of which is more than 4 feet in length, and the humerus nearly 3 feet long, and enormously broad; they were probably to some extent amphibious in their habits, but their limbs were well fitted for progression on the land.

Numerous other fine Dinosaurian remains are to be seen in these cases. As we do not know the teeth of many of these huge reptiles, we are unable to speak positively as to their habits; but it is certain that from the Trias to the Chalk two groups have existed side by side, one having a carnivorous dentition and the other being herbivorous. The *Teratosaurus* of the Trias of Stuttgart and the *Lycosaurus* and *Cynodraco* from the Cape, the *Megalosaurus* of the Stonesfield Slate and Wealden were all carnivores, whilst the *Iguanodon*, *Acanthopholis*, *Scelidosaurus*, and the South African genera *Anthodon* and *Nythosaurus* were all vegetable-feeders. But of *Polacanthus*, *Omosaurus*, *Hylæosaurus*, and *Cetiosaurus* we have no direct dental evidence. No doubt, as amongst the mammalia at the present day, the majority were vegetable-feeders and the minority were predacious in habit.

In this gallery are also exhibited the flying lizards of the Secondary Rocks, most of which have been found in the lithographic stone of Solenhofen and a few in our own Lias, Stonesfield Slate Chalk, and Greensand.

If Comparative Anatomy may be trusted, some of the Pterodactyles from the Chalk of Kent give evidence of a flying lizard having probably an expanse of wings of from eighteen to twenty feet.

An Australian novelty is the great horned lizard (*Megalania prisca*), 14 feet or more in length, with nine horn-like prominences on its skull and an armour-plated tail similar to that of the *Glyptodon*.

The Triassic reptiles from South Africa form a singular addition to our knowledge of ancient life forms long since passed away. They are comprised in Prof. Owen's groups of *Anomodontia* and *Theriodontia*.

Among the fossil Chelonians we have representatives of both the marine turtles, the fresh-water *Trionyx* and *Emys*, and the gigantic and lesser land-tortoises. Of the first of these are the remains of the great *Chelone Hofmanni* from Maestricht, and the *Chelone gigas* from the London Clay of Sheppey, larger by far than the "loggerhead" turtle of the present day. Of the last (land-tortoises) may be mentioned the *Colossochelys atlas* from the Siwalik Hills, which out-rivals the *Glyptodon* in bulk.

Three wide and four narrow galleries built at right angles to the Reptile Gallery, each 137 feet in length, the former being 40 feet and the latter 20 feet in width, are placed alternately, running due north and south, and lighted from above. These fine rooms afford ample accommodation for the fossil fishes, all the classes of the Invertebrata (mollusca, brachiopoda, bryozoa, insecta, myriopoda, arachnida, crustacea, annelida, echinodermata, corals, foraminifera, sponges, and plants). These long galleries, or annexes, and the ones corresponding with them on the western side, are built upon the plan recommended by the Royal Commission of 1874. But the wall-cases are all constructed to open in front, *not at the back* of the case, as suggested. They are however the best-lighted galleries in the whole building, and best suited for museum purposes. Two of these large galleries are not yet ready for occupation, and the third is under arrangement; the narrow galleries give space for a library, special reference collections, a stratigraphical series, and working-rooms for students.

In the basement are twelve workshops, studies, and store-rooms devoted to Geology, ten studies, work-rooms, and laboratories to Mineralogy, and three to Botany.

The Mineralogical Gallery, on the first floor, which corresponds with the South-East Gallery and Pavilion in extent, is also lighted by windows on either hand; it has seven wall-cases, two at each end of the long gallery and three in the Pavilion, the collection being mainly contained in forty-eight large table-cases.

These table-cases form a long row on either hand, commencing at the entrance of the gallery, the odd numbers being on the left hand and the even on the right. Each of the first forty cases nearly equals in capacity two of the cases in the old mineral gallery; we have therefore a much more magnificent display than could have been attempted formerly, when the minerals and fossils were all crowded together in the same gallery.

The collections of naturally and artificially-prepared crystals occupy two large cases in the Pavilion, whilst two of similar construction are filled with meteorites. The great Cranbourne Meteorite and that from Mexico occupy special cases on the east side. In the wall-cases are arranged the extensive collection of rocks, two cases being devoted to polished marbles.

The general plan pursued in the arrangement remains the same as in the old Museum gallery, so that by using boxes corresponding to one quarter of a table-case, the minerals were transported from the old to the new building and re-arranged in an incredibly short space of time, and with the exception of the Pavilion and the wall-cases have long been ready for exhibition.

In the Botanical Gallery the glazed cases for the exhibition of specimens project from the wall into the room like square shop-fronts, having three plate-glass sides. The whole of the glass is permanently fixed, except one division forming the door. A "cell" inside, inclosed by curtains, gives access to the specimens; by this contrivance it is hoped that the dust will be excluded to a great extent.

Accommodation for large specimens, as, for example, portions of stems and sections of various kinds of wood, such as oak, walnut, pine, cedar, and other dicotyledons, and trunks of palms, cycads, tree-ferns, bamboos, and other striking examples of the vegetable kingdom, is provided for by three tall metal and glass cases 14 feet high, occupying the floor-space in the centre of the gallery.

One-half of the main gallery is partitioned off from the public room, and fitted up with cabinets for the reception of the *Herbarium*, the nucleus of which was obtained by Sir Joseph Banks and Solander in their voyage round the world with Captain Cook. This first series of cabinets is entirely occupied with the flowering plants, which are all fastened on single sheets of paper. The Pavilion contains similar cabinets for the reception of the British plants and Filicinæ, whilst the room above in the tower is intended for the Cryptogamia. Down the centre of the large room are cabinets fitted to receive the great collection of fruits and seeds, each being placed near its appropriate family in the Herbarium on either side. These inner rooms, with the valuable library attached to them, are of course only available for purposes of study, but are always accessible to the botanical student and worker.

On the south-west side of the Index Museum, the gallery on the second floor which corresponds with that appropriated to Botany is designed to contain the great collection of Recent Osteology; that on the first floor is to be devoted to stuffed animals, and the front ground-floor gallery to birds. The eight galleries in rear of the main building on the west side will be appropriated to the Reptilia, Fishes, and Invertebrata. The collections preserved in spirits are to be placed in a special building at the north end of these galleries. The basement on the west side contains sixteen studies and work-rooms and a large open space well fitted for workshops and stores.

The Assistant-Secretary (Mr. J. T. Taylor) is provided with offices adjoining the Board Room on the first floor above the British Zoological Hall. The Superintendent, Prof. Owen, C.B., and the Keepers of Geology (Dr. H. Woodward, F.R.S.), of Mineralogy (Mr. L. Fletcher, M.A., F.G.S.), and of Botany (Mr. W. Carruthers, F.R.S.), have each a study in the central towers on either side the entrance.

There are a few scientific men who still strongly protest against the removal of the Natural History Collections from the old to the new building, on the ground that the locality is inconveniently far west, and that they are thereby precluded from using the Collections so freely as heretofore. One of the strong grounds for protesting against the removal has been the serious inconvenience arising from the separation of the collections from the great National Library. This injury will however be gradually removed by the formation of a new Natural History Library in the present building, a vote for which has been already taken.

The comparatively small band of scientific men who use the Natural History Museum for purposes of special work and study, would always do so wherever the collections happened to be located.

So too the holiday-makers, who come to the Museum merely to be amused, will as willingly travel to South Kensington as to the Regent's Park Zoological Gardens, or to the Crystal Palace.

Undoubtedly the highest aim and use of our great National Natural Historical Collections should be to impart instruction to the young and rising generation, and afford every facility for the advancement of our scientific students, and the question whether they are now conveniently placed is mainly for them to answer. If in the future South Kensington is to become a great centre of scientific instruction, then, and not otherwise, the Natural History Collections have been placed in their most suitable position.

We cannot conclude this hasty notice without stating that the old restrictions as to days of admission have all been swept away, and the collections will from and after the 18th be open daily to the public, save on Sundays, Christmas Day, and Good Friday, and other public fast days, &c.; good and cheap guide-books are also to be ready for the 18th.

For this and other concessions the public are mainly indebted to the untiring energy and determination of the present principal Librarian, Mr. Edward A. Bond, LL.D., who has also been the means of introducing many necessary and useful reforms into the old building; not the least being the electric light, which it may be hoped will ere long cast its beams over the collections in the Natural History Museum, Cromwell Road, South Kensington.

TEXT-BOOK OF MECHANICS

A Text-Book of Elementary Mechanics, for the Use of Colleges and Schools. By Edward S. Dana, Assistant Professor of Natural Philosophy in Yale College. (New York: John Wiley and Sons, 1881.)

THIS is a small-sized book of 290 pages printed in fairly clear type, and bound in an unpleasant-looking cover, and we learn from the preface that it has been prepared to meet the special wants of Yale College instruction. An endeavour has been made to dwell more fully than usual on the principles of the subject, at the same time illustrating these principles in their practical bearings by descriptions of various machines and appliances, while no mathematical knowledge beyond the rudiments of algebra and trigonometry is required. From this it may be presumed that the book is intended for a very elementary class of students, at a lower stage, if possible, than "Poll" men at Cambridge, or else that it aims at assisting self-education by supplying the place of a tutor. An undoubtedly good feature in the book is the collection of examples, some of which are interspersed in the text, and others collected in a body at the end, where the answers are given. The metrical and ordinary units are both employed. These examples are perhaps the only part of the book which would be of any value to teachers in this country. With regard to the main subject matter of the book, Dynamics is placed first, and Statics follows, with a chapter on the Pendulum at the end. The definitions and the explanation of the principles of the subject, though aiming at fulness and clearness, are not always so satisfactory as might be wished. A tendency to looseness of expression sometimes counterbalances the value of the fuller explanation. To explain *solidity* we are told that "A solid is characterised by a greater or less degree of rigidity," which in the absence of a separate definition of rigidity leaves us much where we were before. Again, the definition of a *liquid* is this, "A liquid is characterised by its mobility; the molecules are free to move about each other, and the liquid takes the shape of any containing vessel," which is equally true of a *gas*. The proof of the formula $S = \frac{1}{2}ft^2$ is clenched by the proposition that "when two sets of variable quantities, which are always equal, simultaneously approach their limits, these limits are equal," which is suddenly introduced without any explanation of its meaning. This, in a book intended for beginners unacquainted with the idea of a "limit," would be likely to cause some bewilderment. There is a chapter devoted to Work and Energy, as should be the case with all text-books of mechanics nowadays.

In the dynamical section there is an entire omission of "Sliding in Chords of a Vertical Circle" and the pretty problems connected with it. In the statics there is no mention of the stability or instability of equilibrium of one curved surface rolling on another. The micrometer screw surprises us by appearing with the mechanical powers alongside of the wheel and axle and differential screw.

As the compiler has not acknowledged his indebtedness to other works, it is difficult to say how much of this book is original. But we seem to catch echoes of Ganot's "Physics" and of Goodeve's two text-books on Mechanics and Mechanism here and there. For instance, Articles 7, 8, 107, 111 remind one of Ganot, Articles 197, 207, 209, 239 of Goodeve. The woodcuts, some of which are good, and others (*e.g.* those in the chapter on Centre of Gravity) very indifferent, are 190 in number. Some of them are apparently reproductions of woodcuts in English books. We instance Figs. 44 and 175, which are strikingly like Figs. 365 [Joule's apparatus] and 19 [block and tackle] in the eighth edition of Ganot's Physics, translated by Atkinson, and Figs. 142*a*, 150, 152, 155 (in Dana), which bear a very close resemblance to Figs. 49, 58, 110, 113 respectively in Goodeve's "Principles of Mechanics," second edition, Fig. 117 in the latter having apparently supplied Dana's three figures, 162, 163, 164 [on Pulleys]. Fig. 145 in Goodeve's "Elements of Mechanism," fifth edition, may well have been the original of Dana's Fig. 156.

It would have been graceful in the compiler of this work to have expressed his acknowledgments to the two excellent little text-books of Goodeve. On the whole, with the reserve above made in favour of the "examples," we think that neither English teachers nor English students will be the losers if they continue to use already existing English text-books of Mechanics, and leave this American competitor to find an audience on the other side of the water.

CONSCIOUS MATTER

Conscious Matter; or, The Physical and the Psychical Universally in Causal Connection. By Stewart Duncan. (London: David Bogue, 1881.)

AS the title of this little work sufficiently indicates, the aim of its writer is to furnish a scientific basis for the theory of materialism in the region of mind. It is doubtful whether at this time of day anything very original can be said upon this topic, but Mr. Duncan has succeeded in placing some of the facts in a stronger light than previous writers. The facts to which we allude are those which he calls the "analogies" between forces and feelings. Up to a certain point it is by every one recognised that there is some quantitative relation between neurosis and psychosis; mental processes are universally known to entail wear and tear of cerebral substance. Mr. Stewart Duncan traces this quantitative relation as much into detail as he can, by setting forth in a series of twelve "analogies" the resemblances between forces and feelings. These "analogies" are far from being unopen to criticism severally; but here we shall merely mention what they are, as there is more important criticism to apply to them collectively. The analogies are that feeling and force are each without extension, both related to matter, have "plurality predicable of them as respects their locality," are diverse, have time-extension or duration, also the quality of degree and capability of being compounded or combined, are respectively transmutable *inter se*, &c. Doubtless, as Mr. Duncan observes, such analogies, or, as we should prefer to call them, parallelisms, might be largely multiplied; but what would any number of such parallelisms prove? Not, surely, what Mr. Duncan desires them to prove, viz. that forces stand to feelings in the relation of causes to effects. So far as the tracing of such mere parallelisms is concerned, we might almost as reasonably conclude the recent earthquake at Chio to have been the cause of this review, in that they each possess extension, have diverse parts, and so on. In order to establish a relation of causality we should require to show that the observed parallelism is due to that relation; we cannot argue from the observed parallelism as itself sufficient proof of such relation. Were this not so, there would be no need for Mr. Duncan or any one else to write a book on "The Physical and Psychical Universally in Causal Connection"; for as the fact of a constant parallelism between neural processes and mental processes is now no longer an open question, were mere parallelism sufficient to establish proof of causality, materialism would now be a demonstrated theory.

It is needless here to go into the whole question as to the relation of body and mind, or to point out all the shortcomings of materialism as a philosophical theory. But it is a defect in Mr. Duncan's work that he does not attempt to meet some of the most formidable of the difficulties with which this theory is beset. Thus he does not consider the fact that what we know as matter and force we know only as affections of mind, and therefore that in all speculations upon the nature and potentialities of the former, we already by implication have necessarily assumed priority of the latter. Nor does he seek to explain the apparent want of equivalency between supposed physical antecedents and supposed mental consequents—why it is that the brain of a Newton required less nourishment than that of an elephant. Lastly, the greatest of all the difficulties is not adequately treated—that, namely, which is connected with the doctrine of the conservation of energy. Are we or are we not to suppose that thought has a mechanical equivalent? If materialists say that we are, then thought itself becomes a mode of energy, or rather energy by becoming thought ceases to be energy—is destroyed as energy; and so this answer would militate against the doctrine in question. If, on the other hand, it is said that thought has no mechanical equivalent, and yet that energy causes thought, the statement is still in conflict with the doctrine of conservation, because it supposes that energy in the brain differs from energy everywhere else in producing more than its equivalent measure of result. How then under any view are we to conceive of thought as an *effect* of energy? By no stretch of imagination can we attain to the idea of a motor becoming a motive; and if we could attain to such an idea, it would seem to be at the cost of upsetting the most fundamental doctrine of modern physics. And let it be observed in this connection that Mr. Duncan is not very accurate in the statement of his first "analogy," where he says that "Feeling and Force are alike in being both destitute of space-extension." Force in activity is only known as motion in space, while Feeling in activity cannot be conceived as here or there; the conception of Force without any actual or potential relation to space is as impossible as the conception of Feeling in such a relation.

Mr. Duncan's book, however, is worthy of the attention of psychologists, because although we think his attempt to prove a causal relation between physics and psychics a necessary failure, his work is interesting and suggestive if viewed from the standpoint of Clifford's doctrine of "Mind-stuff." If we suppose that Force and Feeling are everywhere one, and so that "all the universe is made up of Mind-stuff," we have a logically possible theory which does not labour under any of the logical disadvantages attending the theory of causality proceeding from matter in motion to mind, or *vice versâ*. Some passages in Mr. Duncan's work seem to show that he has very nearly entered this conception himself; and we therefore feel that he would have written a more valuable treatise if, going a little further, he had discarded the obsolete attempt to explain parallelisms by an impossible theory of *causality*, and undertaken to argue that these parallelisms are really due to a fundamental *identity*, which, as Lewes puts it, is phenomenally diverse only in relation to our modes of apprehension.

GEORGE J. ROMANES

LETTERS TO THE EDITOR

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[*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.*]

Study of the Physical Nature of the Sun

HAVING been engaged for some time past in discussing with that able scientist, the Spanish Astronomer-Royal, Signor Antonio Aguilar, Director-General of both the Astronomical and Meteorological Observatories of Madrid, the best method of realising for the requirements of modern science the peculiar advantages presented by the Peak of Teneriffe for studying and eliminating the interfering effects of the earth's atmosphere on many classes of astronomical, meteorological, and physical observations—it has just resulted, not exactly in the general facilitation which I had hoped for towards the *savants* of all nations—but in a particular letter to myself of gracious recommendation by Spanish royal authority to the Captain-General of the Canarian Archipelago.

