THURSDAY, DECEMBER 3, 1885

THE ETIOLOGY OF CHOLERA

THE announcement by Dr. Koch, as chief of the German Cholera Commission, that he had discovered a micro-organism which was not only peculiar to cholera, but which had a causal relation to that disease, was all along felt by many to have been made on insufficient evidence, and in consequence the India Office in 1884 appointed Drs. Klein and Heneage Gibbes to visit Bombay, Calcutta, and other Indian cities, with a view of studying the disease from the micro-pathological point of view. Their report was received early this year, and whilst it supported Koch's statements to the effect that choleraic dejections were generally characterised by the presence of the comma-shaped bacilli which had been described, it distinctly denied many of the assertions which had been made by that observer, and it altogether set aside the notion that the comma-bacillus bore any causative relation to the disease. The point at issue was felt to be of such importance that the India Office somewhat recently appointed a Committee of physicians to consider the report made by Klein and Gibbes, and to advise them on the matter.

The Committee in question do not profess to have done more than to study the subject as it has been dealt with in the several reports issued by Koch, Klein, and Gibbes, and to communicate their views of the merits of the several reports to the India Office. They deal with the contentions of Koch under several headings. Thus, in the first place, they refer to his assertion that the number of comma-shaped organisms in the intestinal tissues and contents is in proportion to the acuteness of the attack, and that these organisms generate within the body a ferment by which the system is poisoned.

As to this, it is admitted by Klein and Gibbes that if all that Koch asserts on this point were correct there would be strong grounds for believing that the comma-bacilli must in some way or other be related to the cholera processes; but their observations are in direct opposition to the assertion made. As regards the intestinal tissues, and notably the mucous membrane, it was found that, in some most acute cases in which the post-mortem examination was conducted as soon as possible—at times in a quarter of an hour—after death, the comma-bacilli were only conspicuous by their absence; and that these organisms were only present in dead tissues, including the mucus flakes. Indeed, it is contended that the comma-bacilli are only putrefactive organisms; and the Committee, having these facts before them, express the opinion that no direct relation exists between the number of comma-shaped organisms and the gravity of the attack.

Another of Koch's contentions is to the effect that the comma-bacilli are not found except in connection with cholera. Now Klein and Gibbes maintain that these bacilli, or some that in morphological respects appear like them, are found in diarrhœa stools, that they have been met with in cases of dysentery and enteric catarrh, and that in other cases they have been found, together with certain putrefactive organisms, in as large numbers as in many cholera stools. And further, Klein has, since the issue of his report, found that by ligaturing a portion of the bowel of a monkey, large numbers of comma-bacilli were produced, and that these have been found, after cultivation, to present the same character as the so-called cholera bacilli. Besides which, Klein has found comma-bacilli, similar in appearance to those found in cholera, to be ordinarily present in various parts of the alimentary tract in health, and as regards some taken from the mouth, he has succeeded in cultivating them, and in demonstrating that their action on the media in which they grow is identical with that of the bacilli found in cases of cholera. And the Committee, whilst not convinced that the absolute identity of the two sets of bacilli has been proved, are inclined to agree with Klein's contention.

The third point examined is Koch's statement that the presence of comma-bacilli in a tank which supplied certain cholera-affected villages in Calcutta with water was, practically, a proof of the causal connection between the organisms and the disease. As to this, Klein and Gibbes report that they, too, examined the water from this tank, and that it revealed undoubted comma-bacilli in every respect identical with those found in choleraic dejecta; they further added that the water had been contaminated with choleraic evacuations, and that, notwithstanding these two conditions, its extensive use by many human beings had not been followed by a single case of cholera. The reporters hence submit that the water did not contain the cholera virus, and that this latter has nothing to do with the comma-bacilli. Similar evidence as to other tanks is also adduced, and it is added that these tank-commas, having been cultivated, are found to be identical with Koch's comma-bacilli. The question as to the existence of any causal connection between comma-bacilli and disease in animals as the result of inoculations is also discussed, and it is regarded as demonstrated that neither the alvine dejections of cholera nor cultivations of isolated comma-bacilli obtained from such dejecta are capable of producing cholera, nor indeed any disease resembling it.

The Committee, therefore, have concluded that, though comma-shaped organisms are ordinarily present in the dejections of cholera patients, they are not found in the blood or in any of the tissues, even when these are examined in a recent condition; that comma-shaped organisms of closely allied morphological appearance are ordinarily present in different parts of the alimentary canal in health, and can be developed there to an unusual extent in diseases characterised by hyper-secretion of the intestine; and that there is no evidence to show that the comma-shaped bacilli found in cholera induce that disease in lower animals or in man.

According to the Committee, we are now much in the same position as we were before Koch's experiments were instituted, in so far as the prevention of cholera is concerned; and Dr. Timothy Lewis, the Secretary to the Committee, and who has had a wide Indian experience in connection with the micro-pathological study of the disease, further points out that there is nothing new in Koch's observations except in so far as an ingenious and beautiful process facilitating the investigation of micro-fungi is concerned. Dr. Lewis asserts, indeed, that he had made hundreds of cultivations of the bacilli in question, and that he had long since arrived at the conclusion that they were identical with some of the minute vibrios which ha\

so frequently been referred to by former writers as being present in cholera dejecta; the comma being, in short, nothing more than a segment of one of these vibrios which had become detached during the process used by Koch. It is true that Koch's friends deny that any comma found elsewhere than in the cholera intestine grows under cultivation, in the same way as the one he has described, but so far, this is a mere assertion, not a proved fact; and it is evident that we are but at the commencement of any proper apprehension as to the significance of these vibrios. This is pointed out in an appendix to the Committee's report, and the lines of future investigation into the subject are laid down. But for the present the prevention of cholera can only be found in the prosecution of well-advised sanitary measures, and whilst it is of the utmost importance that labours such as Koch and former investigators have carried out should be continued and put to the most rigid test, yet micro-pathology cannot, at present, be regarded as having made more than a small advance towards the solution of the question under discussion.

A MANUAL OF TELEGRAPHY

A Manual of Telegraphy. By W. Williams, Superintendent of Indian Government Telegraphs, &c. (London: Longmans, 1885.)

A MANUAL compiled to order for the use of the *employés* of the Department—very well written, very well printed, very useful to the Department, and very interesting to the technical reader. It embraces a general description of the apparatus used in India, the faults they experience, and the remedies they apply; a full account of the elaborate system of testing reared under the care of the late Louis Schwendler, the able electrician of the Department; and a clear account of the electrical phenomena which interfere with telegraph working and require watching and removal.

It is supplemented by an excellent *résumé* of the laws which determine the strength of electric currents under various circumstances, and a series of formulæ and mathematical solutions of various problems that occur in practice. It is in reality a primer to an admirable work on "Testing," written by Schwendler and edited by another very able electrician who died in India—R. S. Brough.

It is remarkable how India, practically isolated telegraphically from the rest of the world, originated and maintains a system *sui generis*. It was sown by O'Shaughnessy, it was nursed by Robinson, it is maintained by Cappel. It has had engrafted upon it much of the German element, due to the education of Schwendler in the great house of Siemens; but it remains quite distinct from the rapid system in use in England, and also from that in America—more Continental than English, and American only in its long circuits and sound reading. It has been singularly fortunate in the able officers that have served it, most of whom are highly educated gentlemen selected by competitive examination, and well trained in technical matters before assuming office. The proceedings of our societies, especially those of the Telegraph Engineers, contain frequent valuable communications from India, and this last volume fully maintains the reputation of the Department.

There are some curious errors, particularly among those rocks upon which so many young writers are wrecked, viz. *definitions*.

There is a strange, but excusable, confusion between *electrification* and *potential*, while there is an inexcusable confusion between *current* and *quantity*. Definition 1 says "*electric quantity* is the amount of electricity present in an electrified body," and definition 2 says "the unit of quantity or current is called an "Ampère, Weber, or Oerstedt." Now the unit of quantity is called a *coulomb*, and current is not quantity, but quantity per second, a very different thing, and is called an *ampere* only. It was called a weber, but this term has quite died out since the Paris Congress of 1881, and no one ever called it an oerstedt out of India. The relation between quantity and current is shown by Faraday's great law:—

$$Q = Ct$$

It is a pity that p. 5 cannot be reprinted. Definition 16 is curiously worded: "The unit by which capacity is measured is called a *farad*, or more generally for convenience a *microfarad*." A casual reader would think that the same unit is indifferently called a farad or a microfarad, whereas we learn later on that the one is one-millionth of the other.