As however I am totally unable, for reasons well known to our own Government both now and for many years past, to undertake any such research, however useful or pressing—it may be of service to the cause, and to other workers who are more favourably situated financially, to make known how liberally the Spanish Government is inclined at the present moment towards any genuine efforts, even of individuals, to improve our knowledge of the great central luminary by making superior observations with improved instruments at some considerable level above the ordinary clouds and winds of the summer season; and which superiority of site can only be well obtained on this side of the world by means of that grand Mountain-island which Spain has ruled so long and so well,—viz. the Island of Teneriffe. I have therefore now the pleasure of appending a close translation of the official letter, or rather Royal Order, from Madrid,—a copy of which Don Antonio Aguilar kindly informs me has already been communicated by the Spanish Government to the Chief Governor of the Canarian Islands.

"*From the Ministry 'de Fomento,' Madrid, to the Director-General of Public Instruction.*

"ILLUSTRIOUS SIR,—In consequence of the Report of the Director-General of the Astronomical and Meteorological Observatories of this capital, the King has deigned to order that the Governor of the Province of the Canaries, and all authorities dependent upon him, should give special attention to provide whatever assistance he may require to Mr. Piazzi Smyth, Director of the Observatory, Edinburgh, in the expedition which is proposed to the Island of Teneriffe, with the object of trying, on the height of the Peak of Teyde, the instruments designed, or improved by him for the study of the physical constitution of the Sun.

"By Royal Order I transmit this to you for your information, and may God preserve you many years.

"(Signed) — — —

"On the 22nd March, 1881"

A friend well acquainted with both England and Spain informs me that we have not in this country any exact analogue to the Ministry "de Fomento." The literary or theoretical meaning of the word is "supporting, encouraging, cherishing"; and the practical result in this case has been, that a poor individual here, unrecommended by the Government, or the greater Learned Societies, or Universities of his own land, but having an *excelsior* natural object to labour at, has received this very honourable testimony and encouraging recommendation. All honour then to the Government of Spain therefor; and may they meet at last with a more worthy subject for their gracious "Fomento," than Your obedient servant,

Edinburgh, April 9 PIAZZI SMYTH

Winter Gnats (Trichocera)

THE winter gnat (*Trichocera hiemalis*, D. G.) is one of the subjects of phenological observations undertaken by the Meteorological Society. Its appearance directly after long-continued frost, often whilst the thaw is in progress, has frequently led entomologists to inquire whether the insects then seen have been hybernating during the cold weather, or have newly emerged from the pupa. No evidence has been adduced in support of either alternative. Some facts concerning the habits of the fly, noted as opportunity occurred during the last two winters, bear upon the matter in question, and may therefore be of interest to both the above classes of your readers. The name *Trichocera hiemalis* is used here in its meteorological sense, for nobody would pretend to distinguish this abundant species at a distance from the common *T. regelationis*.

With a view to learning what becomes of the winter gnats during inclement weather I frequently jotted down, when the flies were upon the wing, the temperature of the air in the places of their resort, the time of the day, and any peculiarity noticeable in the flight of the insects. Upon other occasions, at corresponding periods of the day, when the weather was colder and no gnats could be seen anywhere, I made similar entries of the temperature prevailing in their usual playgrounds. The instrument employed was a Casella's pocket-thermometer mounted in ebonite, graduated upon the stem at intervals of every two degrees, and duly compared with a standard.

From the notes thus obtained, which need not be quoted in detail, it appears that the flight of *Trichocera* varies in style with the temperature, and, as a general rule, is altogether discontinued when the cold exceeds 36° F. Once indeed I saw a gnat flying when the thermometer stood at 34°·5 F., but there was reason for suspecting that it had just been startled out of the hedge by a passing carriage. When such low readings as these are obtained the insects do not congregate, but fly singly with a heavy drowsy flight, as though impelled by business rather than pleasure; and very few venture to show themselves upon the wing at all. At temperatures of 38° to 42° F. they may be seen occasionally flying steadily in places sheltered from wind; and when a warmth of 45° F., or more, is attained, they throng together and dance for joy. These particulars, by the way, need not prompt meteorologists to do something with their phenological tables by entering in them "*Trichocera* flying" every calm winter's afternoon if the temperature exceeds 40° F., without troubling themselves to go out of doors and look after the gnats.

It was some time before I succeeded in tracing *Trichocera* to the places where it seeks repose after its gambols and whiles away periods of weather too cold or boisterous for excursions abroad. The flies may be seen sometimes at rest upon fences, with their legs stretched out flat, and it appeared probable that they took refuge in the hedges somewhere. A very favourite harbourage of theirs however seems to be the under side of boards and stones frequented by woodlice and earthworms They stand back downwards on the wood or stone, not upon the earth below; and although the specimens found in such situations are mostly females who have gone there to lay eggs, I have once or twice noticed males taking shelter in similar places. Beneath a single flower-pot saucer standing upon damp earth, and eight inches across the bottom, I have counted as many as ten females at once; an individual gnat dislodged crept back underneath it again; but the site became dry, and they forsook it. The wonder was how they managed to enter so shallow a crevice in the first instance. The haunts of the isopod, *Trichoniscus pusillus*, are not too damp for them; but in frosty weather they are apt to take shelter under any dry pieces of wood lying loosely upon the ground. It is obvious that flies with such habits as these cannot fail to be snowed up in great numbers at the first fall; and when the frost is over, having been securely protected from extreme cold, they are ready to take wing again as soon as the snow has melted sufficiently to admit of their creeping forth. Hence, though the temperature may be relatively mild directly after a snowstorm, no gnats are likely to be seen flying until the snow has largely disappeared, when *Trichocera* will become common. Similarly after frost without snow, when the thaw sets in the flies will probably not issue from their retirement immediately, but will rest quietly until the change of temperature has had time to reach them in their lurking-places, whatever may be the warmth of the outer air meanwhile. Perhaps this is the cause of so few winter gnats being seen in the mornings early in the year; but whether it be so or not, the other foregoing surmises harmonise well with my observations.

The maximum of cold to which winter gnats can be exposed without fatal consequences has not yet been ascertained.

Chepstow Road, Croydon, April A. E. EATON

Australian Plants in India

IN NATURE, vol. xxiii. p. 370, some remarks are made (with reference to Mr. Wallace's observations in "Island Life") regarding the apparent inability of Australian plants to become naturalised in the northern hemisphere. It may therefore be interesting to you and to Mr. Wallace to learn of some striking exceptions to this rule in the case of Australian plants which have been introduced on the Nilgiri plateau in Southern India, at elevations ranging from about 5500 to nearly 8000 feet above sea-level. Acacias and Eucalypti in particular have found a congenial home in this region, and visitors from Australia who have seen them say that they appear even more vigorous than in their native soil. Hundreds of acres of *Eucalyptus Globulus* and of *Acacia melanoxylon* and *A. dealbata* have been planted by Government as firewood reserves, and the trees have grown up splendidly. The only drawback to the success of the experiment has been that the *Acacia melanoxylon* has been greatly injured by Loranthaceous parasites. In fact this species will apparently in course of time be exterminated by these indigenous pests. Besides *Eucalyptus Globulus* the following species of the genus have also been introduced, and thrive well:—*E. sideroxylon*, *E. obliqua*, *E. fissilis*, *E. rostrata*, *E. viminalis*, *E. amygdalina*, and *E. perfoliata*. In addition to the two species of *Acacia* already mentioned, the following have also been added to the list of healthy growing exotics on the Nilgiris, viz. *A. pycnantha*, *A. salicina*, *A. longifolia*, *A. decurrens*, *A. cultriformis*, *A. elata*, and others, might also be enumerated. As regards other Australian plants on these hills we have *Hakea*, *Banksia*, *Myoporum*, *Kunzea*, *Tristania*, *Pittosporum*, *Beaufortia*, &c. In short there is a very considerable Australian flora flourishing on the "Blue Mountains" of Madras, and so extensively have the trees been planted out about the principal stations that they have given quite a new character to the scenery. Some of the acacias have a considerable resemblance in shape and colour to the Scotch fir, and this likeness has, to some visitors, added a fresh charm to the beauties of the scenery. G. BIDIE

Madras, March 15

The Tide Predicter

WITH regard to the letter of Sir William Thomson in NATURE, vol. xxiii. p. 482, respecting the above instrument, I may say that the Tide Predicter which I have planned and designed for the prediction of Indian tides owes its development, not to the British Association Tide Predicter, but to a complete two-component working model made by me in the spring of 1873. This model was made before the British Association instrument was designed.

It was on the express recommendation of the Surveyor-General and Superintendent of the Great Trigonometrical Survey of India that I was invited to plan and undertake the construction of the instrument, and I was left absolutely unfettered in my choice of mechanicians to carry out the work. My connection with the instrument is clearly explained in the official prefaces to the Tide Tables for Indian Ports, 1881, published by authority of the Secretary of State for India in Council. I may point out that my paper upon this instrument (*Proceedings* Roy. Soc., No. 197, 1879) was written at the desire of Sir William Thomson, to whom it was first submitted, and by whom it was entirely approved and originally communicated. He was also present at the meeting of the Royal Society when the paper was read, and never expressed the least objection to any of its contents. In that paper credit is given to him for the improved slide, which he, with Prof. James Thomson's assistance, had devised for an harmonic analyser, and also to Mr. A. Légé for the admirable plan of the wheel-gearing. EDWARD ROBERTS

3, Verulam Buildings, Gray's Inn, W.C., March 26

"The Oldest Picture in the World"

IN Mr. Loftie's "Ride in Egypt" is a woodcut (p. 209) of what is called "the oldest picture in the world," a fresco from a tomb at Maydoom, now in the museum at Boolak, wherein are represented six "pasturing geese." Two of these are undoubtedly *Anser albifrons*, two, probably *A. ferus* or *A. segetum*, and the other two seem to be the rare *A. ruficollis*, from Northern Asia. I should be greatly obliged to any one who would let me see a *coloured* copy of this picture, that I might be assured as to my determination of the figures. Mr. Dresser, in his excellent "Birds of Europe," mentions his having received a specimen of *A. ruficollis* sent him from Alexandria by the late Mr. Stafford Allen. Otherwise its appearance in Egypt seems to have been hitherto unrecorded. ALFRED NEWTON

Magdalene College, Cambridge, April 10

Probably New Variable Star

ON January 22, 1879, I observed near O^2 Canis, a very remarkable double star, with one component a fiery red 8·5 magnitude, and the other a blue 9. The contrast of colours was very striking, but there was little difference in size. In a letter recently received from the Rev. Mr. Webb, I find that it was previously observed by him, and it appears as one of his own discoveries in the second edition of "Celestial Objects," published in 1868. The red star is there classed as 6·5 mag., and the blue as 8. The two stars, therefore, appeared to differ very considerably in magnitude when seen by Mr. Webb, while to me, eleven years subsequently, they seemed quite nearly equal. Hence I conclude that the red is a variable, and I wish to call the attention of observers to it while it still remains in view. By a rough measurement I make out its position for 1881 = α 7h. 10m. 44s., and δ − 23° 6'·6. JOHN BIRMINGHAM.

Millbrook, Tuam, April 9

Concealed Bridging Convolutions in a Human Brain

IN his work on the "Convolutions of the Human Brain" Ecker denies explicitly that the first and second external bridging convolutions of Gratiolet, as seen in Cercopithecus, Inuus, &c., are ever concealed, either in the higher apes or in fœtal or adult man. I have however in my possession an adult human brain in which *a* convolution nearly corresponding in position to the external bridging one of Gratiolet is concealed, while another slightly external to it is nearly so. The brain was hardened in nitric acid with the membranes on (a much preferable method, by the by, to that of first removing the membranes; as these, by absorbing the acid and swelling, serve, like so many wedges, to keep the convolutions apart, and prevent the shrinkage that otherwise takes place). There was no indication of any concealed convolution until the membranes, just moistened for the purpose with water, were being removed. Then, owing to the opening out of the sulcus occipitalis transversus of Ecker, the tip of one became visible, and this tip, even now that the edges of the sulcus are widely separated, is from one-eighth to one-sixth of an inch beneath the general surface.

Its position relative to the great longitudinal fissure and to the posterior border of the gyrus supramarginalis seems to me pretty accurately to correspond to that of the external bridging convolution to those parts in the brain of an Indian pig-tailed baboon of undetermined species with which I have compared it; but in the latter the sulcus occipitalis transversus does not exist, while in this human brain, as is very common, the lateral or horizontal portion of the fissura parieto occipitalis, beneath the bevelled edge of which in the baboon the convolution lies concealed, has a very short course indeed.

The only difference then is that in the one specimen (the human) the concealed convolution lies in the transverse occipital fissure, there being no lateral extension of the parieto-occipital fissure, while in the other it lies in the parieto-occipital fissure, the transverse fissure not existing WILLIAM CARTER

Liverpool, March 26

Sound of the Aurora

IF I had consulted Franklin's account of his Polar researches before I sent you my extract from Tacitus, I should not have revived the question of sounds being heard with the aurora borealis. Franklin and his companions watched the aurora 343 times in two successive winter seasons; and never once, he says, did they observe a sound. Were, then, the experiences quoted by your other correspondent and myself mere illusions? Perhaps not. Franklin made his observations at and about the southern shore of Bear Lake, in latitudes varying from 67° to 69° north; might not the greater volume of air through which the phenomenon had to pass in reaching our island have caused the electric fluid to work up a sound? Surely that is possible. The attractive force of the aurora is—we learn from Franklin himself—increased within a certain limit as its rays proceed southwards; for whereas Parry and his party at Port Bowen in latitude 73°.15' noticed no deflection of the compass-needle under the influence of coruscations, Franklin and his party on the shores of the Bear Lake, six degrees further south, constantly observed this effect. And the attractive force is strongly felt here—hindering telegraphic communication at all events. Might not the vibratory force not sensible at within so short a distance from its origin as the attraction be increased within a greater limit? M. L. ROUSE

Sunnymead, Chislehurst Common

PERIODIC OSCILLATIONS OF BAROMETRIC PRESSURE

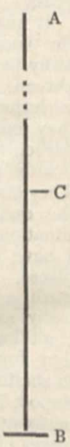
THE MSS. of the accompanying article, which was left unfinished by the late Mr. John Allan Broun, F.R.S., were handed over to me some time ago by Prof. Balfour Stewart, with a request that I would put them into shape for publication.

I have not found it necessary to make many alterations in, or additions to the original, and where made they are mostly indicated in initialed foot-notes.

E. DOUGLAS ARCHIBALD

In an article which appeared in NATURE (vol. xix. p. 6) a remarkable relation was shown to exist between the annual ranges of the atmospheric pressure and of the temperature of the air, as derived from the monthly means obtained from several years' observations of the barometer and thermometer at certain stations in India. The results and the conclusions from them do not appear to have been always understood, and as they bear on some of the most interesting questions on meteorology, I shall now examine them anew with the aid of observations at some other stations, under different local conditions.

For this end it is desirable to employ some elementary considerations. Let us, first of all, consider the action of varying temperature on a vertical column of the atmosphere. Let us consider a column of air reaching from the soil at B to the upper limit of the atmosphere at A; and suppose that the pressure shown by a barometer at B is 30 inches, while at a higher station, C, it is only 20 inches. If, now, the column of air is heated so that the temperature of the part B C is increased by 10° F. we know from laboratory experiments that the air will expand, so that a part of that which was below C will be pushed above it, and while the barometer at B will continue to show 30 inches, that at C will show 20·2 inches, the mercury at C will have risen two-tenths of an inch.



If, now, we suppose that the mass of air remains constant throughout the year, there will be an annual variation of the barometer at C, where its height will be greatest in the warmest month and lowest in the coldest month. For the same reason the difference of the barometric heights at B and C will be least in the warmest month and greatest in the coldest.

It has been supposed that the mass of the atmosphere remains constant throughout the year; if this is not the case the variations of pressure at C will not depend on temperature alone, but also on the other causes which produce variations at B.

In NATURE, vol. xx. p. 55, Mr. Douglas Archibald has given a series of differences of barometric heights at high and low stations in India for the months from October to April. The month of lowest mean temperature, January, shows always, as in the case just supposed, the greatest difference of pressures. As the high and low station is never in the same vertical, the one being sometimes 300 miles horizontally distant from the other, it is difficult to eliminate the part of the variation due to temperature at the higher station, but if we take as an approximation, however rude, the mean of the temperatures at the two stations as that of the vertical column, we can see that a considerable part of the variation at the upper station may be due to the expansion of the column with temperature.

Thus for Leh and Lahore the mean temperatures and difference of barometric heights are[1]:—

[1] The numbers are taken from the work cited by Mr. Archibald, "The Indian Meteorologist's *Vade Mecum*," by Mr. H. F. Blanford, Pt. ii. pp. 176, 178.

	Mean temp.	Diff. of Pressures.
	°	in.
January	35·0 Fahr. ...	9·690
July	74·1 ,, ...	9·105

Now as the difference of the mean temperature of these two months is nearly 40°, according to what has been said before, the expansion of the air from January to July should have increased the pressure at the upper station by about 0·8 inch (eight-tenths of an inch of mercury) and have diminished the difference of pressures by that amount. The observed diminution is, however, less than 0·6 inch, a deficiency of two-tenths, which has to be accounted for in some other way.

In the case of the annual variation of atmospheric pressure near the sea-level, we have to consider only the atmosphere above the station; but in that for a high station we have a much more complicated problem in which the atmosphere below the station plays an important part, a part also which may vary greatly, according as the upper station is on a mountain top, on a gradually ascending height, or on high table land.