At p. 57 we read of a very strange practice. The only cause of errors in the signalling of figures (on which, it must be remembered, the most important issues may depend) is due to a practice, unfortunately too common, known as "exaggerating signals," by which a letter is given more characters than it really possesses: for example, the letter *h*, a most common victim of this ill-treatment, is, by the addition of an extra dot, mutilated into the figure 5. We trust this strange practice is confined to India; we have never heard of it anywhere else.

The *résumé* of laws at p. 241 is very good indeed; but why denominate Ohm's and Kirchoff's laws, and not those of Ampère and Faraday?

The novel practice, in technical books, of printing notes as well as references on the margin instead of at the bottom of the page, has been adopted, and the convenience is certainly very considerable. The printing and get-up of the book are admirable. It should be added to every telegraph engineer's library.

OUR BOOK SHELF

Elements of Inorganic Chemistry. By James H. Shepard, Ypsilanti High School. (Boston: D. C. Heath and Co., 1885.)

THIS little book is evidently intended as a sort of mutual companion of the teacher and student, and is for beginners only, as the author informs us. It is, however, a mixture of elementary and somewhat advanced information on the subject, and certainly would be somewhat difficult for a beginner to be left alone with. The book is well supplied with questions for the student to attempt, and also with suggestions to the teacher as to where questions may be with advantage put. Most of the substances known as elements are mentioned, and their properties to some extent described, even including the so-called rare metals. A chart of "The Natural Classification of the Elements," according to "Mendelejeff," and an appendix on reagents is also included.

Numerical Exercises in Chemistry. By T. Hands, M.A., F.R.A.S. (London: Sampson Low and Co., 1884.)

THIS is a neat little book of easy arithmetical exercises on chemical problems which are likely to crop up in the course of laboratory work. The examples, about 650 in number, are to some extent original and partly collected from examination papers. They extend over a good deal of the physical ground more intimately connected with chemistry, and appear to be generally of a useful character. There is no attempt at theoretical instruction beyond what is absolutely necessary for setting out a question. The first four pages are given to exercises on the metric system, after which thermometers, heat, chemical equations, &c., are dealt with. The book will be very useful for students who have got a little way into the subject, but still in the position of beginners.

An Introduction to the Differential and Integral Calculus, with Examples of Application to Mechanical Problems. By W. J. Millar, C.E. (London: Blackie and Son., 1885.)

THIS is the second attempt within a very short time to give an elementary and, as far as possible, interesting exposition of the principles of the Differential and Integral Calculus. One cannot but feel sympathy with the authors of such attempts, for, sooth to say, we often find writers on the less elementary branches of mathematics anything but good teachers or editors of students' text-books.

The present little work has the peculiarity that, being written for engineering students, its illustrations are mainly such as can best be appreciated by those who have an acquaintance with applied dynamics. It is clearly written, the examples are well chosen, and it is on the whole wonderfully accurate, considering the appearance usually made by practical men when dealing with pure mathematics. On page 7 no distinction is made between the increment of x and the square of the increment of x; on page 12 there is a faulty investigation of the rule for the differentiation of a quotient; and one or two others might be specified. These do not detract much, however, from the value of the exposition as a whole, and we cordially hope that the little book may attain its object of smoothing and rendering attractive to practical engineers the rather forbidding pathway leading to the higher mathematics.

LETTERS TO THE EDITOR

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

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

The Whole Duty of a Chemist

I CANNOT complain if the address which I delivered a few weeks ago to the Institute of Chemistry, although it received an extent of encomium for which I was quite unprepared, should meet here and there with adverse, not to say unfriendly, criticism. Naturally enough, the inculcation of sturdy self reliance is displeasing to the new apostolate of sponging upon others, though it scarcely, I think, justifies a resort to the dialectic juggle of representing the defence of one side of a chemist's duty as meant to be a deliberate expression of "the whole duty of a chemist." The Chemical Society takes cognisance of chemists in one aspect of their work, the Institute of Chemistry takes cognisance of the same individuals in another aspect; and one really need not be a conjuror, though it may put some strain on the fair-mindedness of an editor, to perceive that an address intended for the one organisation would be unsuitable for the other. That distinguished man, the late Dr. James Young, F.R.S., whom you so complacently sneer at, was not a professional chemist at all, but a manufacturing chemist. He was a first-rate manufacturer, whereas Reichenbach was but a third-rate or fourth-rate investigator, if so much; and, your opinion notwithstanding, it is commonly held that the first-rateness of the one man in his own walk more than counterbalanced whatever weight attached to the higher walk of the other. I may cite for your information Sir Frederick Abel, Dr. Frankland, Prof. Dewar, and the late Dr. Stenhouse, as being eminent professional chemists. Though of high repute in forensic circles, I am not aware of their being never heard of at the learned Societies; but I am aware that, in common with other leading chemists of the country, they have had the bad taste to be contemptuous of your own contributions to chemical science. Can it really be that this circumstance has affected unconsciously the spirit of your leading article? I would suggest, moreover, for your editorial consideration, that to supplement criticism of an author's performance with flippant insinuations as to his personal conduct and career, is hardly in accordance with the best traditions of scientific journalism; while it constitutes undeniably bad art, as implying that the production criticised did not of itself afford adequate opportunity for attack, even, of course, with an editor's happy privilege of misrepresentation. As regards the reflections so unmistakably made on myself personally, I have little fear that the irreproachable tone of your remarks will serve to suggest the measure of their trustworthiness; and will only observe "happy are they that hear their detractions, and can put them to mending." As regards, however, your disparagement of the chemical profession at large, from which, I trust, it may not suffer beyond hope of recovery, I would venture to remind you that even that other profession, of which you are so magnanimous a member, has had its calumniators; and the words of a well-known satirist of the last century are considered by some to be as applicable now as ever, that "Of all the cants which are canted in this canting world, the cant of criticism is the most tormenting." Sterne was, happily, unacquainted with the cant of scientific mendicancy, or he might have added that that also was a very fine cant in its way.

WILLIAM ODLING

Oxford, December 1.

[We print the above without comment except on the two following points. Dr. Odling has entirely misunderstood the allusion to the late Dr. Young: no sneer was intended, as will be obvious on a perusal of the whole paragraph. He has also taken as personal to himself remarks made on types not individuals.—ED.]

A Stray Balloon

THE *Times* published on September 29 a short extract from the *Bermuda Royal Gazette*, communicated by me, describing the appearance of a balloon, passing over Bermuda on August 27, and which I suggested might be one of those which ascended this year in England or France, and had not been subsequently heard of. This was followed by a letter from Mr. Charles Harding, F.R.Met.Soc., commenting on the "extreme improbability" of a balloon crossing the Atlantic, and even adding that "a little practical experience in ballooning suggests it to be thoroughly impossible."

As the columns of the *Times* are hardly suitable for the discussion, may I ask that you will allow me to make public through NATURE the further information I have received on the subject.

First, the *impossibility* is, I think, disposed of by the fact that one of the balloons sent up from Paris during the siege did actually travel rather more than half the distance, having descended in Iceland, where it was found long after. We know not how long either balloon was on its course, but it would be bold to assert that if one balloon can float four or five days another cannot float ten days. We know nothing of the exceptional conditions which prolonged the buoyancy: an unusually good varnish, peculiar folding of the silk in its collapse, a film

of ice, may all be supposed capable of checking the escape of the gas. However, we have first to verify the fact. On the appearance of Mr. Harding's letter, I wrote to the Hon. W. H. Gosling, of Bermuda, a gentleman well known for his interest in matters of scientific inquiry, and begged him to investigate the story. His reply is before me, dated November 4:—

"On Saturday, October 31, I visited the spot where the balloon was alleged to have been seen. I am convinced of the fact. The place is a high hill east of the lighthouse. The two women were accidentally out in a field near where they live. Mrs. Bassett saw the object in the sky, high up, many times higher than the light. It seemed to her under the clouds. She knew nothing of balloons, and thought a whirlwind had raised some nets from the sea, as it appeared to her an object from which nets were suspended. She fancied she saw the corks of the net hanging at the bottom." (Mr. Gosling here remarks, "No doubt the basket, or the remains of it, of the former account, with chains, were the suggestion of her husband, who did not see it.") "She called her neighbour, and they both watched its course out over the sea, south, until it disappeared from view, which would not take long, as a brisk north wind was blowing. No one else seems to have seen it, nor would these, had not one of them accidentally looked up.

"I cannot hear of any balloon having been sent up in America, but on September 17, three weeks later, a balloon impaled itself on a church steeple in Chicago, U.S. The basket contained some torn clothing, and a branch of oak, as if it had come in contact with trees. The wind here on the three succeeding days was east, south-east, south. I suppose you know of the report of the missing balloon from Paris, in July, seen afterwards in the Bay of Biscay, going west."

So far Mr. Gosling, who incloses an intelligent letter from Mr. Robert T. Bassett, husband of the first witness, giving some compass bearings.

The *Monthly Weather Review* of the United States for September, which has not yet reached England, may perhaps throw light on the probability of an object seen floating in the air over Bermuda on August 27, whether arrived from Europe or not, being transported to Chicago by September 17. The coincidence is remarkable, but I know nothing of this incident beyond Mr. Gosling's mention of it. High winds with heavy rains prevailed in the South Atlantic and East Gulf States of the American Union on August 31, and the centre of a cyclone travelling in a north-easterly direction was then off the coast of South Carolina. A balloon drifting south from Bermuda on August 27 would be caught in the south-east quadrant of such a cyclone; and if it kept afloat long enough would, in a few days, be landed in a north-westerly and then in a northerly direction. The conditions of the question oblige me to assume that it is not a physical impossibility for a balloon, with very little weight attached, to drift about for weeks; but the singularity of the occurrence calls for every investigation, and should you admit this long communication, I hope that further evidence may be procurable from Chicago. J. H. LEFROY

Par Station, Cornwall, November 23

"Evolution without Natural Selection"

BELIEVING as I do that the words of a reviewer should be final, it is with no small amount of hesitation that I pen the following few remarks on the review of my little work entitled "Evolution without Natural Selection," which appeared in NATURE of November 12 (p. 26). The curious way in which my book has been misunderstood, and my consequent endeavour to put matters in a clear and impartial light, must be my apology for taking up your valuable space. In the first place, Mr. Romanes finds fault with the title of my book; but why, it is hard to conjecture. I venture to assert that nine-tenths of the matter it contains attempt to illustrate the operation of evolution without any natural selective process, as any impartial reader must admit; consequently, I absolutely deny that I only reserved a few odds and ends of small detail which I ascribed to other agencies. I might also state that I had a reason, and I think a very good one, in confining my remarks exclusively to birds. Had I elected to cover a wider area, I could have shown that these "odds and ends," as Mr. Romanes somewhat contemptuously calls them, do not by any means exclusively apply to birds, but to species in every other department of natural history. Mr. Romanes goes on to say that "It is the very essence of the Darwinian hypothesis that it only seeks to explain the apparently purposive variations, or variations of an adaptive kind; and, therefore, if any variations are taken to be non-adaptive, *ex hypothesi* they cannot have been due to natural selection." Precisely. And it was the immense amount of what I may call non-purposive variation which forms the line of demarcation between such vast numbers of species that I have attempted to explain by other agencies when natural selection utterly fails to do so. I most emphatically deny that I ever said, or even inferred, that these variations are "for the most part rare," as Mr. Romanes leads the reader of his review to suppose. All naturalists who are in the habit of working through large series of specimens are well aware of the immense number of species whose claim to rank as such is based upon their slight variation from a dominant type. It took me five years' hard work amongst tens of thousands of specimens to arrive at the conclusions expressed in my little book; and, in my opinion, no naturalist is qualified to write on these subjects without serving such an apprenticeship. That is why, as a specialist, I confined myself to birds alone for my examples. In the face of the array of important facts which I endeavoured to chronicle, it seems strange for a naturalist of such standing as Mr. Romanes to state that these facts "may be freely presented to the anti-Darwinians." Why "anti-Darwinians," Mr. Romanes? No one but an evolutionist (and most evolutionists are surely Darwinians) would attach any importance to these "trivial variations," and consequent intergradation of specific forms. Mr. Romanes is careful to point out how Darwin himself admits that if these trivial specific characters are "really of no considerable importance in the struggle for life, they could not be modified or formed through natural selection." Now probably it is no exaggeration to say that at least one-third of the known recognised species absolutely rest on these "trivial specific characters." If they have not been evolved by natural selection, I maintain that other and as equally potent agents as natural selection have been at work. The object of my little book was to try and explain them.

A word as to the *cause* of variation. No one who understands anything at all about the theory of natural selection ever supposes that it is an original cause of variation. Mr. Romanes cannot have read my essay very closely, for had he done so he would have seen that I drew the reader's attention to this fact (*conf.* p. 49). The *cause* of variation is quite another question, and one which after all did not materially concern my treatment of the subject. Nevertheless, I alluded to the use and disuse of organs as a direct cause of variation. I would also wish to point out that Mr. Romanes is entirely in error in saying that I "everywhere speak of isolation as the *cause* of minute specific characters." All I endeavoured to show was that isolation can preserve a non-beneficial variation when it has arisen, just as much and effectually as natural selection can preserve a beneficial variation.

Did space permit, I would like to say a few words on climatic variation, and the probable times at which natural selection is most active in the evolution of species; on both which subjects Mr. Romanes unconsciously misrepresents me. My reviewer has nothing whatever to say on my treatment of sexual selection; the use and disuse of organs, inter-crossing, the local distribution of specialised forms, polar centres as points of dispersal, &c.

Mr. Romanes seems to think that my little book was written in an anti-Darwinian spirit. Nothing of the sort. On my last page but one I said, "Let it be clearly understood that not one single syllable in the foregoing pages has been written antagonistic to Darwin's theory of Natural Selection. All I have done has been to attempt to explain certain phenomena which the Darwinian hypothesis can never do, and which its supporters ought never to have attempted to make it explain." If I have not made my meaning plain, and thus left myself open to misunderstanding, it will be a source of great regret. Science and simplicity should be synonymous. In the French edition, shortly to be published, which is now being translated by Dr. Varigny, of Paris, I hope to make a few corrections and additions, which I trust may possibly render me less liable to be misrepresented in future. CHARLES DIXON

London, November 21

I FREELY admit that the impression left upon my mind after reading Mr. Dixon's essay was the same as that which was first conveyed by its title—viz. that the author supposed his work to

be, if not "antagonistic to Darwin's theory of Natural Selection," at all events, as I expressed it, "an important emendation of Darwinism." My object, therefore, while reviewing the essay was to show that this is a character which does not belong to it. If I have misunderstood the meaning of its author on this fundamental point, I should have been glad to have received a more express statement of the fact than appears in the above letter; for I might then have felt that Mr. Dixon's views with reference to the value of his work are in full accordance with my own. As stated in the review, I consider his facts most interesting as examples of trivial specific characters—or slight variations of a fixed kind—due to variation presumably unaided by selection; and when I said that such facts "may be freely presented to the anti-Darwinians," I meant that they might be so presented to any one who supposed them anti-Darwinian. It appeared to me that Mr. Dixon himself regarded them in this light (though not as anti-evolutionary), at all events to the extent of imagining that they had not been sufficiently recognised by Darwinians. But, as I have said, if such is not his meaning, I am very glad to find myself in agreement with him upon this point.

I spoke of these trivial specific characters as "odds and ends," and as of "comparatively rare occurrence," because, although both numerous in themselves and of importance for the purposes of detailed classification, they are insignificant when compared with the whole organising work of natural selection. And if, as Mr. Dixon now repeats, it was the object of his little book "to try and explain the agents" (*i.e.* the *causes*) producing these non-purposive specific characters, I can only repeat that in this respect his book has failed in its object. Lastly, my only reason for not mentioning Mr. Dixon's views on natural selection, &c., was that I found nothing in these views particularly deserving of mention.