It was for these reasons that in the article (NATURE, vol. xix. p. 6) under consideration, nothing was said of the annual variation on mountains or at great heights; the results were obtained from observations at stations little above the sea level, and from them it appeared that for every degree Fahrenheit on the range of monthly mean temperature, there was a variation of from ·021 inch at Singapore, to ·025 inch at Bombay and Madras, in the range of the monthly mean barometric height; while at Pekin the amount was diminished to ·015 inch. The conclusion that this ratio was nearly constant in India referred necessarily to stations under similar conditions. Mr. Archibald's letter has brought to notice a series of Indian observations made at stations farther from the sea and in North India, which are given in an interesting and useful work by Mr. H. F. Blanford, Meteorological Reporter to the Government of India, and which merit consideration. The means employed by me previously were derived from observations at standard observatories during five to twenty-six years; and it was mentioned that, as single years gave somewhat variable results, the monthly means from several years' observations were necessary for accurate values. In the cases to be found in Mr. Blanford's work, several are of observations during only two years (or even less), and we have no exact idea of the weight which in any case can be accorded to the observations at the stations. As, however, the results for different stations in general confirm each other (the exceptional cases will be noticed apart), I shall here form a series of groups of stations, each group under nearly the same local conditions as regards latitude, height above, and distance from, the sea. The value of k, the variation in thousandths of an inch, of pressure-range for 1° F. of the temperature-range, is the same for all stations in each group, with the exceptions referred to below.

Thus the most northerly group near latitude 30° N. and 600 miles from the sea, viz., Lahore, Delhi, Dera Ismail Khan, Mooltan, and Roorkee, gives the following result:—

Mean latitude of group (λ).	Mean height above the sea (h).	Mean annual temperature (t).	Mean ranges of temperature and pressure. Δt	Δp	Mean barometric oscillation for 1° Fahr. $\left(k=\frac{\Delta p}{\Delta t}\right)$.
°	feet.	°	°	inch.	
30½	660	75·2	39·0	0·620	0·016

This group extends about 450 miles from Delhi to Dera Ismail Khan, and the heights vary from 440 to 890 feet. The value of k is the some for each station.

The next group comprises Bareilly, Lucknow, Jhansi, and Benares, for which the following are the values of the different elements:—

λ	h	t	Δt	Δp	k
°	feet.	°	°	in.	
26	520	77·7	32·4	0·554	0·017

The distance of the extreme stations is not 300 miles; the heights vary from 270 feet at Benares to 860 feet at Jhansi. For each station k = 0·017.[1]

The third group includes Patua and Gya, and the values are—

λ	h	t	Δt	Δp	k
°	feet.	°	°	in.	
25½	260	78·5	28·0	0·537	0·019

The distance between the two stations is about 70 miles; the heights are 179 and 347 feet respectively, and the values of k are within half a thousandth of each other.

The fourth group includes Berhampore, Burdwan, Dacca, Goalpara, Chittagong, Calcutta, and Saugor Island, for which the values are—

λ	h	t	Δt	Δp	k
°	feet.	°	°	in.	
23½	100	78·0	18·7	0·471	0·025

With the exception of Goalpara and Chittagong, these stations all lie in the Gangetic delta, at nearly the same elevation, and with an extreme variation in the value of k amounting to 0·004 inch.[2]

The fifth group includes Bombay alone, the values for which are—

λ	h	t	Δt	Δp	k
°	feet.	°	°	in.	
18½	37	78·8	11·6	0·287	0·024

The sixth, Madras, Negapatam, Trichinopoly, and Madura, with the values—

λ	h	t	Δt	Δp	k
°	feet.	°	°	in.	
11⅓	190	81·7	11·1	0·243	0·021

The seventh, Colombo, with the values—

λ	h	t	Δt	Δp	k
°	feet.	°	°	in.	
6½	42	81·3	3·6	0·069	0·019

It will be seen from this table that the value of k is a maximum (= 0·025) nearly under the tropic of Cancer, that it diminishes thence both north and south. This diminution cannot, however, be attributed altogether at least to the latitude, since the value is nearly the same at Pekin and at Delhi.

The variation of the value in Northern India from the maximum near Calcutta has an apparent relation to the height above the sea and the distance from it,[3] as well as to the amount of the temperature oscillation; the value of k diminishing as the others increase. We cannot, however, relate the value to any one of the other variables. No doubt height above the sea may have some influence, as has already been shown, but here mountain stations have been avoided; and while in the Lahore group the heights vary from 420 feet (Mooltan) to 890 feet (Roorkee), the value of k remains constant.

It should be observed that the temperature ranges are those of the stratum of air a few feet above the soil, while the ranges of pressure include the whole atmosphere above each station. We see that the value of k dimi-

1 There appears to be some difference in the values of Δp as got by Mr. Broun and those derived from my edition of the "Vade Mecum" for these two groups. Thus from my edition (1877), the value of Δp for Group I. is 0·614, and therefore k = 0·019; there are also slight differences in the value of k at each station. In Group II. k is 0·017 only for Bareilly and Lucknow, the value for Jhansi and Benares being 0·016.—E. D. A.

2 The figures for the fourth group have been supplied, and the fifth, sixth, and seventh groups have been added as the text seemed to imply their intended formation by the author.—E. D. A.

3 Mr. Archibald has considered height not to be an element, and he cites in evidence Lucknow and Sibsagar, very nearly at the same height; the former having k = 0·017 and the latter k = 0·028 (NATURE, vol. xx., footnote p. 54). The latter value, however, is a mistake, for at Sibsagar k = 0·018, very nearly as at Lucknow. Mr. Archibald's conclusion is that it is not height, but distance from the sea, as the stations are at widely different distances from the sea. We should, owing to this error, be obliged to reverse the conclusion, and say it is not distance from the sea, but height, that is in question; but, in reality, Sibsagar though not so far from the sea, is still as far as Patua or Gya, with nearly the same value of k.

[See my note on this point, NATURE, vol. xxi. p. 131.—E. D. A.]

nishes as the range of the surface-temperature increases, and it is certain that the ranges of the temperature at all the stations as we ascend above *the soil*, will approach always nearer to each other the higher we go; so that if we knew in what way the relation between the oscillations is produced, and thence, in all probability, the part of the atmosphere which is chiefly in question, we might find a more constant relation between Δt and Δp at all the stations.

I will now proceed to make some remarks which may aid in the study of these questions. I would first observe with relation to the stations in the preceding table that the value of k is only 0·024 at Chittagong, while it is nearly 0·029 at Saugor Island. I have no doubt, however, that this difference is due to some local or instrumental cause.

In the first article I have, as already stated, used only observations made in first-class observatories. Every one acquainted with the difficulties of obtaining good observations in India, especially at out-stations, will understand that the mere printing of their results cannot give them any certain weight. Thus from the tables of means given in Mr. Blanford's work, it appears that the value of k at Vizagapatam is 0·032, while at Cuttack less than 3° to the north, it is 0·025. This great difference would lead to the conclusion that there must be some remarkable local cause, or that there is some error in the observations; if the former, then farther research as to this cause would be of the highest importance; the latter seems to me the most probable explanation. The following example, that of a station so well known as Madras, will show some reason for this belief. The results for Madras, given in the table, are those employed in the first article, and deduced from observations made in the Magnetic and Meteorological Observatory from 1841 till 1855. In Mr. Blanford's tables, however, means are given from observations for nine years. These means give results markedly different from the others. The following summary for the months of December, January, and June, will prove this:—

Group of Years.	Height of Barometer. December.	January.	June.
1841–45	29·954	29·998	29·691
1846–50	·957	·986	·693
1851–55	·992	·998	·702
Means	·967	·994	·695
1868–71	·978	·967	·671
1872–76	·955	·926	·802
Mr. Blanford's means for nine years	·965	·944	·744

Now the three means for January, each deduced from five years' observations, do not deviate from the mean of the whole more than ·008 inch, while the corresponding extreme deviation for June is ·0 7 inch. Whereas the means from nine years, according to Mr. Blanford's tables, differ by 0·050 inch from the means of fifteen years, and the annual range, which is 0·299 by the fifteen years' observations, becomes only 0·200 by the last series. Judging from the means for four years—given by Mr. Blanford in his valuable memoir in the *Phil. Trans.* on the winds of North India—which I believe to be part of the nine years, the means for five years, 1872–76, give a range of only 0·124 inch from January to June; but even the mean pressure for the place and the annual law of variation is altered by the nine-year series, the maximum pressure occurring in December instead of January. It is essential in such investigations that some confidence can be placed in the observations, and if this can be done anywhere it is certainly in observations made at such a station as Madras. I have employed previously means deduced from fifteen years' observations in the Magnetic and Meteorological Observatory; but these means differ in a manner so extraordinary (for a South Indian station) from the means given by Mr. Blanford from nine years' observations, that this demands attention and explanation.[1]

We see that the annual oscillation of pressure increases with that of temperature, and as shown in the article already cited, that this relation holds for two places on opposite sides of the Ghâts, nearly at the same height within sixty miles of each other, for which the annual oscillations at one are twice those for the other.

Let us now see what our knowledge from laboratory experiments of the laws of expansion and equilibrium of gases would induce us to conclude with reference to the stations in question.

In the first place, let us remember that the yearly mean temperature at Pallamcottah is about 7° Fahr. greater than at Trevandrum, while the yearly mean pressure is the same. We conclude at once from this result that the mean pressure does not depend on the mean temperature.

I stated that the mean temperature in January at Pallamcottah, on the east side of the Ghâts, was 4° Fahr. greater than at Trevandrum, sixty miles distant on the west side of the mountains, and that the mean pressure was 0·065 greater at the former than at the latter. Sir John Herschel has shown that according to our knowledge of the expansion of gases, there should be a single diurnal atmospheric tide due to one side of the earth being warmer than the other, and this due to the expansion of the gases in the warmer half causing the centre of gravity of the air to be higher than in the other, should produce a sliding motion of the warmer air towards the colder in twelve hours.

If such a result is what may be supposed to occur in the period of a day, there cannot be the smallest doubt that if a mass of the atmosphere has a lower pressure and a lower temperature than another mass at a short distance, the former should flow towards the latter, and produce equilibrium within twenty-four hours. Here, however, we find that there is a difference of pressure of 0·065 inch, which remains during a whole month at a distance of sixty miles, and this continued difference of pressures is not to be explained by any known property of gases.

We see, indeed, the remarkable fact that the oscillation of the monthly mean pressure at one station proceeds quite independently of that at the other, and both in a constant ratio with the variation of the temperature of the atmosphere in the lowest stratum.[2] All this is inexplicable by any heating action alone.

I have omitted all notice of the aqueous vapour in the atmosphere. It is obvious, however, that this cannot explain the annual oscillation of pressure, since it is just when the tension of vapour is greatest, that the barometric height is least. The introduction of more vapour into the atmosphere does not make the whole lighter, but heavier; and when we adopt the arithmetical operation of Dove and subduct the vapour pressure from the barometric height, we find the oscillation to be greater, not less, than before.

It is not easy to determine the variation of vapour pressure from the indications of the dry- and wet-bulb thermometers, and the exact result of the total vapour above the barometer cannot as yet be determined, but its amount will not explain the annual law, nor will it explain the independent oscillations in question. I have, however, long ago suggested that the humidity of the air may be in question, and as the oscillations of dryness or humidity of the lower mass are probably related to the temperature, the oscillations of pressure may also be related to them.

Sedgwick has said, in his inaugural discourse on the

[1] Mr. Broun asked me if I knew what years made up the nine, but I know of no one except Mr. Blanford himself who can give a satisfactory answer to this question, and he is in India. The "Vade Mecum" being an official work, ought certainly to be trustworthy.—E. D. A.

[2] And probably of the mean temperature of a layer of some considerable height.

studies of his University: "To explain difficulties in these questions, the atmospheric strata have been shuffled in accordance with laboratory experiments." Thus, for example, the mean pressure of the atmosphere remains, on the average of the whole year, 0·038 inch lower for every 100 miles we proceed north in this country, a difference which is called a *gradient*, as if it were a fall on a railway line, though it is really the position of equilibrium like that of the watery ocean, which has also a gradient of nearly thirty miles from the equator to the poles.

I have previously remarked that at Bombay the maximum pressure precedes nearly by a month the minimum temperature, while the minimum pressure is a month later than the maximum temperature. This is also true for all the stations in North India. At Madras, however, and Trevandrum, January becomes the month of maximum pressure. I do not, therefore, place much weight on this fact as showing that the two oscillations are not cause and effect. The month of maximum pressure at Pekin agrees most nearly with that of minimum temperature.

I have stated in the first article on this subject that I did not admit that the oscillation of pressure was due to that of temperature, and therefore could not allow that a higher annual mean temperature [would in any case cause a lower annual mean pressure]. From the fact that the annual variation of pressure and temperature in Central Asia is greater than in any other portion of the globe, the greatest pressure coinciding nearly with the lowest temperature, and the least pressure with the highest temperature, it was concluded by Mr. Chambers that years of greatest mean pressure should also be years of least mean temperature. Now if we assume that the pressure depends only on the mass of the air and watery vapour in it, as the former is constant, and the latter, the only variable part, is greatest when the temperature is highest, it would follow that years of greatest heat should be years of greatest pressure, which is just the reverse of the conclusion deduced by the analogy from the annual variations.

Indeed, it is one of the great difficulties in the hypotheses which have been proposed, to explain the annual variation of pressure of the mixed atmosphere, that when we subduct the vapour pressure, as far as our means of calculating this exist, we have a much larger dry air oscillation than before.

I gave, however, different reasons for concluding that the range of temperature was not itself the cause of the diminished pressure, although the two go nearly together. One was that the observations of Bombay showed the greatest pressure to precede the lowest temperature by a month, and this is true for all the stations in the groups of North India already given. I also pointed out that were the two directly related, the mean pressure at Trevandrum should be greater than at Pallamcottah by nearly one-tenth of an inch, which is not the case, the isobars and isotherms having no relation to each other.

If we suppose that we have the same atmosphere over each station as over the whole earth, there is no possibility of explaining the variation of pressure by that of temperature. The only known property of heat which affects the mass has no doubt been employed to cause the hotter air to flow away somewhere, and surely in that case it should flow to the nearest colder station, where the pressure is less; but we have seen that this is not so in the case of Trevandrum and Pallamcottah, nor is it so in the valleys of the Ganges and Indus, where the oscillation increases as we ascend from the sea. These oscillations proceed with the greatest regularity, approximately in proportion to the temperature variation from month to month, and without the slightest regard to the hypothesis which should cause equilibrium in twenty-four hours, by the sliding of the most expanded masses over those least so. In what way, then, can we associate the two oscillations if one is not the cause of the other? I have long ago suggested that the varying humidity of the air may be in question; this is only a suggestion. I do not mean the mere tension of vapour—as already stated when we try to get rid of that from the total atmospheric pressure, the subject becomes more difficult, the dry air oscillation being greater not less than that of the whole—but if we suppose that the attraction of gravity is not the only attraction which affects the pressure of the atmosphere, but that this pressure varies through some other attracting force such as an electric attraction of the sun depending upon the varying humidity of the air, and this again depending on its temperature; we should find a method of relating the two variations which does not exist if gravitation alone is employed.

It is quite certain that many physicists will not admit the idea of an electric attraction on our atmosphere in the present state of our knowledge, hence the efforts to make expansion, and a shuffling of the atmospheric strata suffice. We must not, however, in our ignorance, attempt to force conclusions in opposition to facts, and if these can be satisfied more easily and with greater probabilities in its favour by the aid of the hypothesis of an electric attraction of the sun, that hypothesis will have a better claim to acceptation than the other.

I shall here note a few facts which cannot be explained by thermic actions.

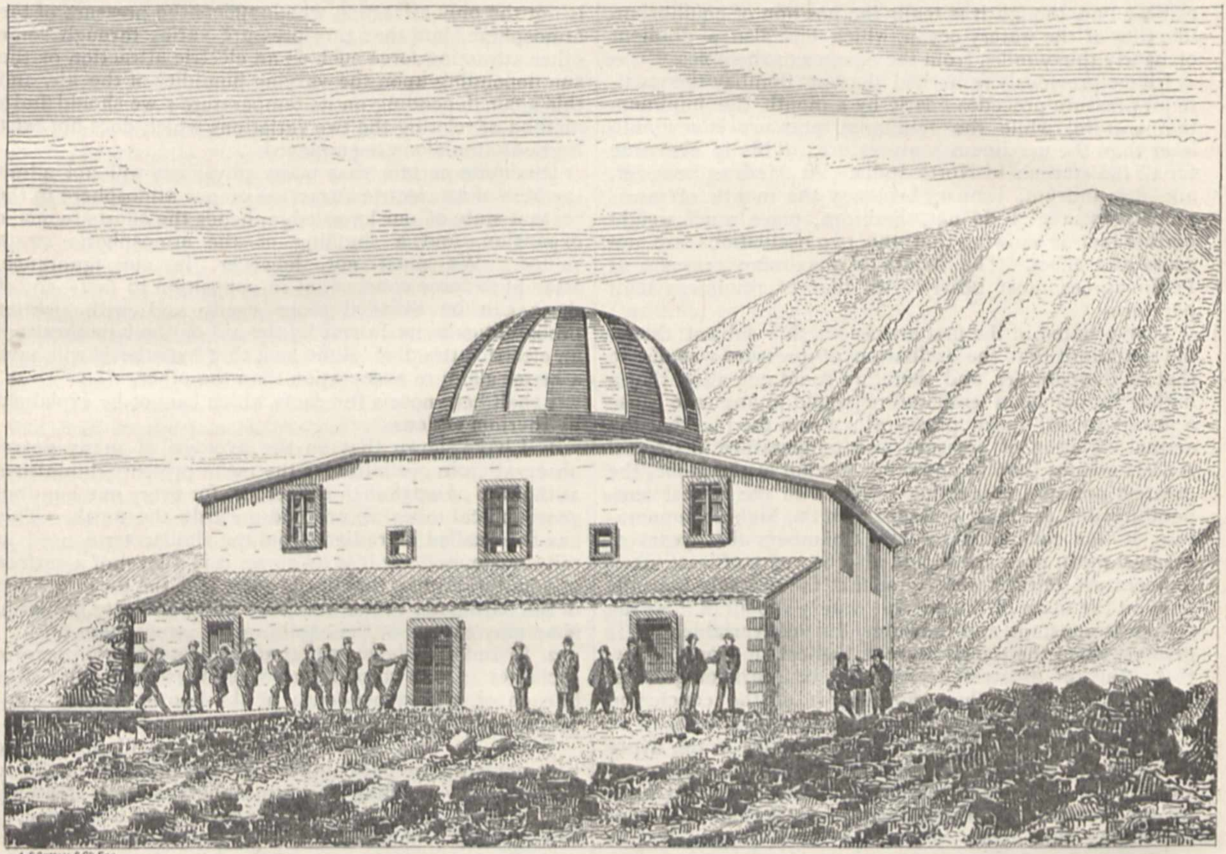
1. I have shown that on the average of many years' observation in our latitudes the mean pressure diminishes at the rate of 0·038 inch of mercury for every one hundred geographical miles we proceed towards the north. This has been called a gradient from the similar term used in railway slopes; but it is no slope, it is a level of a surface of equilibrium like that of the sea. It is the mean heights of the barometer at the sea-level which indicate the form, if we may say so, of the equilibrating atmosphere.