GEORGE J. ROMANES

On Radiation of Heat from the Same Surface at Different Temperatures

WITH respect to my recent communication to you on the subject of radiation of heat at different temperatures (p. 85), I wish to remark that the temperature given as the temperature of the surroundings must be taken as only approximate. A remark to this effect was in fact included in the first draft of my note to you, and was inadvertently omitted in the final copy.

If the glass envelope surrounding the wire were perfectly diathermanous, and likewise the intervening air, then the temperature of the surroundings would be simply that of the walls of the room. As it was there is a great difficulty in saying precisely what is to be taken as the temperature of the surroundings. The glass envelope becomes heated to some extent, and will return a certain amount of radiation to the wire. When the vacuum is nearly complete, however, the heating of the glass is slight, and is very small in comparison with the heating when the vacuum is only partial.

The reason I have not used a metallic envelope blackened inside and cooled outside, is that it is very difficult to attach such an envelope in a satisfactory way to the Sprengel pump. I am, however, hopeful of being able to overcome this difficulty.

November 28 J. T. BOTTOMLEY

THE NOVEMBER METEORS

THE watch which was kept on November 27 in the hopes of seeing a shower of meteors from the stream connected with Biela's comet was very amply rewarded. At the Royal Observatory, Greenwich, the weather was somewhat unfavourable, the sky being partly clear only at intervals, yet, when the meteors were first seen, between 6h. and 7h. p.m., they were appearing at the rate of from 30 to 40 per minute. The average brilliancy of the meteors was remarkable. The radiant-point as determined at the Greenwich Observatory from a number of paths was estimated to be about R.A. 20°, Decl. 49° N.

We have received the following communications with reference to the meteor showers:—

THE great display of Andromedes, or meteors of Biela's comet, which occurred on the evening of November 27 last, and which fortunately has been widely observed, adds another corroborative link to the theory, already demonstrated by facts, connecting comets and meteors. Not only does this stream exhibit a perfect orbital resemblance to that of the comet with which it has been associated, but it recurs only at the special times when, according to computation, the comet is in the vicinity of that region of its orbit encountered by the earth on November 27.

Many meteors appeared on the evening of November 26 this year, the hourly rate, as estimated at Bristol, being considerably over 100, and they nearly all belonged to the shower from Biela's comet. But the display on that night was not of very exceptional richness, though it gave distinct intimation of what was to follow. The meteors of November 26 were simply the *avant couriers* of the advancing host, for, as soon as twilight deepened on the following evening, it was seen at once that the shower had greatly intensified. Meteors were falling so thickly as the night advanced that it became almost impossible to enumerate them. Frequently they came in simultaneous groups of five, seven, or ten, all radiating from the immediate region of the star γ Andromedæ, and appeared in every quarter of the firmament with that uniform slowness of movement which is a peculiar feature of the shower.

The prediction that such a display would occur has thus been completely verified, and the character of its leading features has been precisely conformable to anticipation. For not only has a meteor-shower occurred at the appointed time, but it has coincided in all its salient attributes with what has been expected. The radiant-point near γ Andromedæ has been accurately marked, as on November 27, 1872, and the meteors have presented the same visible traits of appearance.

As to the strength of the display, it has been variously described, but there can be no doubt, from the observations, that it will rank in importance with any similar phenomenon recorded in modern times. At stations where the clearness of the atmosphere permitted its full grandeur to be recognised, it would seem that about one meteor per second was counted, and this means a rate of 3600 per hour.

These facts warrant us in the assumption that the earth has recently encountered a very dense region of the meteor-stream. Notwithstanding that these meteors have to overtake the earth in her orbit, and that they therefore travel with the minimum velocity (about eleven miles per second) possible in the case of such bodies, they have returned in surprising abundance. A far more attenuated system, encountering the earth under similar conditions to the Leonids of November 13, which directly meet the earth in her path, must have originated a more numerous display, because a far greater range of such a stream would be traversed in the same interval. Here the velocities of the earth and meteors would be combined by the favourable circumstances of the *rencontre*, and the earth would really penetrate the stream at the rate of some forty-four miles per second. But in the instance of the meteors from Biela's comet, they are travelling in the same general direction as ourselves, and it is only their greater native velocities which enable them to catch up the earth, and become visible in the form under which we have just observed them.

When all the accounts of this remarkable display become available for reduction, it will be important to compare them with those of its predecessor in November, 1872. Though the present shower has been an obvious repetition of the one just referred to, it may exhibit some differences which it will be essential to investigate. In one respect certainly there would appear to be a want of accordance. We refer to the relative durations of the two displays. In 1872, on November 26 and 28, that is, on the nights preceding and following the great shower, very little sign of it appears to have been observed. It was

immediately confined to the night of November 27. In NATURE, vol. vii. p. 104, Prof. Herschel writes:—

"On the evening of the 28th [November, 1872], Mr. Greg watched for shooting-stars, and for any remnants of the star-shower of the previous evening which might be visible, but although the sky was quite clear, he failed to see any meteors. A strict watch for outlying meteors of the shower was also kept by two observers at Hawkhurst, in Kent, on the evening of the 28th, where the sky was quite cloudless between 9h. and 11h. 15m. p.m., but without success, only four shooting-stars of ordinary character being visible."

Prof. Herschel also quotes some observations proving that on November 26 of that year, meteors were singularly rare, and justly concludes from this that the display was confined to an interval of forty-four hours. Now the recent phenomenon was already a conspicuous shower on the 26th, when it was observed at Bristol at about 8.30 p.m., and on the 28th, in a four-hours watch before 11.30, 55 Andromedes were counted in a cloudless sky. We here have a period of fifty-one hours for its observed duration, but there is not the slightest doubt from the activity it exhibited at the opening and termination of the observations this year, that the shower must have been probably visible both on November 24 and 25, and also on the 29th. At Bristol the sky was overcast on these dates, so that the progress of the display during its complete rise and decadence could not be observed. It is certain, however, that it extended over several nights, and that its increase was more gradual, as in the case of the August Perseids, than its decline.

The outlying members of the shower observed at Bristol in the very clear sky of November 28 this year were extremely faint, the majority being of the 5th and 6th magnitude. It is therefore suggested that on the environs of the denser part of the stream, the meteors are of very diminutive size, and this may possibly have enabled them to elude detection at places where the atmosphere was not very clear. W. F. DENNING

AN extraordinarily bright display of Cassiopeiad shooting-stars occurred this evening, commencing, I am told, as soon as darkness set in, at about five o'clock. The sky was then cloudless here, but owing to street-lights I missed observing them between five and seven, and until informed of their appearance a little after half-past seven o'clock. Reaching an open space, and looking up at Cassiopeia, just overhead, I then counted about twenty meteors, all with short courses near that constellation, in the four minutes onwards from 7.40. Such a thick haze overspread the sky except just round the zenith, that only the bright stars of Cassiopeia and two in the Square of Pegasus (β Pegasi and α Andromedæ) were visible there; but several first and second magnitude meteors of the display which proceeded at the same rate until 7.50, left streaks on their short courses visible for two or three seconds through the haze, and these being sometimes actually in sight in groups together, made the direction of radiation very easy to determine. The thickening haze, however, hid the stars so completely at the latter hour, and afterwards, that further observations of the shower for the night have proved fruitless.

To my surprise, this active meteor-shower was diverging, not from the usual Biela radiant-point near γ Andromedæ, but the short meteor-tracks all streamed away from Cassiopeia! This was conspicuous in the meteors near Cassiopeia which travelled thence, as most of those visible did, westwards and southwards towards the Square of Pegasus across Honores Frederici, and eastwards and northwards across Camelopardus and Custos Messium. Although no faint stars in sight allowed their courses there to be regularly mapped, yet, from such a short collection of very good accordances for fixing it very nearly, I would place the radiant-point (by rough eye-estimation only) very near α, or between ζ, η, and θ Cassiopeia, which is about 15° from the Biela radiant-point near τ Andromedæ.