2. In India we have seen that the atmospheric pressure oscillates at each station even when these are quite near to each other, independently of the known laws of equilibrium of pressure of gases.

When we turn to the semi-diurnal oscillation of the barometer we are only amused at the attempts made to explain it by shuffling the atmospheric strata. Nothing can be more certain than that the theories of expansion, or resistance to expansion and overflow, are the vain efforts to make the laws of nature agree with a theory. Over the great ocean within the tropics, where the diurnal variations of temperature are small and the air is absolutely without perceptible currents for days together, the barometer rises and falls a tenth of an inch twice in twenty-four hours with the regularity of the solar clock. The action of the sun on the whole atmosphere which produces this movement varies chiefly during the day hours at inland stations with the temperature oscillation, so that, as in the case of the annual variation, the fall of the barometer at 4 P.M. is greater in the same latitude as the temperature is higher. This variation occurs during the most complete calms; the smoke rises vertically from the plains of Tinnevelly; no current is visible in the motion of the clouds; yet the barometer falls at four in the afternoon as it did at four in the morning, only it falls farther.

THE ETNA OBSERVATORY

THE accompanying illustration of the Observatory on Mount Etna is reproduced from the *Memoirs* of the Italian Spectroscopic Society. It shows that the building is so far complete, and surmounted by its revolving dome for the protection of the large Merz equatorial of thirty-five centimetres aperture. In the engraving the volcanic cone appears much nearer the Observatory than it really is. The work of building was suspended during the stormy weather of 1879, but was completed in the summer of last year. But it cannot be said that the building is yet quite finished and ready for occupation; a good deal of work has yet to be done to the internal walls, the doors and windows, flooring, &c., besides the scientific equipment of the building. Therefore the announcement by the Alpine Club of Catania that the building would be ready for inauguration at the meeting of the Alpine Congress in Catania next September was premature. The Observatory will not really be ready to be opened till 1882. The difficulties that have had to be contended with can only be comprehended by those



who have visited the place; all the materials have to be conveyed 3000 metres above the level of the sea, and that during only three months in the year. So that even if not ready till 1882, the work may be said to have been rapidly accomplished. The mounting of the equatorial is finished and the construction of the meteorological apparatus is being proceeded with. The Ministers of Agriculture and Public Instruction are doing their best to provide the Observatory, by 1882, with a director and a staff both of astronomers and meteorologists.

MODE OF MASKING OR CUTTING OFF SHARPLY THE LIGHT FROM REVOLVING APPARATUS ON ANY DESIRED COMPASS-BEARING BY MEANS OF A RECIPROCATING SCREEN

OWING to the optical properties of the lens employed in revolving lights, a formidable element of difficulty comes in the way of effecting a sharp cut-off on a particular bearing; for the direction of the axis of the beam of light which is projected by the lens is being continually changed in the horizontal plane by the revolution of the frame on which it is fixed. So long as the axis of this beam of rays points outside of the line of obscuration the light will not of course encroach on the danger arc, unless to a small extent, when the axis is nearly on the line of cut-off due to the ex-focal rays proceeding from the outer edges of the flame. The light however will begin to be diminished in power from a bearing varying from 12° to 21° outside of the line of cut-off dependent on the size of the lens, the light on the line of cut-off being diminished to the power of one-half. But when the axis crosses that line, then as the rays which come from that part of the apparatus which is still outside of the darkened panes of the lantern is not intercepted by them, the light will begin to be seen within the arc of danger, and as the apparatus goes on revolving the axis will at last point from about 12° to 21° within the danger-arc, according to the breadth of the lens which is employed. Owing to this peculiarity of a revolving light the difficulty of confining the flashes within any required arc of the horizon by means of *fixed* screens is in fact an insurmountable one.

The mode which I have to suggest is as follows:—In front of the revolving apparatus and on the safety side of the danger arc, let a light canvas or metallic screen be constructed for running on rollers on a slightly inclined rail or circular path close to the apparatus. If now a small projecting rod or snug be fixed to the side of each lens it will in revolving be brought against the edge of the screen, and will gradually press the screen before it up the inclined plane at the same rate of motion backwards as that of the lens forwards. By the time the lens reaches the edge of the danger-arc the screen will have been pushed to the top of the inclined plane, and the full beam of light coming from the now entirely uncovered lens will be pointing in the required line of cut-off which is the border of the danger-arc. But whenever the further revolution of the apparatus causes the snug to pass clear of the edge of the screen so as to free it from pressure, it will immediately run back again to its original position in front of the lens, so as to prevent any light being now sent forwards. If that light were not at once intercepted part of it would, by the movement of the frame, begin to pass across the line of cut-off, so as to be seen within the danger-arc. By this continued reciprocative movement of the screen as lens after lens comes round, the same effect will be successively produced, and the light will always be cut off in the line of obscuration as sharply as in the case of a fixed light, so that the flashes will never be seen within the danger-arc.

In cases where the light has to be cut off on both sides of a danger-arc a similar reciprocating screen is as applicable to the lenses when passing out as when passing into the danger-arc. But in this case the lens, on leaving the danger-arc, will take the screen round with it up an inclined plane until the axis of the lens is parallel to the line of cut-off, when the screen will recoil and the light become visible with full power in the line of cut-off.

A small spherical mask placed inside of the apparatus may be made to produce the same effect by reciprocating between the lenses and the flame. When the danger-arc is of small amplitude the screens, which must always be as broad as the lens, might come in the way of the light passing over the safety-arcs. To obviate this, cloth curtains might be made to wind up on vertical rollers similar in construction to those used for ordinary house-blinds.

THOMAS STEVENSON

CHLOROPHYLL [1]

AN account was given in NATURE, vol. xxi., p. 85, of Prof. Pringsheim's first publication on this subject. He had then found that exposure to intense light for a few minutes causes the chlorophyll-corpuscles contained in the cells of plants to lose their green colour; he also pointed out that this effect is produced not by heat but by light, and only in the presence of oxygen, and further, that the highly refrangible rays of the spectrum are those which are principally concerned in it. He also announced the discovery in the chlorophyll-corpuscles of a substance termed Hypochlorin.

The paper now under consideration gives a full account of all the observations and experiments which he has made up to the present time, and he considers that they tend to confirm the conclusions at which he had previously arrived. It will be well, before entering upon a discussion of the very difficult questions which are raised, briefly to enumerate the principal new facts which he now brings forward.

In the first place, he is able to throw some light upon the intimate structure of chlorophyll-corpuscles by means of a new method for investigating them. This method consists in treating them with a dilute acid (*e.g.* 1 vol. of glacial acetic acid to 2 of water, or 1 vol. of picric acid to 3-6 of water, or 1 vol. of sulphuric acid to 20-40 of water, or 1 vol. of strong hydrochloric acid to 4 of water), or warming them in water, or exposing them to the action of steam. The effect of this treatment is to cause the escape of the chlorophyll from the corpuscle, together with certain fluid or semi-fluid substances which accompany it, in the form of viscid drops, leaving the ground-substance of the corpuscle as a colourless, apparently protoplasmic, hollow sphere, with a much perforated wall.

[1] "Untersuchungen über Lichtwirkung und Chlorophyllfunction in der Pflanze," by Prof. N. Pringsheim (*Jahrbücher für Wiss. Bot.*, Bd. XII., Heft 3: Leipzig, 1881).

These viscid green drops, when produced by the action of warm water or of steam, appear to consist of an oil which holds the chlorophyll and other substances in solution. When they are produced by means of a dilute acid, they appear to contain a substance which is not present when they are extracted by warm water or by steam. Certain dark brown masses make their appearance which are of a tolerably firm consistence and of varying form. These gradually become harder, and assume a crystalloidal appearance, probably, as Prof. Pringsheim suggests, in consequence of a conversion into resin of the oily matter which is present; but it is by no means the whole of the substance which thus solidifies, but only a certain constituent of it. The colour of the mass is doubtless due to the presence of altered chlorophyll, and this may affect even the crystalloids, but they may be obtained colourless. It is to the substance which assumes the crystalloidal form, or rather to some substance pre-existent in the chlorophyll-corpuscle from which these crystalloids are derived by the action of the acid, that Prof. Pringsheim gives the name of Hypochlorin.

He meets the doubts that may arise as to the chemical individuality of this substance, as also the suggestion that it may be a product of the alteration of the chlorophyll, by pointing out that it cannot usually be obtained at any one time from all the corpuscles of a given cell. It is therefore a substance which, as it is present in some and not in others, cannot be derived from chlorophyll which is present in them all, and which probably bears some definite relation to the metabolic processes going on in the corpuscles.

Since no hypochlorin can be obtained from cells which have been warmed in water or acted upon by steam, it appears that this substance is decomposed by heat.

After giving a detailed description of the arrangement of the apparatus used in his observations, Prof. Pringsheim goes on to give an account of the effects produced by exposure to intense light in the different parts of which the cell consists. He again insists that none of the following phenomena can be the results of excessive heating of the object, for he found that cells not containing chlorophyll (*e.g.* colourless zoospores) could bear the exposure for half-an-hour without injury, and further, that the phenomena were produced more readily by blue or green light than by red light which has a much greater heating effect. The principal phenomena observed are as follows:—

1. The colouring-matter.

The chlorophyll-corpuscles lose their colour in a few minutes, but this does not take place when oxygen is not present, nor in red light. There is no trace of chlorophyll left in the corpuscles. Prof. Pringsheim is therefore of opinion that its decolorisation is a phenomenon of oxidation, and that the products are gases. Further, this disappearance of the chlorophyll is not prevented by the absence of carbonic acid gas. The corpuscles which have lost their green colour do not regain it, although the cell in which they are contained, still continues to live; on this account Prof. Pringsheim regards the decomposition of chlorophyll as a pathological and not as a normal process.

Colouring matters, other than chlorophyll, which occur in the cells of plants, are likewise decomposed, but not all of them. Thus, the blue pigment of the Phycochromaceæ, the brown of Fucus, the red of the Florideæ, the orange of the corolla of Calendula, the blue in the cells of the staminal hairs of *Tradescantia virginica*, disappear, but the blue pigment in various flowers is not decomposed by exposure to intense light.

2. The ground-substance of the chlorophyll-corpuscles and their contents.

If a cell of Nitella or of Spirogyra be killed by the action of heat, for instance, the chlorophyll-corpuscles of the one and the spiral band of the other will absorb water and swell up. If the cell has been killed by prolonged exposure to light, no such absorption of water will take place.

Prof. Pringsheim mentions starch, oil, and tannin as commonly occurring in the chlorophyll-corpuscles[1]; these substances, which contain a considerable proportion of oxygen in their molecule, are not affected by the action of light.

3. Hypochlorin.

No trace of this substance can be detected in cells which have been exposed.

4. The protoplasm of the cell.

The turgidity of exposed cells is lost; the protoplasm readily allows colouring matters to pass through it, and treatment with plasmolytic reagents produces no contraction. In a long cell, part of which has been exposed to the action of light, it is only the portion of the protoplasm which has been exposed that exhibits these alterations in its properties. Moreover, these changes are apparently accompanied by a perceptible loss of substance.

A brief exposure causes an arrest of the rotatory movements of the protoplasm in cells which exhibit it. If the exposure has not been prolonged, these movements will recommence after a time. If a portion only of such a cell be exposed for not too long a time, the movements will be arrested in the exposed portion, whereas it continues in the rest of the cell.

5. The cell-wall.

The only effect which the exposure produced on cell-walls appears to have been that the cells of the more delicate filaments of species of Spirogyra and Mesocarpus become isolated.

The following are the general conclusions which Prof. Pringsheim draws from the facts which have been stated above. He concludes that the injurious effects produced by the exposure of a cell to intense light in an atmosphere containing oxygen, are due to an increased oxidation of certain substances which are essential to its life. The rays which are active in this process are not those which reach the interior of the cell after having passed through the chlorophyll-corpuscles, but those which reach it directly. He finds, it is true, the cells which do not contain chlorophyll are, on the whole, less sensitive to the action of light than those which do contain it, but there are no grounds for believing that this greater sensitiveness is due to the absorption of any light-rays by the chlorophyll. On the contrary, the presence of chlorophyll in a cell seems rather to diminish than to increase the oxidising action of light. Facts are adduced to show that chlorophyll exercises a protective influence in this respect, and it is further pointed out that the death of the cell, when exposed to intense light, takes place *before* the complete decolorisation of the chlorophyll-corpuscles has been effected. The greater sensitiveness to the action of light of a cell containing chlorophyll is ascribed to the presence in it of the readily-oxidisable products of its assimilatory activity, and of these hypochlorin is the most important.

Prof. Pringsheim's theory of the function of chlorophyll is, then, (1) that the respiration of a cell is increased by exposure to light; (2) that, in consequence of the absorption which takes place when light passes through chlorophyll, the presence of chlorophyll in a cell tends to counteract the influence of light, so that, when the light is not intense, the respiration of the cell is so far diminished that processes of reduction can take place within it, but when the light is very intense the chlorophyll itself undergoes decomposition, and the death of the cell is brought about by the excessive oxidation of certain of its essential constituents.

[1] He quotes the observations of Briosi to prove that oil, and not starch, is the substance which is formed in the chlorophyll-corpuscles of the Musaceæ, without being aware, apparently, that Briosi's results have been shown to be incorrect by Holle and Godlewski ("Flora," 1877).

After having stated his own views, Prof. Pringsheim proceeds to criticise the current hypotheses concerning the function of chlorophyll. The first of these is the one according to which chlorophyll is itself converted into carbohydrate in the assimilatory process. It is not easy to understand, from a chemical point of view, how such a conversion can be effected in the plant, and it becomes quite impossible when it is shown, as Prof. Pringsheim has done, that chlorophyll does not undergo any perceptible change when it is exposed to light in an atmosphere containing carbonic acid but no oxygen. The second relates to the absorption-spectrum of chlorophyll. The question naturally arises as to whether or not the rays which chlorophyll absorbs are those which effect the reduction of carbonic acid and water in the chlorophyll-corpuscle. That it must be answered in the negative is clear when it is borne in mind that the maximum, of the decomposition of carbonic acid does not coincide with the maximum of absorption in the chlorophyll-spectrum. From what source, then, is the energy derived which is necessary for this reduction? It is derived, according to Prof. Pringsheim, from light-rays absorbed, not by the chlorophyll, but by the other cell-contents. He is of opinion that the chlorophyll takes no direct part in this process.

The next question which is dealt with is the existence of an optimum intensity of light for the decomposition of carbonic acid. Prof. Pringsheim does not consider that this is the intensity which effects the greatest evolution of oxygen, for, from his point of view, the amount of oxygen given off at any time is the resultant of the action of two distinct processes, respiration and assimilation, both of which are affected by the intensity of the light. He concludes that, so far as an actual gain of carbon is concerned, there is no general optimum intensity. He applies this mode of reasoning also to the question of the relative activity of the different rays of the spectrum in the process of assimilation. The green and yellow rays have been found to be more active than the blue, because, as he points out, they are not absorbed to the same extent by the chlorophyll, and not because they are endowed with any special reducing power. Finally, he proceeds to the discussion of the fact that the volume of an atmosphere in which green plants are exposed to light remains constant. This fact has led to the conclusion that, since the volume of carbonic acid decomposed and of oxygen exhaled is the same, the substance formed in the process is a carbohydrate. Prof. Pringsheim's inference from this fact is very different. He argues that since oxidation and reduction are going on simultaneously, the substance formed contains a smaller quantity of oxygen than a carbohydrate,—in fact a quantity which is smaller by just that amount of oxygen which has been used up in respiration.

Stated in the briefest possible manner, Prof. Pringsheim's principal results are as follows:—

1. That the presence of chlorophyll favours the assimilatory activity of the chlorophyll-corpuscle in consequence of the absorption, by the chlorophyll, of light, which would promote the respiratory activity.

2. That hypochlorin is the substance which is the first visible product of this assimilatory activity, and that the other substances (starch, glucose, oil, tannin) which are found in chlorophyll-corpuscles are derived from hypochlorin by oxidation. This conclusion is based upon the general occurrence of hypochlorin in chlorophyll-corpuscles, upon the fact that the amount of hypochlorin in a corpuscle varies inversely as the quantity of starch which is present, and upon the observation that hypochlorin cannot be detected in seedlings until they have been exposed to light of such an intensity as to enable them to assimilate.

It is of interest to note that hypochlorin makes its appearance at the later stages of germination in seedlings of various species of Pinus which have grown in the dark, inasmuch as it has long been known that these plants become green in darkness.

This paper cannot be regarded as other than a most important contribution to our knowledge of the physiology of plants, and it will be readily admitted that Prof. Pringsheim's theory of the function of chlorophyll is at least as satisfactory as any which are now current. But although the number of facts upon which the theory is based is large, yet the evidence in favour of it can hardly be considered to be complete at present; there are certain points which require further elucidation. For instance, Prof. Pringsheim regards the chlorophyll of a corpuscle as undergoing no change under ordinary circumstances, but it is difficult to reconcile this view with the fact that an alcoholic solution of chlorophyll loses its colour under the same circumstances. Then again, as to the source of the reducing energy in the process of assimilation, if the rays absorbed by the chlorophyll are not directly concerned in it, it is most desirable that more information should be obtained as to the nature of the rays which are active, and as to the particular cell-contents which absorb them. Further, the correctness of the principle that an increase in the intensity of light to which a cell is exposed produces an increase of its respiratory activity, needs more direct and general experimental confirmation than is given here. In his views as to the respiratory function, he appears to insist too strongly that the chlorophyll-corpuscles are to be regarded not only as assimilatory, but also as respiratory organs. It is not easy to see that any of the observations which he gives in this paper directly suggest such a view; on the contrary, they tend rather to show that exposure to intense light increases oxidation in the *whole* of the protoplasmic cell-contents. Prof. Pringsheim evidently desires to bring out that hypochlorin is *the* substance which undergoes oxidation in the cell, and since it is present exclusively or nearly exclusively in the chlorophyll-corpuscles, he considers that these bodies are the especial seats of the respiratory process. His observations, however, do not warrant this conclusion; what they prove is that the hypochlorin in the chlorophyll-corpuscles is oxidised when they are exposed to intense light in an atmosphere containing oxygen, and that certain changes (including a loss of substance) take place in the rest of the protoplasm, in consequence, doubtless, of the excessive oxidation of some substance or substances which it contains. His view may be fairly met with the *à priori* objection that it is highly improbable that the same organ should be the seat of two such opposite functions as respiration and assimilation. The true physiological significance of the chlorophyll-corpuscles becomes apparent when it is borne in mind that assimilation does not take place in cells which do not possess them, whereas respiration proceeds actively, perhaps most actively, in such cells.

And, finally, as to hypochlorin, it is to be hoped that a method will be devised for the extraction of this substance in such quantities as to allow its properties to be studied and its chemical composition to be ascertained. The curious fact that hypochlorin cannot be detected in plants which are not distinctly green (Diatomaceæ, Fucaceæ, &c.), is worthy of further investigation.

These desiderata may perhaps be supplied in the future publications on this subject which Prof. Pringsheim promises.

SYDNEY H. VINES

NOTES

WE take the following from the *Times*:—At their meeting last week the President and Council of the Royal Society selected, from the whole number of fifty-two candidates for the fellowship, the following fifteen to be recommended to the Society for election at the annual meeting on June 2 next:—W. E. Ayrton, H. W. Bates, J. S. Bristowe, W. H. M. Christie, G. Dickie, A. B. Kempe, A. Macalister, H. McLeod, J. A. Phillips, W. H. Preece, B. Samuelson, M.P., B. B. Stoney, R. H. Traquair, Rev. H. W. Watson, C. R. A. Wright.

A *conversazione* of the Society of Telegraph Engineers was held in honour of Prof. Helmholtz in the rooms of University College on Monday night. Among those who were present to meet the guest of the evening were many eminent English men of science. Many of the members of the Society and other had lent instruments and apparatus showing some of the purposes to which electricity has recently been applied, and also the means by which electrical research is still being carried on. On entering the College grounds the visitors saw a very pretty effect caused by one of Mr. Crompton's electric lights, which had been placed on the top of the portico. The reception-room itself was lit up with little incandescent electric lamps on Mr. Swan's principle. They were arranged in bunches of three or four in ground glass globes suspended from the ceiling, and in fact at first sight they looked like very brilliant gas-burners, no wires being visible. On each side and down the centre of the room were placed tables on which were arrayed all the newest inventions in electrical science. On one it was demonstrated how perfectly easy it was to manage Mr. Swan's lamps; taking one lamp out of the stand and putting in a new one occupying only a few seconds, there being no binding-screws or switches to attend to. Perhaps the most interesting experiment of the evening was the transmission of pictures of natural objects by telegraph, the picture of a butterfly being most beautifully transmitted by means of a selenium plate. This was shown by Mr. Shelford Bidwell's telephotographic machine. Mr. Latimer Clark exhibited some rare books on electricity and magnetism, autographs and portraits of eminent electricians; also a portion of the original telegraph line which was laid by the late Sir Francis Ronalds in 1816, with the original model of Ronalds' telegraph, the original type cast for the Morse telegraph, with autograph of Prof. Morse, and a portion of line laid by W. F. Cooke in 1837. Mr. Cotterell of the Royal Institution exhibited a very delicate mercury electrometer on Lippman's principle, belonging to Prof. Dewar; and Mr. Robert Sabine performed some pretty experiments illustrating the cause of the motion of the mercury. Mr. Stroh showed the beautiful apparatus made by him to illustrate Prof. Helmholtz's vowel theory, and Mr. Preece performed several experiments in explanation of the remarkable sounds produced by intermittent light on solid, liquid, and gaseous matter. Mr. George Lund, of the firm of Messrs. Lund and Blockley, exhibited some synchronous clocks for the London, Chatham, and Dover Railway Company for coupling up two ordinary telegraph lines at 10 a.m., in order to send the time current. They also applied to the clock a novel automatic arrangement of their own invention, by which, at two minutes to 10 a.m. daily, the current will ring a warning bell, couple up and block against false currents two ordinary telegraph wires, then at 10 a.m. the clock sends the time-current of two seconds' duration, giving time to the clocks in circuit. Immediately upon the termination of the two seconds' current the lines will be automatically re-established as distinct lines for their ordinary telegraph purposes. All present were pleased to have the opportunity of inspecting Prof. Kennedy's engineering laboratory, where the machine for testing the strength of materials up to fifty tons was seen in operation, and various pieces of brass and copper were tested. The machine-tools were in operation, and a steam-engine of peculiar construction driving them. We look forward with interest to the scientific results we may expect to be brought to light with the testing-machine. The President (Prof. Carey Foster) showed some interesting electrical instruments; Mr. Richard Anderson a portable galvanometer for testing lightning-conductors; Professors Ayrton and Perry a variety of apparatus, as also Siemens Brothers, Newall and Co., and others. Prof. Helmholtz ended on Tuesday his visit to London, and went with Mr. Spottiswoode, president of the Royal Society, to his country house at Coombe Bank, Sevenoaks. From thence he proceeds to Dublin to receive an honorary doctor's degree from the University of that city.

THE National Fisheries Exhibition will be opened at Norwich by the Prince of Wales on the 18th inst. The delay in opening it has been caused by the necessity for enlarging the space to admit of satisfying the numerous applications that have poured in. Every point connected with the growth and nurture of fish, the modes of capturing them, the condition of the fishermen will be illustrated. The aquatic fauna of Norfolk and Suffolk will be a special feature, as also fish-eating birds. The Earl of Ducie, Viscount Powerscourt, Lord Lovat, Mr. Spencer Walpole, and Prof. Huxley, H.M. Inspectors of Fisheries; and Mr. Calcraft, Permanent Secretary to the Board of Trade, have been appointed by the Home Secretary to act as Her Majesty's Commissioners. In addition to a large number of special money prizes, Government gold, silver, and bronze medals, diplomas of honour, will be awarded by the jurors. Prof. Huxley will give an address on the occasion.

MUSEUM No. 1 in the Royal Gardens, Kew, will be reopened to the public on Easter Monday, after being closed during the winter. It has been enlarged by the addition of a new wing, terminating in a wide staircase with ascending and descending flights. The expense has been borne by the India Office in consideration of the maintenance at Kew of the botanico-economical collections recently forming part of the India Museum. The whole collections have been entirely re-arranged by the curator, Mr. John Jackson, A.L.S. On the staircase has been placed a large painted window, presented to the museum by Alderman W. J. R. Cotton, M.P. This window represents the successive stages of cotton cultivation and manufacture. Amongst other recent additions to the museum may be mentioned a series of models of farm and garden vegetables prepared and presented by Messrs. Sutton of Reading; a collection formed by Col. Pearson, who has charge of the Indian forest-students at Nancy, of the various objects manufactured in France from native-grown woods; a further series of vegetable products and manufactured articles, collected in Afghanistan by Surgeon-Major Aitchison. The collection of portraits of botanists has also been much enlarged and re-arranged. An oil portrait of Thomas Andrew Knight, F.R.S., well known for his classical researches in vegetable physiology, has been presented on behalf of the family by Sir Charles Rouse Boughton, Bart.

THE President of the United States of America has notified to the French Government his intention of appointing a special commission to preside over the arrangement of the American Section at the Electrical Exhibition. A number of commissioners have been already selected for the purpose. M. Philippart has written to M. Berger, placing at his disposal a sum of 4000*l.* for the best system presented of transporting electric force at a distance.

ON Sunday week a deputation composed of eminent representatives of French science waited upon the venerable M. Milne-Edwards to present him with a medal in commemoration of the completion of the great naturalist's work on Comparative Physiology and Anatomy. Warm congratulatory addresses were made by MM. Quatrefages, Blanchard, and Dumas, the last speaking of himself as the oldest of M. Milne-Edward's friends. In thanking the deputation the recipient of this well-earned honour was naturally much moved.

ON March 26, in presence of the Minister of the Interior, the Commission of the Observatory, several State functionaries and men of science, there were repeated at the Brussels Observatory experiments with Van Rysselberghes' telemeteorograph, which prove that the registration of the meteorological elements by this instrument may be made automatically at very great distances (several hundred kilometres). The author explained to the Minister a plan of International Telemeteorography, the realisation of which would be of the greatest utility for the scientific study of the atmosphere, and which would render possible the prevision of the weather.

THE destruction caused by the Chios earthquake has been even greater than we stated last week. The Constantinople Correspondent of the *Daily News* sends some interesting particulars: The temperature on the 3rd was heavy and oppressive, and the horizon was broken by broad flashes of light that seemed to denote a coming storm. In all this atmospheric disturbance however the inhabitants saw nothing extraordinary, and were far from being alarmed by what they fancied would result in a thunderstorm. At ten minutes to two in the afternoon a terrific shock was felt, bringing three-fourths of the houses in the town to the ground like so many packs of cards, and burying a thousand persons under the falling ruins. Then commenced a fearful scene of horror. The ground rocked and danced, kneading the ruin already formed into an unrecognisable mass of stone. The survivors ran hither and thither, not knowing where to flee to escape the horrible fate that menaced them, and were tossed and flung about by the heaving earth, like feathers in a breeze. Even those who gained the open country were by no means safe. The earthquake attacked not only the towns and villages, but worked its ravages in the hills and mountains of the island. Enormous masses of rock and earth came rushing down the hill-sides, carrying all before them, bounding far into the plains, and tearing roads in the solid rocks of the mountain such as might have been formed by a torrent a thousand years old. The town presented a pitiable spectacle. Great fissures and crevices yawned in the streets, walls were falling with a crashing report, and entire buildings crumbled in fragments to the ground. In many places whole streets had disappeared, and it was hard to say where the different well-known buildings had stood. The ground still heaved and tossed, bringing fresh buildings to the ground at every moment, and hurrying innumerable victims to destruction. It is impossible to say what the number of victims would have been if a second shock had not displaced the ruins formed by the first and thus permitted thousands of sufferers to escape or to be rescued by others from the horrible imprisonment to which they had been condemned. All the fissures and crevices run from east to west. In the country the effects of the horrible upheaval have been even more terrible than in the town. The shocks are now, April 8, diminishing. In all there were counted 250 since the first three awful upheavals which destroyed the greater part of the island. A telegram of the 12th states that earthquake shocks of considerable violence have recommenced in Chios, and it is estimated that barely twenty houses now remain habitable in the whole island. Forty-five villages have been totally destroyed, and in many localities the population has absolutely disappeared.

SOME slight shocks of earthquake were felt on the morning of the 5th inst. at San Cristobal, Cuba. A violent shock was felt at two o'clock on Sunday morning throughout the centre of California. Earthquakes were reported from South Hungary on Wednesday last week.

THE *Daily News* Naples correspondent, telegraphing on the 6th, states that Mount Vesuvius was displaying greater activity. Abundant streams of lava were descending northwards, and great numbers of smoke fissures had opened round the crater, some at 100 metres distance from the centre of eruption.

PROF. C. V. RILEY has just published, in the Second Report of the United States Entomological Commission, "Further Facts about the Natural Enemies of Locusts," meaning, of course, by the latter term, the Rocky Mountain pest in particular. His observations entirely concern insect parasites. The most interesting are on the habits of two species of *Diptera*, allied to *Bombylius*, the larvæ of which feed on the eggs of "locusts." The plate (xvi.) illustrating the subject is above praise, not only on account of the scientific accuracy shown in the drawings (which are by the author), but also as regards the reproduction of them by the "lithocaustic" process adopted by a Baltimore firm. We have seen other plates of entomological subjects emanating from the same firm, and the impression formed on our mind is that no other process is equally adapted for the purpose. Why cannot some of our own enterprising "lithographers" produce the same result?

THE following are the lecture arrangements after Easter, at the Royal Institution:—Prof. Dewar, M.A., F.R.S., six lectures on the Non-Metallic Elements, on Tuesdays, April 26 to May 31; Prof. Tyndall, D.C.L., F.R.S., six lectures on Paramagnetism and Diamagnetism, on Thursdays, April 28 to June 2; Prof. H. Morley, three lectures on Scotland's Part in English Literature, on Saturdays, April 30, May 7, 14; one lecture on Thomas Carlyle, on Tuesday, June 7; Mr. E. C. Turner, Lector at the University of St. Petersburg, five lectures on the Great Modern Writers of Russia, on Saturdays, May 21, 28, June 4, Thursday, June 9, and Saturday, June 11. The Friday evening meetings will be resumed on April 29, at 8 p.m. Prof. J. S. Blackie, F.R.S.E., will give a discourse on "The Language and Literature of the Scottish Highlands," at 9 p.m. Succeeding discourses will probably be given by the Hon. G. C. Brodrick, Mr. Francis Galton, Mr. W. H. Pollock, Prof. H. E. Roscoe, Prof. W. G. Adams, and Prof. Dewar.

THE usual course of Mayfair Lectures will commence, under the auspices of the National Health Society, on Friday, April 22, at 23, Hertford Street, Mayfair. The list of lecturers will this year include the names of Dr. Siemens, F.R.S., Dr. Robert Farquharson, M.P., and Prof. Fleeming Jenkin.

WE are glad to find from an announcement in the current number of the *Quarterly Journal of Microscopical Science* that Dr. C. T. Hudson, of Manilla Hall, Bristol, is preparing a volume for the Ray Society on the "British Rotifers." Dr. Hudson is known not only for his numerous contributions to our knowledge of this group, but especially for his discovery and excellent illustrations of one of the most important members of the group (Pedalion). Dr. Hudson will have the advantage of the use of Mr. P. H. Gorse's beautiful drawings of Rotifers, which that observer has placed at his disposal.

A LARGE party of the Members of the Geologists' Association were on Saturday last conducted through the Geological Department of the British Museum (Natural History), South Kensington, by Dr. Henry Woodward, F.R.S., &c., the Keeper of that Department.

Apropos of the meeting of the French Association at Algiers the *Revue Scientifique* for April 9 devotes most of its space to a series of articles on Algeria, its colonisation, statistics, botany, anthropology, hygiene, and zoology.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. R. J. Short; a Common Paradoxure (*Paradoxurus typus*), from India, presented by Mr. C. W. C. Fletcher; a Viverrine Cat (*Felis viverrina*) from India, presented by Major C. R. Oxley; two Squirrel-like Phalangers (*Belideus sciureus*) from Australia, presented by Mr. D. W. Barker; three Paradise Whydah Birds (*Vidua paradisea*), a Pintailed Whydah Bird (*Vidua principalis*), a Red-shouldered Weaver Bird (*Urobrachya axillaris*), a Red-beaked Weaver Bird (*Quelea sanguinirostris*), a Wiener's Finch (*Pytelia wieneri*), two Yellow-rumped Seed-Eaters (*Crithagra chrysopyga*) from Mozambique, presented by Mr. Maurice C. Angel, F.Z.S.; two Laughing Kingfishers (*Dacelo gigantea*) from Australia, presented by Mr. Edward Trelawny; an Alexandrine Parrakeet (*Palæornis alexandri*) from India, presented by Mr. Henry Day; a Common Gannet (*Sula bassana*), British, presented by Mr. G. Randall; a Common Marmoset (*Hapale jacchus*) from South America, deposited; an Indian Chevrotain (*Tragulus meminna*) from India, six Weeper Capuchins (*Cebus capucinus*) from Brazil, four Chestnut-eared Finches (*Amadina castanotis*) from Australia, three Common Crowned Pigeons (*Goura coronata*) from New Guinea, an American Tantalus (*Tantalus loculator*) from South America, purchased; two Sclater's Curassows (*Crax sclateri* ♂ ♀) from South America, on approval; an Indian Darter (*Plotus melanogaster*) from India, received in exchange.

GEOGRAPHICAL NOTES

THE Royal Medals of the Geographical Society have this week been awarded as follows:—The Founder's Medal to Major Serpa Pinto, "for his remarkable journey across Africa, from Benguela to Natal, during which he explored nearly 500 miles of new country, defined the fluvial systems of the southern slopes of the Benguelan Highlands, and fixed the position of numerous places by a series of astronomical observations; also for the admirable account of his journey, now in course of publication in London, containing numerous original maps, tables of observations, and a large amount of valuable and exact information regarding the African interior;" and the Patron's Medal to Mr. Benjamin Leigh Smith, for his discoveries on the south coast of Franz-Josef Land during last summer, as well as for his previous expeditions along the north-east land of Spitzbergen.