In his "Periodische Sternschnuppen," published at Aix-la-Chapelle in 1849, Heis described a radiant-point of several meteors seen there by him on the nights of December 8 and 10, 1847, between γ and τ Andromedæ, as a prominent one on those nights; and on the evening of November 30, 1867, Zezioli, at Bergamo, mapped a number of meteor-tracks, from which Prof. Schiaparelli obtained a well-marked radiant-point position closely agreeing, like Heis's, with the subsequent exact determination of the place of the "Andromede" star-shower's radiant-point made by numerous observers of the shower's great return on November 27, 1872.

Besides the radiant "A" in Andromeda, seen on the nights of December 8 and 10, 1847, Heis also described, in the same work, another, "C," close to α Cassiopeiæ, as conspicuous on the nights of November 12 and 13, in the years from 1839 to 1847; and he notices that Danse (*Comptes rendus*, vol. v. p. 759), on November 15, 1837, observed a shower of seventeen shooting-stars in a minute and a half diverging from the constellation Cassiopeia. In connection with the December epoch it is also noted that of a large number of meteor-tracks observed by Herrick at Newhaven, U.S., on December 7 and 8, 1838, about three-quarters diverged from the principal stars of Cassiopeia, and that Flaugergues, at Toulon, in France, made a similar observation on December 6 of the same year, 42 meteors, about 9 o'clock, falling vertically from the zenith, and 31 of them on nearly parallel courses from about Cassiopeia's place in it (as the account implies) between the Milky Way and the Square of Pegasus.

Although the connection of this "Cassiopeiad" stream with Biela's comet would seem, from the position of its radiant-point, to be somewhat doubtful, yet the occurrence now, as it appears, of a shower with nearly the same radiant point on the night of the famous Biela star-shower's date in 1872, makes the probability much greater than before that the "Cassiopeiads" of December 6 to 10 and the "Andromedes" of Heis, belonging to the same date and to November 27 to 30, may not be unassociated star-showers, but that both may possibly have had their origin in some bygone disruptions of Biela's comet! The position of this star-shower's radiant-point will, it is to be hoped, have been determined accurately by more fortunate observers than myself of its very striking apparition, so as, if it befits them, to corroborate these slight observations generally, and to fix the shower's centre of divergence with the astronomical position which is most desirable from these suggestive indications.

Four Leonids, varying from first to third magnitude stars in brightness, and leaving no streaks, were seen here between 2.10 and 2.50 a.m. on the 15th inst., together with two small sporadic meteors, in a clear moonless sky. They indicated plainly, by the accordant radiation outwards on a map of their long swift courses, from a moderately wide area in Leo's Sickle, a slender recurrence of that great star-shower this year. Its maximum now appears to present itself at least as distinctly on the morning of the 15th, as on that of the 14th of November, as the nodal line of the meteor-stream advances. Its short-lived displays, it may be gathered from this regular progression, need scarcely now be looked for any longer, on that account, on either of the historically famous dates of the 12th and 13th of November, of its once pre-eminently grand and imposing exhibitions, while a centenary view of one of those is not actually now a very distant event to look forward to on a coming 15th of November morning in the year 1899.

A. S. HERSCHEL

Newcastle-on-Tyne, November 27

P.S.—*November* 28.—On looking at the stars in a clear sky to-night, I find that those described above as having been just visible near Cassiopeia were not chief stars of the Square of Pegasus, as supposed, but bright stars in Cygnus and Cepheus! Instead of crossing Honores, therefore, the chief meteor-flights of the stream observed were shooting from the true Biela radiant-point near r Andromedæ, past Cassiopeia into Cepheus. Other stragglers there certainly were, whose general radiation from Cassiopeia could not be thus accounted for. Just similar variations of direction, however, were common among a rather large proportion of the "Andromedes" in the great shower of November 27, 1872, which had rather an average than a very sharply marked radiant-point in Andromeda. There appears no reason to doubt, therefore, that on this occasion also the shower proceeded from the same prevailing centre of divergence.

From many observers' descriptions of it here, the present shower would seem to have been hardly, if at all, inferior in any respect—of duration, of brightness and multitude of its meteors, or of persistency in the light-streaks left upon their tracks—to the great and well-remembered display of the Biela's comet meteor-shower in November, 1872.

As you may be desirous to make known any observations respecting the meteor-shower of the 27th inst., I beg to furnish you with those noticed by myself.

At sunset the sky was overcast, but happily at 6.30 p.m. the clouds dispersed, when the phenomenon was seen here in full splendour; the heavens were alive with the meteors making their rapid appearance and extinction.

My attention was attracted chiefly to the constellations of Cassiopeia, Andromeda, and towards Perseus, from whence the most brilliant portion of the shower was in operation, and from that locality the most conspicuous meteors shot forth. Selecting the most remarkable out of the numerous luminous trains for their length of traverse, and conceiving the line of direction to be thrown backwards, the convergence of these trains concentrated towards a point in Andromeda, in accordance with the position of the radiant-point as predicted in the Dun Echt Observatory Circular.

The paths taken by the above meteors were, in many cases, directed towards the southern horizon, and several towards the Pleiades in the east, from the radiant-point; others flitted away to every point of the compass, exhibiting longer or shorter trains during their ephemeral existence.

The general illuminating effect produced by the shower was appreciable, but it was not very powerful; and with regard to the colours which were exhibited in the luminous trains, my views combined with the opinions derived from other observers coincide—that the colour aspect of these transient illuminants varied apparently between golden and very pale-green tints.

But with reference to the zenith and its surrounding region, it was noticeable there that the conditions of the meteors had other characteristics, inasmuch as they were almost devoid of path or connection with any radiant-point, they were remarkably numerous, a great proportion of them exhibited no more than feeble flashes or scintillations of white light, the display was maintained with great rapidity and continuously.

It was also noticed that an erratic meteor was seen occasionally taking an independent course of considerable length, about 45° of arc, sometimes at low elevation, making an acute angle with the horizon.

About 7.15 p.m. clouds obscured the sky for the night, so I did not see either the beginning or the termination of this interesting phenomenon.

Comparing the great display of meteors which I observed in November, 1866, it was in all respects more magnificent than this recent shower. I could not on this occasion define any head or nucleus to any of the luminous trains, but this feature was remarkable in the large meteors of 1866.

As a single observer, it was impracticable for me to attempt any enumeration of the enormous number of meteors, and to observe the prominent features of the phenomenon at the same time. At midnight it was blowing a strong gale from the south-west; thick weather, with a mild temperature of 53°.

ERASMUS OMMANNEY

Yarmouth, Isle of Wight, November 29

THINKING, from the character of the weather on the night of the 27th, that opportunities of seeing the late splendid display of meteors may have been extremely local, I have taken the liberty of forwarding my notes of them as I saw them here from between a little before 6 p.m. until 7.35 p.m. How long the shower had been going on before (attracted by the cries of some passing boys) I looked out, I cannot say, but just before six when I did so, the sky was covered in many places with a thin haze, through which the larger stars and planets were looking greasy, as sailors say, while in nearly every direction meteors were gliding and bursting from a point a little to the eastward of the zenith toward the horizon; the meteors varying in brightness from that of the planet Venus to the faintest streaks of light. The larger ones were very like pale inverted rockets, having trains of many degrees in length, and often prismatic in colour; that is, near the head the light of the train was bluish, blending from green to yellow, followed by rose or crimson sparks. In many cases this train was visible for quite thirty seconds after the star was burnt out, first as a bar of warmish dusky light, and often becoming curved, as though by wind, as it faded away.

The silence of the display was almost oppressive, as one expected each moment to hear the bang of fireworks. During most of the time masses of luminous-looking vapour floated slowly across the sky. Some of the meteors seemed to burst end on, right over head, and though, being foreshortened, these left no train, yet they were among the brightest. I noted a considerable variation in the speed of the meteors, and am inclined to think that those which appeared farthest off moved slowest. It was next to impossible to say in which direction the star rain was thickest, for just as one was trying to make up one's mind upon this point, a troop of stars from an unexpected part of the sky would appear. Other observers may be able to speak more positively than I can upon this subject; but my impression, as well as that of those who saw them with me, was that they streamed down in groups of two, three, and four toward almost every point of the compass. About 7.20 p.m. the number seemed to become rather less, and at 7.35 this was markedly the case, though they were quite frequent enough then to have attracted attention any other night. Shortly after 7.35 the sky here became overcast by a storm-cloud, and it has remained so ever since, blowing a hard gale at S.S.W.