AT the meeting of the Geographical Society on Monday last Mr. R. N. Cust read a paper by Col. Tanner on Kafiristan and the Siah-posh Kafirs of the Hindu Kush. The paper, which was hardly a geographical one in any sense, dealt chiefly with the inhabitants of the Valley of Dara Nur and the Chugan tribe, and to a less extent with the Kafirs, who are called "Siah-posh" from their wearing black clothes, and furnished some very interesting information regarding their manners and customs. Some philological notes had also been sent by Col. Tanner, but these will be communicated to the Asiatic Society. Some of the more striking passages in Col. Tanner's notes, if we remember rightly, were read at the Swansea meeting of the British Association. As much interest attaches to Kafiristan and the Kafirs, and the results expected from Col. Tanner's expedition were so eagerly looked forward to, it was rather disappointing to be told by Col. Yule that we have even now learned no more than was buried in the record of a Jesuit Missionary's travels some 200 years ago. No doubt had his health not failed at the critical moment, and compelled him to return to India, Col. Tanner would have succeeded in penetrating into Kafiristan itself, and collected valuable geographical information.

THE Society formed at Milan for commercial exploration in Africa is showing increased activity, and has despatched another expedition to Tripoli, under the command of Capt. Camperio, who is accompanied by Signor Cingia, an ex-cavalry officer. The principal objects of this expedition are the exploration of the Gulf of Bomba, and it will particularly examine the ports of Tobruck and Derna, not far from the Egyptian frontier. Capt. Camperio will afterwards make an attempt to penetrate into the interior of the oasis of Jazabud, in order to open commercial relations with its inhabitants.

WE are glad to learn that there is good hope that Col. Flatters and many of his followers, who were reported to have been massacred by the Touaregs, are still alive, though probably retained as prisoners.

DOCTORS SCHWEINFURTH AND RIEBECK, who have been travelling in Egypt, left Cairo last month to explore the island of Socotra. They do not seem to be aware that quite recently

Prof. I. B. Balfour visited the island on behalf of our Zoological Society.

THE April number of *Petermann's Mittheilungen* has a long article, with map, on Mr. A. Forrest's expedition through North-West Australia in 1879; Herr Clemens Denhardt continues his paper on Researches in Equatorial East Africa; Herr F. v. Stein gives details on the new French land fortifications, with map, and there are several interesting letters from Dr. Junker, on his experiences in the Niam-Niam country.

No. 2, for 1880, of the *Bulletin* of the American Geographical Society contains an unusually interesting paper by Prof. J. B. M'Master, of Princeton College, on the Bad Lands of Wyoming, in which he endeavours to trace out their geological history; Mr. B. R. Curtis describes his journey round the world; and there is a historical article on Arctic Exploration by the Rev. B. F. De Costa.

THE *Bulletin* of the Antwerp Geographical Society (tome v. fasc. 6) contains a paper of considerable value by the Abbé van den Gheyn, on the present state of research with regard to the primitive cradle of the Aryan race. M. A. Baquet contributes a paper on the fauna and the chace in the countries of South America watered by the Paraguay and the Parana.

CHEMICAL NOTES

B. HEINDL has recently made investigations into the compounds of calcium chloride with ethyl alcohol, isobutyl alcohol, and amyl alcohol, and has obtained the following formulæ:—

$CaCl_2 . 3(C_2H_6O)$; $CaCl_2 . 3(C_4H_{10}O)$; and $CaCl_2 . 3(C_5H_{12}O)$.

IN continuation of his investigation of the action of hydrochloric acid on metallic chlorides, already referred to in these notes, M. Ditté describes several new compounds of this acid with mercuric chloride, viz.,

$$2HgCl_2 . 4HCl . 7H_2O : 3HgCl_2 . 4HCl . 7H_2O :$$
$$2HgCl_2 . HCl . 6H_2O : 4HgCl_2 . 2HCl . 9H_2O : \quad \text{and}$$
$$3HgCl . HCl . 5H_2O.$$

MM. FOUQUÉ AND LÉVY describe (in *Compt. rend.*) the artificial preparation of the basaltic minerals peridote and labradorite, by prolonged heating of a homogeneous mixture of the constituents of a basalt rich in olivine.

DR. A. R. LEEDS has recently examined the action of nitrogen tetroxide—N_2O_4—on various hydrocarbons (*Journ.* of American Chem. Soc.). The results are interesting, and promise to be even more so. Benzene, when acted on by N_2O_4 yields mono-nitro-benzene, picric acid and oxalic acid; two other compounds were also obtained, but under conditions which have not been successfully realised a second time. One of these the author calls monoxy-benzene—C_6H_4O—an isomer or metamer of quinone; the other has not been purified. Naphthalene yields mononitro-naphthalene, α and β dinitro-naphthalene, and two compounds which, so far as they have been examined, appear to be napthodiquinone, $C_{10}H_4O_4$, and tetroxy-naphthalene, $C_{10}H_8O_4$. The products of the action of nitrogen tetroxide on cymene are chiefly α nitrocymene (probably also a dinitro derivative) and paratoluic acid.

THE American Chem. Soc. *Journal* (vol. i. Nos. 11 and 12) contains an interesting historical sketch of the lines of discovery of ozone, and of peroxide of hydrogen, by Dr. A. R. Leeds; to these papers is added a full list of references to all publications on ozone and hydrogen peroxide; the ozone references occupy thirty-two pages, and the hydrogen peroxide, ten pages.

AN important paper by M. Étard—important both by reason of the results obtained and because of the natnre of the problem attacked—on the oxidising action of chromyl dichloride, appears in *Annales Chim. et Phys.* for February. M. Étard has studied the mechanism, so to speak, of the chemical changes which occur when chromyl dichloride acts as an oxidiser; he finds that in the case of the hydrocarbons containing methyl groups attached to an "aromatic" nucleus the methyl groups are transformed into the aldehydic group (COH), and that when the aromatic nuclei are themselves attacked, quinones are produced. The chromyl dichloride forms compounds with the aromatic hydrocarbons, which may be formulated as $X . 2CrO_2Cl_2$ (where X = hydrocarbon): these compounds are then decomposed by water, and yield the products already mentioned.

IN the same journal there is a lengthy and interesting paper by M. W. Spring on the effects of great pressure on solid bodies. It is shown in this paper—which is chiefly physical—that the particles of crystalline bodies tend to solder themselves closely together at high pressures, the effect of pressure being analogous to that of fusion; and that amorphous bodies may be divided into two classes, viz. those which behave similarly with crystalline bodies, and those which are not thus affected by high pressures.

THE influence of pressure on chemical changes is also considered, and it is shown that as a general rule a chemical change which results in the production of a system the volume of which is less than the volume of the initial system, may be brought about by subjecting the initial system to great pressure, but that if the change involves an increase of volume, pressure alone does not cause the change to proceed.

M. BRAME describes (in *Compt. rend.*) experiments on animals with pure hydrocyanic acid, the results of which seem to show that the bodies of animals killed by this acid (pure) do not undergo decomposition even when kept for a month; that the acid remains during that time in the animal tissues, and notably in the stomach, and that the acid is readily obtained by distillation from the tissues of a herbivorous, but much less readily from those of a carnivorous animal.

IN continuing his researches on chemical affinity Herr Ostwald (*Journ. für pract. Chem.*) has made the remarkable observation that while the solvent action of polybasic acids on salts is diminished by the presence of the normal salts of the acids employed, the solvent action of monobasic acids is considerably increased by the presence of the normal salts of these acids. In his third paper Herr Ostwald gives a large series of measurements which show that the solvent action of free nitric or hydrochloric acid on calcium or zinc oxalate is increased by addition of potassium, sodium, ammonium, or magnesium nitrate or chloride. The solvent action increases proportionally to the increase in the quantity of normal salt added. Ostwald confesses that he can as yet give no thoroughly satisfactory explanation of this phenomenon; the explanation which appears at present most probable involves the assumption that there is a slight chemical action between the normal salt (potassium nitrate, &c.) and the salt which is being dissolved by the acid (calcium or zinc oxalate): this small chemical change alters the "stability" of the whole system, and so increases the amount of the primary change, *i.e.* solution of calcium oxalate, &c., in a given time.

FROM thermochemical data J. Thomsen regards the generally accepted formula for benzene as incorrect. The number obtained by him for the heat of combustion of benzene (805,800 thermal units) agrees fairly well with that calculated (800,400), on the assumption that all the carbon atoms in benzene are "singly-linked." The heat of combustion of the metamer of benzene, viz. dipropargyl, is, according to Berthelot, 853,600 units; Thomsen's caculations, assuming the formula

$$HC{\equiv}C{-}CH_2{-}CH_2{-}C{\equiv}CH$$

to be correct, give the number 888,400. The formula above given for dipropargyl is therefore probably correct.

IN the last number of the German Chemical Society's *Berichte* are published some recent observations on dipropargyl by Henry, the discoverer of this curious compound. He describes, but not yet in any detail, a solid polymer produced by the action of heat on dipropargyl. He also describes the tetriodide $C_6H_6I_4$, and the octobromide $C_6H_6Br_8$.

THE arguments in favour of the number 240 being adopted as the atomic weight of uranium have been strengthened by the preparation by C. Zimmermann (*Berliner Berichte*) of the normal uranate of lithium, Li_2UO_4, analogous with the normal chromates, tungstates, and molybdates.

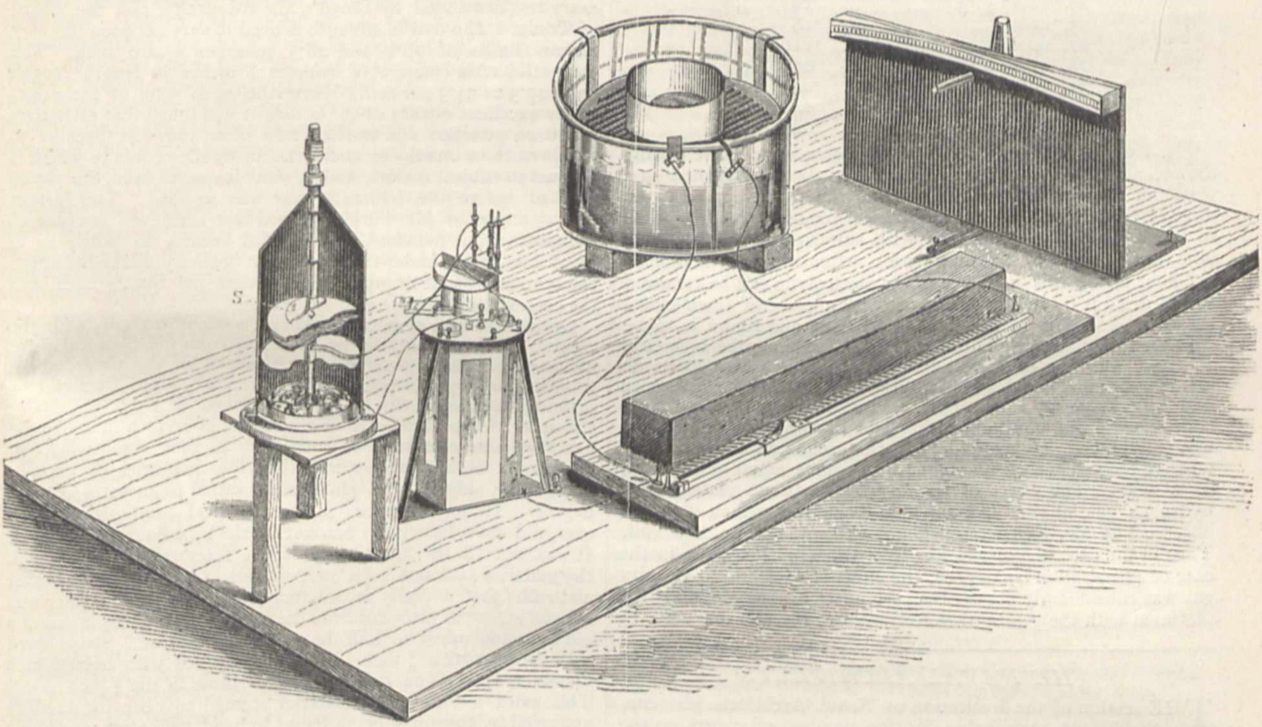
IN the *Chem. Soc. Journ.* for March, Dr. Ramsay continues his investigations on atomic and molecular volumes; he adduces evidence in support of the number 7 as representing the atomic volume of nitrogen; the generally-accepted number is 2·3. He also shows that the molecular volumes of compounds of the benzene, naphthalene, and anthracene series are smaller than those calculated from the best established atomic volumes of the constituent elements, and his numbers suggest that the condensation in these compounds may very probably be proportional to the number of carbon atoms in each molecule, and also to the manner of "linking" of these atoms.

ON A METHOD OF MEASURING CONTACT ELECTRICITY[1]

IN my reprint of papers on electrostatics and magnetism (§ 400, of date January, 1862) I described briefly this method, in connection with a new physical principle, for exhibiting contact electricity by means of copper and zinc quadrants substituted for the uniform brass quadrants of my quadrant electrometer. I had used the same method, but with movable disks for the contact electricity, after the method of Volta, and my own quadrant electrometer substituted for the gold-leaf electroscope by which Volta himself obtained his electric indications, in an extensive series of experiments which I made in the years 1859-61.

I was on the point of transmitting to the Royal Society a paper which I had written describing these experiments, and which I still have in manuscript, when I found a paper by Hankel in Poggendorff's *Annalen* for January, 1862, in which results altogether in accordance with my own were given, and I withheld my paper till I might be able not merely to describe a new method, but if possible add something to the valuable information regarding properties of matter to be found in Hankel's paper. I have made many experiments from time to time since 1861 by the same method; but have obtained results merely confirmatory of what had been published by Pfaff in 1820 or 1821, showing the phenomena of contact electricity to be independent of the surrounding gas, and agreeing in the main with the numerical values of the contact differences of different metals which Hankel had published; and I have therefore hitherto published nothing except the slight statements regarding contact electricity which appear in my "Electrostatics and Magnetism." As interest has been recently revived in the subject of contact electricity, the following description of my method may possibly prove useful to experimenters. The same method has been used to very good effect, but with a Bohnenberger electroscope instead of my quadrant electrometer, in researches on contact electricity by Mr. H. Pellat, described in the *Journal de Physique* for May 1880.

The apparatus used in these experiments was designed to secure the following conditions:—To support two circular disks of metal about four inches in diameter in such a way that the opposing surfaces should be exactly parallel to each other and approximately horizontal, and that the distance between them might be varied at pleasure from a shortest distance of about one-fiftieth of an inch to about a quarter or half an inch. This part of the apparatus I have called a "Volta-condenser." The lower plate, which was the insulated one, was fixed on a glass



stem rising from the centre of a cast-iron sole plate. The upper plate was suspended by a chain to the lower end of a brass rod sliding through a steadying socket in the upper part of the case. A stout brass flange fixed to the lower end of this rod bears three screws, one of which, S, is shown in the drawing, by which the upper plate can be adjusted to parallelism to the lower plate. The other apparatus used consisted of a quadrant electrometer, and in my original experiments an ordinary Daniell's cell, in my later ones a gravity Daniell's cell of the form which I described in *Proc.* R.S. 1871 (pp. 253-259) with a divider by which any integral number of per cents. from 0 to 100 of the electromotive force of the cell could be established between any two mutually insulated homogeneous metals in the apparatus.

Connections.—The insulated plate was connected by a brass wire passing through the case of the Volta-condenser to the electrode of the insulated pair of quadrants. The upper plate was connected to the metal case of the Volta-condenser and to the metal case of the electrometer, one pair of quadrants of which were also connected to the case. One of the terminals of the divider, which connected the poles of the cell, was connected to the case of the electrometer, and to the other terminal was attached one of the contact wires, which was a length of insulated copper wire having soldered to its outer end a short piece of platinum. The other contact surface was a similar short piece of platinum fixed to the insulated electrode of the electrometer. Hence it will be seen that metallic connection between the two plates was effected by putting the divider at zero and bringing into contact the two pieces of platinum wire.

Order of Experiment.—The sliding piece of the divider was put to zero, and contact made and broken and the upper plate raised: then the deflection of the spot of light was observed. These operations were repeated with the sliding piece at different numbers on the divider scale until one was found at which the make-break and separation caused no perceptible deflection. The number thus found on the divider scale was the number of per cents. which was equal to the contact electric difference of the plates in the Volta-condenser.

[*Addendum*, November 23, 1880.—Since the communication of this paper to the British Association, I have found that a dry platinum disk, kept for some time in dry hydrogen gas, and then put into its position in dry atmospheric air in the Volta-condenser, becomes positive to another platinum disk

[1] By Prof. Sir William Thomson, M.A., F.R.S.; being a paper read before Section A of the British Association at Swansea, 1880, with additions.

which had not been so treated, but had simply been left undisturbed in the apparatus. The positive quality thus produced by the hydrogen diminishes gradually, and becomes insensible after two or three days.]

P.S.—On December 24, 1880, one of two platinum plates in the Volta-condenser was taken out; placed in dried oxygen gas for forty-five minutes; taken out, carried by hand, and replaced in the Volta-condenser at 12.30 on that day. It was then found to be negative to the platinum plate, which had been left undisturbed. The amount of the difference was about ·33 of a volt. The plates were left undisturbed for seventeen minutes in the condenser; and were then tested again, and the difference was found to have fallen to ·29 of a volt. At noon on the 25th they were again tested, and the difference found to be ·18. The differences had been tested from time to time since that day, the plates having been left in the condenser undisturbed in the intervals. The following Table shows the whole series of these results:—

Time.	Electric difference between surfaces of a platinum plate in natural condition, and a platinum plate after 45 minutes' exposure to dry oxygen gas.
Dec. 24, 12.30 p.m.	·33 of a volt.
24, 12.47 p.m.	·29 "
25, noon	·18 "
27, noon	·116 "
28, 11.20 a.m.	·097 "
31, noon	·047 "
Jan. 4, 11.0 a.m.	·042 "
11, 11.40 a.m.	·020 "

Mr. Rennie, by whom these experiments were made during the recent Christmas holidays, had previously experimented on a platinum plate which had been made the positive pole in an electrolytic cell with an electromotive force of one volt, tending to decompose water acidulated with sulphuric acid; the other pole being a piece of platinum wire. After the plate had been one hour under this influence in the electrolytic cell he removed it, and dried it by lightly rubbing it with a piece of linen cloth. He then placed it in the Volta-condenser, and found it to be negative to a platinum plate in ordinary condition; the difference observed was ·27 of a volt. This experiment was made on October 21; and on November 8 it was found that the difference had fallen from ·27 to ·07. Mr. Rennie also made similar experiments with the platinum disk made the negative pole in an electrolytic cell, and found that this rendered the platinum positive to undisturbed platinum to a degree equal to about ·04 of a volt. The effect of soaking the platinum plate in dry hydrogen gas, alluded to in my first postscript, which also was observed by Mr. Rennie, was found to be about ·11 of a volt. Thus in the case of polarisation by hydrogen, as well as in the case of polarisation by oxygen, the effect of exposure to the dry gas was considerably greater than the effect of electro-plating the platinum with the gas by the electromotive force of one volt.

THE NAVAL ARCHITECTS

THE session of the Institution of Naval Architects just concluded was remarkable for the number of papers on the use of steel both for shipbuilding and marine engineering. This was perhaps to be expected in consequence of the commotion among steel-users caused by the total failure of the steel plates supplied for the boilers of the Russian yacht *Livadia*. Accordingly we find four papers on this subject. The first, by Mr. Samuda, deals with the effect which the introduction of steel hulls and steel-faced armour has had upon the design of ships of war. This paper is based upon the results attained by the author with a steel corvette which he has recently constructed for the Argentine Government. The dimensions of this vessel as actually constructed, and the corresponding dimensions which must of necessity have been adopted, had the material of construction been iron instead of steel, should be carefully noted in order to appreciate the true benefits to be derived from the use of the latter material.

The vessel as actually constructed is 240 feet long by 50 feet wide; the displacement is 4200 tons, the power 4500 horses, and the coal-supply 650 tons, which is sufficient to allow her to steam 6000 miles at a speed of 8 knots, or 4300 miles at a speed of 10 knots. The speed which it is expected will be attained on the measured mile is 13¾ knots. If the vessel had been built of iron and cased with iron armour, the speed and shot-resisting power remaining the same, the dimensions would have been as follows:—Length, 260 feet; breadth, 55 feet; displacement, 5200 tons; power, 5000 horses; and coal-supply, 720 tons. This example is a very good illustration of the great benefit which naval architects will derive from the use of steel, a benefit, be it remarked, which comes most opportunely in these days of powerful ordnance; for not only has the steel-faced armour about 25 per cent. more resisting power than an equal thickness of iron, but also the weight saved in the hull and machinery by the use of steel enables a greater quantity of armour to be carried.

The second paper on steel was by Mr. W. Parker, Chief Engineer Surveyor to Lloyd's Registry, "On the Causes of the Failure of the Steel Plates supplied for the Boilers of the *Livadia*." Steel, as is well known, had formerly a bad reputation for treachery and uncertainty of behaviour. Latterly however a more intimate knowledge of the methods of manufacture and a better acquaintance with the processes of working had apparently quite removed this impediment to its general introduction. The failure therefore above referred to came as a surprise to shipbuilders, and the circumstances demanded and received a most searching inquiry at the hands of the engineer officers of Lloyd's. It was found that samples cut from the broken plates fulfilled every test demanded by Lloyd's, the Admiralty, and the Board of Trade. The tensile strength proved to vary between the very narrow limits of 26·1 and 28·3 tons per square inch. The elongation after fracture of samples 8 inches in length ranged from 27·3 to 34·3 per cent. Nevertheless in spite of the apparently excellent quality of the plates, it was found that after they had been punched and worked into place they had become so brittle as to be unable to stand the hydraulic proofs to which it is usual to subject boilers, and in some instances even, the plates cracked before the hydraulic test was applied. The further investigations of Mr. Parker proved that whenever samples of the plates were punched, the material became so brittle as to break into pieces under the blow of an ordinary sledge-hammer; the tensile strength dropped to 18·4 tons per square inch, and the extensibility disappeared altogether.

Specimens were next subjected to chemical analysis, with the result of proving that, the material was from the chemical point of view far from homogeneous. A portion of the plates, about 8 inches long by 4 inches wide, was carefully freed from rust by grinding, and successive layers were planed off from one side to the other. Each layer was one-sixteenth of an inch in thickness, and they were numbered in succession as they were planed off. The result of analysis showed that the quantities of carbon, manganese, sulphur, and phosphorus varied in an extraordinary degree. . These differences in the chemical composition, however, did not satisfactorily account for the behaviour of the metal. It was not till the appearance of the fractures suggested, that the material had not been properly worked under the hammer and rolls, that a really satisfactory solution of the mystery was arrived at. "A piece cut from the fractured plate was raised to a red heat and rolled to half its original thickness. Strips were then cut from this ⅜-inch plate, and punched with holes ½ inch diameter, being one half the size of those in the ¾-inch plate. This extra work on the material seemed to raise its ductility appreciably, the strips being found to bend well after punching, several of them bending to right angles, and only one of them breaking short off, while none of them showed such extraordinary signs of brittleness as were observable in the material when of the original thickness. Three pieces tested for tensile strength after rolling broke under a stress of 33 tons, 34·25 tons, and 32·3 tons per square inch respectively, with an elongation in 8 inches of 12 per cent., 11·25 per cent., and 17·5 per cent. respectively, the last-mentioned specimen being annealed."

Mr. Parker concludes his paper by expressing the hope that the facts which he was able to lay before the meeting will tend to allay alarm and to strengthen confidence in the use of mild steel for constructive purposes. When it is considered what an enormous quantity of this material is now being used in the construction of marine boilers, as well as for the hulls of vessels, this wish will be heartily re-echoed. In the spring of 1878 there were only two marine boilers of the modern form made of mild steel in existence. Within twelve months subsequently to that date 120 steamers had been fitted with boilers of this material, and during the same period in the following year 280 vessels more. At the present moment there are no less than 1100 steel boilers in use in steamships, weighing together over 17,000 tons.

The third paper on steel was by Mr. J. R. Ravenhill, and gave an account of the improvements which have recently been made in mild steel castings. Many portions of machinery and steam-engines which till quite recently were invariably made of cast iron can now be formed of cast steel, with the attendant advantages of gain in strength and saving in weight.

Perhaps the most interesting paper of the four was that by M. Berrier Fontaine, the eminent French naval architect, "On the Use of Mild Steel for the Construction of the Hulls of Ships in the French Navy." The French were undoubtedly the first to introduce this material into the national navy; but though their experience of it is longer than our own, they do not seem to have acquired the same confidence in its use which is now felt in this country. For instance, we are in the habit of constructing the entire hulls of ships, including the below-water plating, of steel; the French, on the other hand, continue to use iron for all work which has to be exposed to the action of sea water. The reason advanced is that they find that steel when immersed in salt water corrodes with far greater rapidity than iron. M. Berrier Fontaine quotes as examples two gunboats, the *Épée* and the *Tromblon*, the hulls of which, completely steel-plated, have both given proof of rapid and deep corrosion. "The *Tromblon* was launched at Toulon on January 20, 1875, and remained afloat till October 27 of the same year. During that period of nine months it was found necessary to dock her three times, that it is to say, about every two months to paint the hull, the plates being rapidly and deeply attacked, especially in the neighbourhood of the water-line. The progress of this corrosion went on with such unusual rapidity, that when the time came to pass the *Tromblon* into the reserve it was thought necessary to haul her on to a slip instead of keeping her afloat." The whole subject of the corrosion of steel plates is at present involved in great mystery, and no two authorities seem able to agree about the cause. In the English Admiralty it is commonly believed that it is due to the presence on the surface of the plates of portions of black oxide, which constitute with the steel so many active galvanic couples, which of course rapidly promote corrosion, and hence great care is now taken to remove all traces of this oxide before the plates are coated. Whatever may be the cause, it is perfectly certain that the experience of English builders does not tally with that of M. Berrier Fontaine in this particular. Certain cases of corrosion have no doubt occurred in this country, and the hull of the *Iris* is an example in point; but as far as present experience goes such cases are the exception instead of the rule.

M. Berrier Fontaine gives an interesting account of the tools and other plant used in the French dockyards for the working of steel. He describes also the early difficulties which the workmen experienced, all of which have been successfully overcome. As regards the process of manufacture adopted in France, it appears that equally good results are obtained from the Bessemer and the Siemens methods, so much so that when contracts are given out it is never specified that the material is to be prepared by either of the two processes. In some works the Siemens system is employed for the superior sorts of steel, and the Bessemer process reserved for inferior descriptions, such as rails, while in other works exactly the opposite takes place. In this country, on the contrary, it is almost universally the rule to specify the Siemens process for the production of mild steel plates for ship-building and for boiler purposes.

DUNES AND MOVING SANDS

In a communication made to the Russian Society of Naturalists, M. Sokoloff has given a description of the dunes which are seen close by Sestroryetsk, at the eastern end of the Gulf of Finland. The whole of the isthmus between the Gulf and the basin of Sestroryetsk is covered with dunes which have a double origin. Those which are close by the sea-shore are old shore-ridges, mostly covered with vegetation, parallel to one another, and having each the form of a straight line, while those which are situated more east are true dunes, built up of sand driven by the wind. They have the direction north and south, and they reach the height of a hundred feet. Several of them are quite covered with pine-forests and with moss, while others are almost quite naked. The latter are constantly brought into motion by the west wind, and south of the Sestra River a high dune will shortly cover the houses of the working men of the Sestroryetsk manufactory. This dune, about 700 feet broad, has already covered several houses, and it is always advancing further, forming smaller parallel dunes fifteen feet high; its western side is covered with numerous excavations, from which the wind has taken the sand to move it further east. M. Sokoloff, while agreeing with the well-known classification of dunes established by the explorer of Sahara, M. Vatonne, thinks that the dunes of the deserts, which owe their origin to the action of wind, might be very easily distinguished from the mostly lower ridges which appear on the sea-shores under the influence of waves, these last usually having the form of straight lines, whilst the true dunes always have a semicircular form. M. Severtzoff observed after this communication that in the steppe of Kyzyl-koum, true dunes often have the same form of parallel, quite straight ridges. However, having at their origin a circular form which is so characteristic of the *barkhans* of the steppe, they lose by and by this form, and several smaller dunes, uniting together at their ends, take the form of a long straight ridge perpendicular to the prevailing direction of wind. M. Moushketoff, who has made a close acquaintance with the sands of Central Asia, observed that these sands, which are all sporadic, being spread among older formations, are very different as to their extent, their stratigraphical and petrographical characters, and their origin. They might be subdivided into three different classes:—1. Those which have a marine origin and which might be observed on the south-eastern shores of Lake Aral, and especially in the Kara-koum steppe. They are about 250 yards and 70 feet high, and mostly parallel to the shore. They are typical marine dunes, but their extension closely depends upon the extension of the Aralo-Caspian formation, the fossils of which are always found broken in these sands. 2. The fluvial dunes, which are very common in the valleys of the Amou, Syr, Sourkhan, and others; their height rarely exceeds 10 to fifteen feet, and their length is from 100 to 150 feet; their sand is steel-gray, and contains gypsum and clay. 3. The *barkhans* are subaërial formations; they prevail in the central part of the steppe Kyzyl-koum, but are rather rare in the Kara-koum steppe. They have the form of a sickle, and are somewhat conical, their maximum height being as much as 20 to 30 feet; their slopes are very different, that which is under the influence of the wind having an inclination from 5 to 13 degrees, whilst the other slope is short and steep, the inclination reaching sometimes as much as 43 degrees; they consist of a dirty-yellow or red sand, owing to their origin in the Tertiary sandstone, or sometimes in other harder rocks, as for instance, in the valley of the Ili River. Sometimes typical *barkhans* are met with among dunes, being a secondary formation arising out of the marine dunes. As to the plantations of trees on dunes, M. Moushketoff thinks that it would be far more rational first to determine whence the sand is brought by the wind, and to make the plantations of trees or bushes, according to the chemical character of the sand on this place, instead of making them on the dunes themselves.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

MANCHESTER.—We learn that the Council of the Owens College proposes shortly to establish an independent Chair of Applied Mathematics.

EDINBURGH.—The tercentenary of the University of Edinburgh will be celebrated in 1883. The senatus are to invite representatives from other universities to be present; they also propose to bring out a history of the University during the first 300 years.

THE winter session of the College of Agriculture, Downton, Salisbury, was brought to a close on Wednesday, when the prizes were presented by Earl Nelson, who dwelt at considerable length on the present state and future prospects of British agriculture, taking a very hopeful view of the latter. The High Sheriff of Wilts warmly advocated such a combination of science with practice as was in vogue at the College. The Scholarship offered for competition amongst students who have completed their first year at the College was awarded to Mr. Louis Johnstone, son of Sir Harcourt Johnstone, Bart., Hockurss Hall, Scarborough, the Hon. Victor A. N. Hood *proxime accessit*.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 31.—"Permanent Molecular Torsion of Conducting Wires produced by the Passage of an Electric Current," by Prof. D. E. Hughes, F.R.S.

In a paper on "Molecular Electro-Magnetic Induction," presented to the Royal Society (March 7, 1881, I gave a description of the induction currents produced by the torsion of an iron wire, and the method by which they are rendered evident. The electro-magnetic induction-balance there described is so remarkably sensitive to the slightest internal strain in anywise submitted to it, that I at once perceived that the instrument could not only determine any mechanical strain such as torsion or longitudinal stress, but that it might indicate the nature and cause of internal strains. Upon putting the question to it, Does the passage of electricity through a wire produce a change in its structure? the answer came, It does, and that to a very considerable extent; for an iron wire adjusted to perfect zero, and which would remain free from any strain for days, becomes instantaneously changed by the first passage of a current from a single cell of a Daniell's battery; the wire has now a permanent twist in a direction coinciding with that of the current, which can be brought again to zero by mechanically untwisting the wire, or undoing that which the passage of electricity has caused. Before describing the new phenomenon, I will state that the only modification required in the apparatus is a switch or key by means of which the telephone upon the wire circuit is thrown out of this circuit, and the current from a separate battery of two bichromate cells passed through the wire alone, at the same time, care being taken that no current passes through the coil, but that its circuit should remain open during the passage of the electric current through the wire under observation; an extra switch on this circuit provides for this. The reason for not allowing two currents to react upon each other, is to avoid errors of observation which may be due to this cause alone. When, however, we take an observation, the battery is upon the coil and the telephone upon the wire alone. An experiment thus consists of two operations. First all external communications interrupted, and an electric current passed through the wire; and, second, the electric currrent taken off the wire, and all ordinary communications restored. As this is done rapidly by means of the switches, very quick observations can be made, or if desired the effects of both currents can be observed at the same instant.

Now if I place upon the stress bridge a soft-iron wire ½ millim. diameter, 25 centims. long, I find, if no previous strain existed in the wire, a perfect zero, and I can make it so either by turning it slightly backwards or forwards, or by heating the wire to a red heat. If I now give a torsion of this wire, I find that its maximum value is with 40° torsion, and that this torsion represents or produces electric currents whose value in sonometric degrees is 50; each degree of torsion up to 40 produces a regular increase, so that once knowing the value of any wire, we can predict from any sonometric readings the value in torsion, or the amount of torsion in the opposite direction it would require to produce a perfect zero.

If now I place this wire at zero, and thus knowing that it is entirely free from strain I pass an electric current through it, I find that this wire is no longer free from strain, that it now gives out induction currents of the value of 40, and although there is no longer any battery current passing through this wire that the strain is permanent, the outside coil neither increasing nor diminishing the internal strain it has received by the passage of an electric current through the wire; upon giving a torsion to the wire in one direction, I find the inductive force increase from 40 to 90, but in the other direction it is brought to zero, and the amount of torsion, some 35°, required to bring the wire again to zero represents exactly the twist or strain that had been produced instantaneously by the passage of an electric current. If I repeat the experiment, but reverse the battery current sent through the wire, I find an opposite twist of exactly the same value as previously, and that it now requires an opposite torsion to again bring the wire to zero. It is not necessary however to put on an equal opposite torsion on wire to bring the currents to zero, for as I have shown in my late paper, the sonometer not only allows us to measure the force and indicate its direction, but allows us to oppose an equal electric current of opposite name, thus producing an electrical zero in place of the mechanical one produced by torsion.

Evidently here there has been a sudden change in the structure of the wire, and it is a twist which we can both measure and reproduce. The question at once becomes, Has a molar twist been given to the wire such as would be detected by the arm or free end of the wire, or a molecular change leaving no trace upon its external form of what has passed?

It will be found that, notwithstanding that it requires some 40° of torsion to annul the effects of a passage of an electric current, no visible movement nor any tendency of the free end to turn in the direction of the twist it has received can be observed. I believe however to have noticed a slight tremor or movement of half a degree, but as I could not always reproduce it, and as it is so slight compared with the 40° of internal twist, I have not taken it into account, for if the wire is firmly fastened at both ends no molar torsion being possible, except an elastic one, which would instantly spring back to zero, the current on passing produces its full effects of twist and it is permanent. Thus the molecules have in some extraordinary way rearranged themselves into a permanent twist, without the slightest external indication of so great a change having taken place. An equally remarkable change takes place in aid of, or against (according to direction of current) an elastic permanent strain. Thus, if I first put the wire under 40° right-handed permanent torsion, I find its value to be 50. Now, passing the positive of battery through its free end, and negative to fixed end, the induction currents rise at once in value to 90; if, now, the negative is momentarily passed through the free end and positive to fixed end the induced currents at once fall to 10, and these effects remain, for on taking off the elastic torsion the wire no longer comes to zero, but has the full twist value produced by the current.