ROBERT LESLIE

Moira Place, Southampton, November 28

A BRILLIANT display of the Andromedes was seen here on the night of November 27 from about 6 p.m. to 9 p.m., after which time the sky was clouded over. During a walk of ten minutes (from 6.20 to 6.30), facing the north-west, I counted 150 meteors within that half of the visible heavens; and as they appeared to be nearly if not quite as numerous in the other half their total number would not be less than 1500 per hour. The radiant point was almost directly overhead. The meteors varied greatly in size, many being very small and faint. The larger ones left bright trails of a white or bluish colour. I observed one only in an opposite direction, and none with curved or zigzag paths. The shower was less grand than that of

the Leonids in 1866, in which there was a larger proportion of brilliant meteors, many of them coming in flights of three to six at once, all near together; but with that exception the display of the Andromedes this year was the finest piece of celestial pyrotechny I have ever had the good fortune to witness. We seemed to stand under an encircling canopy of dropping lights.

Birstal Hill, Leicester, Nov. 28 F. T. MOTT

AN extraordinary meteoric display was visible here last night. I first observed it at 6.40 p.m., and was watching it at intervals for more than an hour later, when the sky became overclouded. Altogether the number of shooting-stars was immense. Unlike the correspondent of the *Daily News*, who observed a similar phenomenon at Naples the same night, I was unable to count the number per minute. Appearing suddenly, and often many at a time, in all parts of the heavens, from the zenith to the horizon, they quickly disappeared from view, the distance travelled not being more than a few degrees in any case. Some were much more luminous than others, and all in their passage through the air were followed by the usual trail of light. E. F. BATES

Leicester, November 28

THOUGH densely cloudy during the afternoon of the 27th, the sky became clear here about 6.30 p.m., when great numbers of meteors were to be seen, falling at the rate of fully 60 per minute, many being of great brilliancy. During the evening their number gradually decreased, till towards 10 o'clock very few were visible. The sky then again became overcast. PERCY T. INGRAM

Belvoir Gardens, Grantham, November 29

THE star-shower predicted by several astronomers was well seen here on Friday evening last. When first observed, at 5.30, the rate of fall was 25 per minute; the numbers, however, increased rapidly during the next half-hour, till, at 6 o'clock, more than 100 meteors were counted in a minute.

At 6.20 a marked decrease in the intensity of the shower was noted; but at 6.38 the numbers once more increased, till a rate of 70 per minute was attained; after this, however, they gradually diminished as the hours went on. It is right to mention that the numbers given above are those of the meteors seen by an observer looking towards the east; they do not represent the total number that fell at these two periods.

The radiant-point, as indicated by the position of several meteors which suddenly flashed out without sensibly changing their position, was close to γ Andromeda, or, more exactly, R.A. 21°, N.P.D. 46°.

Most of the meteors were mere "shooting-stars"; a large number, however, had brilliant phosphorescent trains, which continued to glow for several seconds after the meteors themselves had vanished. Occasionally one of the trains would break up into fragments, and in one instance a curious spiral form was assumed.

A special feature of the shower was its varying intensity, and that more particularly between 6 and 7 o'clock.

JAMES SMIETON

Broughty Ferry, Dundee, November 30

OUR Paris Correspondent writes:—The shower of falling stars has been observed at a number of French stations—Toulouse, Central France, Tunis, and Algiers. The point of emanation was, in the case of some of them, between Andromeda and Cassiopeia. In Paris it was not observed, owing to the foggy state of the atmosphere, and no balloon observation having been tried.

The following letters on the meteors appeared in the *Times* of Saturday:—

Mr. T. G. Dyson, of 1, Rothesay Villas, Windsor, wrote on Friday night:—"I was fortunate in witnessing this evening from 6.15 to 6.40 a most magnificent shower of stars, which might be compared to a flight of swallows, with a lull of a few seconds between each flight. Although the sky was anything but clear—only stars of the larger magnitude being visible—the meteors were brilliant, and in many instances left a distinct trail behind them. The direction was principally from east to west, varying to north-west."

The Leicester Correspondent of the *Times* telegraphed last night:—"A remarkable display of meteors was witnessed in Leicestershire to-night from dusk until a late hour. The display was most brilliant towards the western horizon, the meteors falling in perpetual showers, with brilliant trails, like a very fine display of fireworks."

A Reuter telegram from Athens, dated November 27, says:—A brilliant shower of meteors was observed here to-night."

A Newcastle-on-Tyne correspondent telegraphs:—"There was a splendid meteoric display here. I saw about 500 an hour. Radiating point Cassiopeia."

Prof. Pritchard, of the University Observatory at Oxford, telegraphs that he counted 251 meteors between 6.34 and 6.39 p.m., and 305 between 7.14 and 7.19.

IN case no one else may have reported the complete fulfilment of the prediction suggested by Lord Crawford's Dun Echt Circular allow me a few lines to do so.

I did not begin to observe systematically until nearly 8 p.m. (7h. 58m.), when I found that, confining my attention to one-third of the sky (south-south-east to west-north-west), and computing therefrom, meteors were falling at the rate of 33 a minute. Shortly after this they became more numerous, and from 8h. 5m. to 8h. 10m. they were falling at the rate of 56 a minute (nearly one a second), or more than 3000 an hour. From 8h. 30m. to 9h. 30m. the view was much hindered by cloud, but it was evident that the number was decreasing. From 9h. 30m. to 10h. the average fell to about 12 a minute, or scarcely a fifth of what it was at 8h. 5m.; and shortly after 10 p.m. the sky became entirely overcast.

I well remember the glorious shower in 1866. On that occasion the meteors were both larger and more numerous than they have been this evening, but occasionally they were very frequent—for example, at 7h. 59m. five were visible in less than two seconds (the precise period was one second and six-tenths).

G. J. SYMONS

62, Camden Square, N.W., November 27

In Paris, according to the *Times* Correspondent, the sky was overclouded all Friday night, but the meteor-shower was seen to advantage in the South of France, in Belgium, Germany, Spain, and Italy, as also in Tunis, where the natives were much startled. At Châtelhérault the meteors were well seen. At Cologne, Dr. Klein counted 636 between 6 and 7 o'clock, though the sky was at times overclouded. Most of them moved very slowly and left a trail of light, which quickly disappeared. Four were large and brilliant enough to be styled fire-balls. From 7.30 to 8 he counted 309, from 8.30 to 9 there were 375, and from 9 to 9.30 there were 208. The sky then became cloudy. Not one can have reached the ground, for they must have burned out and dispersed in the upper atmosphere. At Munich the sky was perfectly clear, and the display was very striking.

THE LATE SIR WILLIAM SIEMENS

ON Thursday last the relations and friends of the late Sir William Siemens assembled in the Jerusalem Chamber of Westminster Abbey for the purpose of doing

honour to his memory by the unveiling of a memorial window, which has been contributed by members of the five engineering Societies with which Sir W. Siemens was associated in the Abbey. The day was chosen as being the second anniversary of the funeral service which was held in the Abbey previously to the interment of the great *savant* at Kensal Green Cemetery.

Among those present were Mr. Arnold Siemens, Miss Gordon, Dr. Werner Siemens, and Mr. Alexander Siemens. Of the Civil Engineers Sir Frederick J. Bramwell, F.R.S., President, Sir Charles H. Gregory, K.C.M.G., Mr. Bateman, F.R.S., Mr. Barlow, F.R.S., Sir J. W. Bazalgette, C.B., Mr. Preece, F.R.S., Sir R. Rawlinson, C.B., and others, besides representatives of other Societies, among them Admiral Sir R. Spencer Robinson, K.C.B., Dr. Percy, F.R.S., Sir Bernhard Samuelson, Sir Henry Bessemer, F.R.S., Prof. W. G. Adams, Sir F. A. Abel, C.B., Prof. D. E. Hughes, F.R.S., Prof. Ayrton, F.R.S., and Dr. Hopkinson, F.R.S.