Tempered steel gave only one or two degrees against fifty for soft iron, but supposing this might be due to its molecular rigidity, I carefully brought the wire to zero, and then observed the first contact only. I found then that the first contact gave a value of 40, but the second and following only one or two. By bringing the wire back to zero by a momentary touch with a magnet a continued force of 40, or if constant reversals were used instead of a simple contact, there was constant proof of a similar great molecular change by the passage of a current in steel as well as iron.

I can find no trace of the reaction of the wire upon the magnetism of the earth, as in all positions the same degree of force was obtained, if great care is taken that the wire is absolutely free from longitudinal magnetism; there is however a slight reaction upon its own return wire if brought within 1 centim. distance of the wire, and this reduces the twist some 10°. The maximum effects are obtained when the return wire is not nearer than 25 centims.; thus the action is not one produced by a reaction, but by direct action upon its internal structure.

Copper and silver wires so far show no trace of the action. I believe, however, that a similar strain takes place in all conductors, and I have obtained indirectly indications of this fact; in order, however, to verify this, would require a different method of observation from the one I have described, and I have not yet perfected the apparatus required.

It seemed probable that if I approached a strong permanent magnet to the wire, I should perceive a twist similar to that produced by the passage of a current; but no such effects were observed. But it has a most remarkable effect of instantly bringing to zero a strain produced by the current, and, no matter which pole, the effect was the same. Thus, a strain of 50°, which remains a constant, instantly disappears upon the production of longitudinal magnetism, and I have found this method of reducing an iron wire to zero of strain far more effective than any other method yet tried, such as vibrations, heat, twisting, &c.

It will be seen from this that the molecular arrangement set up by magnetism is very different from that produced by the passage of an electric current. It evidently has a structure of its own, else it would not have instantly destroyed the spiral strain left by the passage of electricity if it had not taken up a new form, as rendered evident in the longitudinal magnetism, which we could at once perceive on the wire. This question, however, belongs to a separate investigation, and I hope the apparatus will aid me later in throwing some new light upon this subject.

Another method of reducing the wire to zero, after the passage of a current, is to keep the wire in a constant state of vibration. It requires in time about one minute to bring it to zero, but if, on the contrary, I set the wire vibrating during the passage of the current, the permanent twist becomes greater and more difficult to reduce to zero.

If a wire which has internal strains is heated to redness, these strains almost entirely disappear, and I can thus reduce by heat a strain which a current had produced, but heat, whilst allowing of greater freedom and motion of its molecules, does not prevent an internal strain being set up, for whilst heat can reduce the wire to zero, after the passage of the current, the effects are increased. If, during the time that the wire is at a red heat, the current is passed in the same time, and at the same instant we take off the current and the external heat, the wire when cold will be found to have a higher degree of strain than previously possible with the wire when cold.

We have seen that both mechanical vibrations and heat can reduce the wire to a zero, but its action is very slow, several minutes being required; but the action of electricity in producing a permanent twist is exceedingly quick. I have found that a single contact, whose duration was not more than 0·01 of a second, was equal to that of a prolonged contact of several minutes, and magnetism was equally as quick in reducing this strain to zero. And it is the more remarkable when we consider the very great mechanical force required by torsion of the wire to untwist the strain produced in an instant of time by electricity.

The results I have given are those obtained upon soft iron wires of ½ millim., but I have experimented with different sizes up to 3 millims. diameter. The results with 1 millim. diameter were quite as evident as the ½ millim., but on the 3 millim. wire the strain was reduced to 25° instead of 50°, owing to the extreme rapidity and low electrical resistance compared with my small battery wires. On a telegraph line, the wire of which is almost entirely of iron, there must be a very great strain set up, which however would remain a constant, except where reversed currents are used, and in this case a constant movement of the molecules of the wire must be the result.

I believe it to be most important that we should determine, as far as we can by experimental research, the nature of all molecular changes produced by electricity and magnetism, and in this belief I am happy in being able to bring this paper before the Royal Society.

Chemical Society, April 7.—Dr. Russell in the chair.—The following papers were read:—On the organic matter in sea-water, by W. Jago. The author concludes that the organic matter of sea-water is much more capable of resisting oxidising agents than that present in ordinary fresh water, and that it is probably organised and alive.—On the action of compounds inimical to bacterial life, by W. M. Hamlet. The cultivating fluids used comprised Pasteur's fluid, beef tea, hay infusion, urine, brewer's wort, and extract of meat; these were sterilised by boiling for ten minutes in Pasteur's flask, cooled with suitable precautions, and then seeded with hay solution, and the substance under examination added. Many gases, &c., were tried. Chlorine and hydric peroxide were fatal to bacteria, while chloroform, creosote, carbolic acid, salicylic acid, &c., hindered their development, but did not destroy them.

Anthropological Institute, March 22.—F. W. Rudler, F.G.S., vice-president, in the chair.—The election of George B. Waterhouse was announced.—Mr. R. W. Felkin exhibited a series of photographs of scenes and natives of Central Africa, taken by Herr Buchta.—Prof. Flower, F.R.S., exhibited a collection of crania from the Island of Mallicollo in the New Hebrides, which had been lately presented to the Museum of the Royal College of Surgeons by Mr. Luther Holden. The peculiar conformation of the heads of the people of this island attracted the attention of Capt. Cook and the naturalist Forster, who accompanied the great navigator on his second voyage, and who writes that "the depressed and backward inclining forehead causes an appearance in the looks and countenances of the natives similar to those of monkeys." Yet Cook bears testimony to the activity, intelligence, and honesty of this "ape-like nation," as he calls them. A few years ago Mr. Busk described some skulls collected in the island by the late Commodore Goodenough, and found that they all showed signs of having undergone alterations in form from pressure applied in infancy. The present collection corroborates Mr. Busk's views; some of the skulls being deformed to a remarkable degree, and closely resembling the well-known Peruvian crania from the neighbourhood of Lake Titicaca. This is the more remarkable, as on no other of the numerous islands of the neighbouring ocean is the practice known to exist. Besides the deformed crania the collection contained several monumental heads, said to be those of chiefs. In these the features are modelled in clay upon the skull, apparently with the intention of preserving a likeness of the dead person; the face is painted over with red ochre, artificial eyes introduced, and the hair elaborately dressed and ornamented with feathers. In one case the hair had been entirely removed, and a very neatly-made wig substituted. The head thus prepared is stuck upon a rudely-made figure of split bamboo and clay, and set up in the village temple, with the weapons and small personal effects of the deceased. This is a custom not hitherto known to exist among the Mallicollese, and its motive is not completely understood, but it is obviously analogous to many others which have prevailed throughout all historical times and in many nations, manifesting itself, among other forms, in the mummified bodies of the Ancient Egyptians and the marble busts over the mouldering bones in Westminster Abbey.—Mr. Joseph Lucas read a paper on the ethnological bearings of the terms Gipsy, Zingaro, Rom, &c.

Zoological Society, April 5.—Prof. W. H. Flower, LL.D., F.R.S., president, in the chair.—Mr. Sclater exhibited five bird's skins obtained by the Rev. G. Brown, C.M.Z.S., on the Island of Rotumeh, and presented by him to the *Challenger* Expedition. Mr. Sclater also exhibited specimens of two new species of birds from New Britain, belonging to the Museum Godeffroi, which he proposed to call *Trichoglossus rufigularis* and *Ortygocichla rubiginosa*.—Mr. H. E. Dresser exhibited and made remarks on a specimen of *Saxicola deserti* killed in Scotland, and a specimen of *Picus pubescens* believed to have been killed in Normandy.—Mr. W. A. Forbes, F.Z.S., read some notes on the external characters and anatomy of the Californian Sea Lion (*Otaria gillespii*), and exhibited some coloured drawings of this animal.—Prof. Flower, F.R.S., read a note upon the habits of the Manatee, chiefly in reference to the question as to whether this animal had the power of voluntarily leaving the water for the purpose of feeding on the herbage of the banks, as stated by many authors, and as supported by a communication from the late Mr. R. B. Dobree, notwithstanding which Prof. Flower considered the evidence upon which the statement was based to be very unsatisfactory.—A paper was read upon the same animal by Miss Agnes Crane, consisting of observations upon the Manatees lately living in the Brighton Aquarium.—Dr. A. Günther, F.R.S., read an account of the Amphisbænians and Ophidians collected by Prof. Bayley Balfour in the Island of Socotra. A new form of snakes allied to *Tachymenis* was named *Ditypophis vivax*, a new species of *Zamenis* was named *Z. Socotræ*, and a new form of Amphisbænian *Pachycalamus brevis*.—Mr. W. T. Blanford, F.R.S., gave an account of six species of lizards which had been collected by Prof. Bayley Balfour in Socotra; of these the three following appeared to be undescribed:—*Hemidactylus homæolepis*, *Pristurus insignis*, and *Eremias Balfouri*.—Mr. Charles O. Waterhouse read a paper on the coleopterous insects which had been collected by Prof. Bayley Balfour in Socotra. The number of species of which examples were collected was twenty-four, and showed that the fauna of Socotra, judging from this collection, was distinctly African. Twelve of the species appeared to be new.—A communication was read from Prof. J. O. Westwood containing observations on two species of Indian butterflies, *Papilio castor* and *P. pollux*.—A communication was read from Mr. Edgar A. Smith, containing some observations on the shells belonging to the genus *Gouldia* of C. B. Adams.—Mr. Sclater read the fifth of his series of notes on the birds of the vicinity of Lima, Peru, with remarks on their habits by Prof. Nation, C.M.Z.S. A new species of *Buarremon*, of which an example was in the collection, was proposed to be dedicated to its discoverer as *B. Nationi*.—Mr. G. E. Dobson read some notes on certain points in the muscular anatomy of the Green Monkey, *Cercopithecus callithrix*.

EDINBURGH

Royal Society, March 21.—Sir Wyville Thomson, vice-president, in the chair.—Prof. Geikie communicated a paper by Mr. C. A. Stevenson, B.Sc., on the earthquake of November 28, 1880, in Scotland and Ireland. The main conclusions at which the author arrived were the following:—The centre of the disturbance was at a point some thirteen miles south-west of Fladda, in the continuation of the line of the fault that lies along the great glen which stretches in a south-westerly direction from Inverness. The disturbance was felt over an area of 19,000 square miles, extending as far east as Blair Athole, as far north as the Butt of Lewis, and as far south as Armagh in Ireland. The undulation was everywhere of an up-and-down character; its breadth was estimated at 1100 feet, and its velocity seemed to vary from 3·75 to 7·75 miles per minute, having a mean value of 6·75 over the sea and 4·68 over the land. The accompanying rumbling was not heard at all the stations, and appeared to have been best heard where but little soil covered the hard dense substratum of rock. The disturbance was felt better over the older rocks. Noises were not heard outside a radius of 38 miles from the centre, except in the north of Ireland, where however it was suggested that the noise was due to the indirect action of the earthquake in causing a secondary local disturbance.—Mr. P. Geddes read his first communication on the classification of statistics. After pointing out the utter confusion that exists in many of the national classifications of the present time, the author criticised the arrangements suggested by Deloche and Mouat, which were equally unsatisfactory, because of their unscientific and artificial methods. Any classification, to be natural, must be based upon some broad principle common to all kinds of communities or societies. A fundamental meaning must therefore be attached to the word society—a definition given to it that will include societies of all kinds of organisms. Such a definition must obviously take account of the vital functions of organisms in relation to the matter and energy of the universe. We have thus matter and energy on the one hand, organisms on the other. Mr. Geddes, confining himself meanwhile to the first of these two great divisions, proceeded to classify the sources of energy, adopting the classification given by Prof. Tait in his Thermodynamics, and showing how naturally such things as food, fuel, machines, &c., fell into their places in such an arrangement. He then considered the classification of sources of matter used for other than energy-properties, taking for this purpose the well-known three-fold division into minerals, vegetables, and animals. The development of ultimate products through their successive phases of raw material, manufacture, exportation, trade, &c., and the classification of all products under the three chief headings of potential, mediate, and ultimate, completed the one aspect of the statistical method in so far as it related to the matter and energy of the universe. It still remained however to take account of the loss, or more properly the degradation or dissipation, suffered. The classification must indicate not only the kind of loss, *e.g.* whether in raw material, in manufacture, in trade, in ultimate product, or in remedial effort, but also the agency that was the direct cause of the loss, whether physical, as earthquake, flood, storm, &c.; or biological, as insects, fungi, &c.; or social, as crime, war, or folly.—Mr. T. Muir communicated three mathematical notes: on Prof. Cayley's theorem regarding a bordered skew determinant; on the law of extensible minors in determinants; and on a problem of arrangement.—Mr. J. Y. Buchanan read a short paper on the oxidation of ferrous salts.—Prof. Tait made a brief communication on some space loci.

PARIS

Academy of Sciences, April 4.—M. Wurtz in the chair.—M. de Quatrefages presented an example of the Edwards Medal.—The following papers were read:—On micrometric measurements during the transit of Venus of 8 December, 1874, by M. Puiseux. These measurements (393 in number and in five categories) at St. Paul and Pekin fairly agree, though the conditions were unfavourable, and give for the parallax 9″·05.—On the same subject, by M. Mouchez. He considers the method is to be strongly recommended for 1882.—Note on the methods of Wronski, by M. Villarceau.—On photographic photometry and its application to study of the comparative radiating powers of the sun and of stars, by M. Janssen. A shutter with triangular aperture is made to pass with uniform motion of known rate before a sensitised plate; this gives (with light) a series of shades on the plate, decreasing from the base side to the apex side. To compare the sensibility of two plates, differently prepared, or the photogenic intensity of two sources (using two like plates) the points of equal shade on the plates are noted. (The photographic intensity does not increase as rapidly as the luminous intensity.) For the sun he finds the time of action (with gelatine bromide of silver plates) must be reduced to $\frac{1}{40000}$ sec. to give the most rapid variation in the opacity. The sides of the slit are curved (for a special reason). A series of circular images of stars are obtained by putting the plate a little out of focus.—On alcoholate of chloral, by M. Berthelot.—On lightning flashes without thunder, by M. d'Abbadie. He observed such quite near, in a fog, when in Ethiopia.—On the combinations of phtalic anhydride with hydrocarbons of the benzene series, by MM. Friedel and Crafts.—Note on chalcomenite, a new mineral species (selenite of copper), by MM. des Cloizeaux and Damour. This is from near Mendoza in the Argentine Republic.—Researches on changes of state near the critical point of temperature, by MM. Cailletet and Hautefeuille. By colouring carbonic acid the liquid is rendered always visible. It is found that Andrews's undulatory striæ dissolve blue oil of galbanum, so that they are produced by streaks of liquefied carbonic acid. Neither in disappearance of a meniscus through compression, nor in change of state at the critical temperature does matter pass by insensible degrees from the liquid to the gaseous state.—Magnetic anomaly of meteoric iron of Santa Catharina, by Prof. Lawrence Smith. Small fragments are very feebly affected by a magnet till they have been flattened on a steel surface with a steel hammer, or heated red hot.—Attenuation of effects of virulent inoculations by use of small quantities of virus, by M. Chauveau.—M. Jordan was elected Member in Geometry in room of the late M. Chasles.—On the winter egg of phylloxera, by M. Lichtenstein.—Researches on the causes which enable the vine to resist phylloxera in sandy soils, by M. Saint-André. Weak capillary capacity of a soil seems to be the direct or indirect cause of the resistance of vines.—On the bismuthine produced by coal-mines on fire, by M. Mayençon.—On functions proceeding from Gauss's equation, by M. Halphen.—On a new application and some important properties of Fuchsian functions, by M. Poincaré.—On the relations between solar spots and magnetic variations, by M. Wolf. Tables for 1880 are given. The solar curve is also shown to be quickly rising again; a maximum may be expected in 1882 to 1883. The increase of magnetic declination for 1879-80 is 1′·18 by formula, 0′·99 by observation.—On the viscosity of gases, by Mr. Crookes.—Luminous intensity of radiations emitted by incandescent platinum, by M. Violle. From observations ranging from 775° to 1775° he constructs a formula.—On the change of volume accompanying the galvanic deposit of a metal, by M. Bouty. It is always possible in electrolysis of the same salt to diminish the intensity of current below a certain limit such that the compression produced by the deposit is then changed into attraction (the metal dilating instead of contracting in solidifying).—On the voltaic conductivity of heated gases, by M. Blondlot. He describes an experiment made by way of putting the conductivity of gases beyond doubt, and in which all parts of the apparatus are constantly open to inspection.—On the internal discharges of electric condensers, by M. Villari. The laws of the phenomenon are enunciated.—On magical mirrors, by M. Laurent. A common silvered mirror of any thickness may be rendered magical by means of heat; *e.g.* applying the end of a heated brass tube to it. The section of the tube is imaged.—On hydrosulphite of soda, by M. Schutzenberger.—On some new processes of desulphuration of alkaline solutions, by M. Scheurer-Kestner.—On application of the crystals of lead chambers, by M. Sulliot. For disinfection of rooms he places in them porous vessels containing nitrous sulphuric acid, and to attenuate the irritating action of the vapours the vessel is placed in another containing ethylic alcohol. In another case odorous gases are drawn through a column of coke moistened with nitrous sulphuric acid.—On secondary and tertiary amylamines from the active amylic alcohol of fermentation, by Mr. Plimpton.—Action of perchloride of phosphorus on isobutylic aldehyde, by M. Œconomidès.—Preparation of isobutylic acetal, by the same.—On the products of distillation of colophony, by M. Renard.—Artificial reproduction of diabases, dolerites, and meteorites of ophitic structure, by MM. Fouqué and Levy.—On the Devonian formation of Diou (Allier) and Gilly (Saône-et-Loire), by M. Jullien.

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