The Dean opened the proceedings by a brief address. "It is not for me," he said, "to dwell for a moment on the signal services to the cause, not only of science, but still more the application of science to the well-being of mankind, that will be always associated with the name of Sir W. Siemens. But I may add my own personal testimony to the impression which the character of your friend and leader, for such in a wide range of subjects I may surely call him, made on all who came into contact with him. He was, as you know, and as I know, not only admired and honoured, he was beloved and deplored. May the window which we shall now uncover do its proper work. . . . And may it remind us and far-off generations of the achievements and character of him whose memory will henceforth be here linked with that of his illustrious brethren, whose names the floor on which we shall soon stand, and the walls beneath which we shall pass, proclaim and preserve—the Newton, the Herschel, and the Darwin, the Stephenson, the Locke, and the Brunel, the Barry, to which add the Gilbert Scott, and Street—who sleep, or are honoured hard by."

Sir F. Bramwell, who spoke as the President of the Civil Engineers, the senior of the Societies represented, then made some remarks on Sir W. Siemens's contributions to applied and pure science.

The window, which has been designed and executed by Messrs. Clayton and Bell under the direction of Mr. J. L. Pearson, is intended to illustrate the maxim "Laborare est orare." It consists of two lights with a sixfoil in its traceried head. Each of these lights is composed of three panels in vertical order. In the left-hand light appear ironsmiths, chemists, and agriculturists; in the other groups in corresponding positions show astronomers, artists, and the professor with his scholars. Between these groups are in all cases angels bearing labels inscribed with the words giving the key-note of the conception—namely, "Laborare est orare." In the sixfoil at the head of the window is a representation of the sun as the source of light, surrounded by the words, "Dixit autem Deus fiant luminaria in firmamento cœli," and by the various heavenly bodies from which light emanates or is reflected. At the base is the following inscription:—"In memory of Charles William Siemens, Knt., D.C.L., LL.D., F.R.S., Civil Engineer. Born 4 April, 1823; died 19 November, 1883. Erected as a tribute of respect by his brother Engineers."

NOTES

IT is gratifying to be able to announce that a pension of 300*l.* a year has been conferred upon Prof. Huxley from the Civil List Fund. We are also much pleased to notice the admirable articles in the *Times* and other papers on the retirement of Sir Joseph Hooker and Prof. Huxley, indicating, as they certainly do, the general growth of scientific interest.

WE regret to learn of the death, in his 72nd year, of Prof. Thomas Andrews, F.R.S., the eminent chemist. We hope to be able to refer to his work in detail in our next number.

BOTANISTS all the world over, we are sure, will he glad to learn that Mr. W. T. Thiselton Dyer, C.M.G., F.R.S., has been nominated to succeed Sir Joseph Hooker in the Directorship of Kew Gardens.

OUR Paris Correspondent informs us of the death of M. Bouley, President of the Paris Academy of Sciences, who was to have held office until the first meeting of 1886. M. Bouley, who was born in Paris in 1814, died of heart disease, under which he had been labouring for many years. He was, during many years, Director of the Veterinary School of Alfort. He has published a large number of memoirs on physiological researches, and was a popular writer and an eloquent debater.

THE reports of observations of the total eclipse of the sun of August 7, 1869, made by parties under the direction of Prof. Coffin, Superintendent of the *American Nautical Almanac*, have recently been published by the authority of the Secretary of the Navy. All lovers of astronomy will regret to know that this late publication in full of observations made sixteen years ago is due to the failing health and sickness of Prof. Coffin. This is, however, the less to be regretted since pretty full reports were made by the individual observers at the time, and the important observations secured have in this way found their place among the records of eclipse phenomena. The illustrations which accompany the volume are very beautiful.

WE have received No. 15 of the professional papers of the Signal Service of the United States Army, containing a full account of Prof. Langley's researches on solar heat and its absorption by the earth's atmosphere, undertaken during, and in connection with, the Mount Whitney Expedition. Prof. Langley has already himself given an account in NATURE of the important results he thus obtained. A perusal of the volume, however, shows that all who are interested in this subject will do well to refer to the present volume and the more detailed accounts they will find there touching the various parts of the research. It is a monument of industry and skill and undaunted perseverance of which Prof. Langley may well be proud.

THE Christmas Lectures at the Royal Institution will be given by Prof. Dewar, on "The Story of a Meteorite" (with experimental illustrations), commencing on December 29. Courses of lectures will probably be given before Easter by Prof. R. S. Ball, Mr. R. S. Poole, Mr. C. T. Newton, Dr. A. Gamgee, Mr. W. C. Roberts-Austin, Prof. Boyd Dawkins, Prof. Tyndall, Mr. A. Geikie, Rev. C. Taylor, Mr. E. B. Poulton, and Mr. H. Grubb. The Friday Evening Meetings will begin on January 22, when a discourse will be given by Prof. Tyndall. Succeeding discourses will probably be given by Sir William Thomson, Mr. T. P. Teale, Prof. O. Reynolds, Mr. W. K. Parker, Mr. A. A. Common, Prof. A. Macalister, Mr. R. S. Poole, Mr. W. H. M. Christie, Mr. W. Anderson, Sir Henry Roscoe, and others.

THE curriculum of the Paris School of Ethnology (founded by M. Broca in 1876) for the current session embraces courses of lectures on zoological, general, and prehistoric anthropology, ethnology, medical geography, and the history of civilisation. The course on linguistic anthropology does not commence until the spring. On zoological anthropology Dr. Duval will lecture on anthropogeny and comparative embryology: the blastoderm and the first phases of development. In general anthropology, Dr. Topinard will take type and race: the first part analytical—the races of Europe from prehistoric times down to our own

days ; the second part synthetical—the succession and transformation of races, their past and future. In ethnology, Dr. Dally will take ethnical craniology ; in prehistoric anthropology, M. Mortillet takes Tertiary man ; and in the history of civilisations, Dr. Lebourneau will lecture on the evolution and ethnography of morality.

WE have received the price list of the publications of the Smithsonian Institution up to July last. It includes only such publications from 1847 to the present year as can be supplied, all others being out of print. The latter are very numerous, for of the first hundred publications only forty-six are now to be procured, the remaining sixty-four being out of print. The list first gives the papers according to their numbers in the publication catalogue of the Institution, then according to the authors, then according to their subjects, and finally they are arranged under heads according to their mode of publication, such as "Annual Reports," "Contributions to Knowledge," "Proceedings of Societies," &c.

TELEPHONIC communication between Paris and Rheims was opened to the public on Tuesday. The distance is 172 kilometres, but the electric resistance to be overcome between the two points is estimated at 217 kilometres. The ordinary telegraphic wire is utilised for the purpose, but there is a special telephonic station in the Plain of St. Denis, at the Pont de Soissons. The tariff is one franc for five minutes' conversation. At the inaugural *séance*, conversations were held with sundry public functionaries at Rheims, whose voices were heard with perfect distinctness.

PROF. DU BOIS-REYMOND, it is known, has recently availed himself of good opportunities for studying the electric ray in the live state ; and among several important facts elicited by him is that of irreciprocity of conduction in the electric organ. That is, when short currents are passed through the organ in the same direction as that of the animal's proper current, viz. from belly to back, and in the reverse direction, the conductivity in the former case is considerably greater. This irreciprocity begins to appear only when the current has acquired a certain strength ; it increases with the strength, but more slowly. Both this irreciprocity and the small conductivity of the organ (which is considerably less than that of sea water) are proved to be connected with the life of the animal ; the former disappears and the latter increases in the case of spontaneous death. The former depends also on the duration of the current, diminishing with a continuous current. This phenomenon of irreciprocity appears to have the effect of strengthening the animal's current and so intensifying its physiological action in external space. The author's researches on the subject have been recently laid before the Berlin Academy (*Sitzungsberichte*, Berlin Academy, 1885, p. 691).

THE fresh-water mussel, it is known, closes its shell by contraction of two strong muscles—one before and one behind ; but how does it open its shell? This question has recently been studied by Herr Pawlow (*Pflüger's Archiv*). The animal (*Anodonta cygnæa*) was fixed on a board by one shell, while the other free shell was connected by means of a silk thread with the short arm of a lever, the longer arm of which indicated the movements on a slowly-rotating drum. The nerves were variously irritated ; but without giving details we may say that Herr Pawlow finds there are two classes of nerve-fibres connected with the muscles—the one motor, producing contractions ; the other inhibitory, producing relaxation. The motor nerves for each muscle spring from the ganglion next it ; the inhibitory fibres all proceed from the two front ganglions. The posterior ganglion can thus only send an impulse of movement to the posterior closing muscle, while the front ganglions, besides being thus related to the front muscle, can also produce relaxation in both muscles. When separated from the ganglions belonging to them the muscles pass but very slowly from the contracted to the relaxed state. A remarkable fact, noted by Herr Pawlow, is that by stimulation of the nerves in the muscles contraction does not always follow, but sometimes relaxation. Such phenomena are rare ; they have been observed in the blood-vessels, and Herr Biedermann has noticed them in the heart of the snail.

THE hatching of fish-ova has commenced at the establishment of the National Fish-Culture Association, South Kensington, several agents having been employed lately to artificially spawn fish, which in many parts are well forward. The species chiefly operated upon have been the *Salmo fario* and *S. levenensis*. The American Government have promised to forward large consignments of ova from the various species of Salmonidæ abounding in their waters, particularly the whitefish, whose eggs will be incubated in very large numbers by the Association.

THE telegraph system of the Great Northern Telegraph Company has been extended to Seoul, the capital of Corea, and to its port, Jenchuan, or Chemulpo. These two places are therefore in telegraphic communication with the rest of the world.

A WRITER in the *North China Herald*, on ethnology in China, points out that while there have been geologists, botanists, and zoologists in China, no one has yet given himself specially to ethnology who was already distinguished in it. The province of Szechu'en is a very interesting and important region for the work of the ethnological geographer, because of the Thibetan tribes, the Lolos, and others located there. In the historical ethnology of China, De Guignes led the way in the last century in his "History of the Huns," which unfortunately were not the real Huns, for the Huns of Hungary were not, as he supposed, the powerful race known in China as the Hiung Nu. Yet he did much in elucidating the history of all the Tartar races, and his great merit was that he collected a large store of historic facts from Chinese sources, from the second century B.C., when the Chinese began to know Tartary, down to the days of the Mongol conquest. Klaproth settled the point who the Hiung Nu really were by the simple method of taking the words mentioned as theirs by Chinese authors, and finding out to what linguistic stock they belonged. Besides making this step forward, Klaproth also tabulated the facts of Chinese history relating to all Asiatic races.

WHAT remains to be done for ethnology in the field of Chinese history is, the same writer adds, by no means a small amount of work. It is possible to trace the Indo-European races mentioned by ancient Chinese authors, and follow them in their movements westward, from Kansu to the Tsemgling mountains, and beyond, where at Bokhara and Kunduz they meet with other Indo-European stocks. In the north-west, besides these, Chinese history introduces us to several Indo-European peoples, occupying before the birth of Christ the country around the Sea of Aral, from which the Germanic races appear to have moved westward. The Chinese tell us nothing of the first emigrants, the Cimbri and Celts, but they give very considerable information about the Germanic races, the value of which has not yet been fully appreciated. Then the Huns, Avars, and Turks went forward, and the facts respecting them in Chinese history are, taken altogether, more abundant than upon any other foreign stock of nations. "Hence there is every inducement for the historical ethnologist to study Chinese history carefully."

MESSRS. MACMILLAN AND CO. will publish immediately a work on the "Elements of Thermal Chemistry," by Mr. M. M. Pattison Muir, assisted by Mr. D. M. Wilson. It is intended to present a connected account of the methods and results of the

most important researches in the subject. Dealing rather with principles than with details, it is adapted for the use of students with a fair knowledge of the principles of Chemistry and the outlines of the study of Energy. The book is divided into two parts—the first devoted to the statement and consideration of the various branches of thermal chemistry; the second comprising most of the data on which the science is built. These data are classified and tabulated in five appendices, which it is hoped will prove of considerable service to students.

A NEW and thoroughly revised edition of Mr. H. B. Woodward's "Geology of England and Wales" is announced. The author has devoted nearly all his leisure hours since 1876 to the preparation of it, sparing no pains to render it as complete and accurate as possible. While giving prominence to the general description of the rocks, their leading fossils, and economic products, some details will be inserted to show the chief variations of the strata when traced across the country. Numerous tables and diagrams will also be given, to show the relations of the larger groups and of the local and minor divisions of each series of stratified rocks. The history of each rock-name, and its synonyms, so far as possible, will be briefly noted. The endeavour is made to explain every local rock-name, as well as the terms applied to particular beds or zones of fossils. The account of the geology of the principal lines of railway will be very much enlarged. The book will be published by subscription. Mr. Woodward's address is 7, Kelvin Terrace, Highbury Park, N.

THE additions to the Zoological Society's Gardens during the past week include a Levaillant's Cynictis (*Cynictis levaillanti* ♂) from South Africa, presented by Mr. W. Hope; a Yellow-footed Rock Kangaroo (*Petrogale xanthopus* ♀), a Wedge-tailed Eagle (*Aquila audax*) from Australia, presented by Mr. G. T. Wills; a Cape Buffalo (*Bubalus caffer* ♂) from South Africa, presented by Mr. J. Gorton; two Cape-crowned Cranes (*Balearica chrysopelargus*) from South Africa, presented by His Excellency Sir Henry E. Bulwer, G.C.M.G.; a Goshawk (*Astur palumbarius*), European, presented by Mr. W. H. St. Quintin; an Indian Kite (*Milvus govinda*) from India, presented by Mrs. E. C. Mathews; a Cerastes Viper (*Vipera cerastes*) from Moses' Well, Arabia, presented by Lieut.-Col. G. W. Smith; two Moose (*Alces machlis* ♂ ♀) from Norway, a Blue and Yellow Macaw (*Ara ararauna*), a Red and Yellow Macaw (*Ara chloroptera*) from South America, four Gold Pheasants (*Thaumalea picta* ♂ ♂ ♀ ♀) from China, deposited; two Ring-tailed Lemurs (*Lemur catta* ♂ ♂) from Madagascar, two Aldrovandi's Skinks (*Plestiodon auratus*) from North-West Africa, purchased; three Lions (*Felis leo*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE DEARBORN OBSERVATORY.—Prof. Hough's report to the Directors of the Chicago Astronomical Society is as usual chiefly occupied with the observations of Jupiter which have been made with the great refractor. The great red spot still forms, of course, the object of greatest interest. The curious filling up which it underwent last February, whereby for a time it presented the appearance of a reddish elliptical ring, with a white centre, is described, and also its gradual return to its normal appearance. The red spot has now been watched for seven years, and during that time its latitude, shape, and size have undergone but little change. The length, however, appears to have diminished slightly in 1884 as compared with 1883, Prof. Hough's measurements being 12″·29 for 1883, and 11″·26 for 1884. The breadth, on the other hand, seems somewhat greater, so that it is less markedly elliptical than in former years. The mean rotation period for the interval 1884 September 25 to 1885 June 29 was found to be 9h. 55m. 40·4s., or somewhat greater than in previous years. "The depression in the equatorial belt under the red spot, which was formed in 1882, has continued, but is gradually being obliterated." "The principal equatorial white spot which has been observed since 1879 was not so conspicuous as in former years." The old rotation value, 9h. 50m. 9·8s., satisfied the observations.

Of other observations the principal recorded are the discovery of thirty-nine new double stars, an observation of the companion to Sirius, 1885·195, Dist. = 7″·96, Posn. Angle = 32°·7, and a series of photographs of the sun taken during the partial eclipse of 1885 March 16. Prof. Hough describes a printing chronograph which he has had constructed, and which records at once the time of an observation to the hundredth of a second, and obviates the labour now necessary to convert the ordinary chronographic record into numbers. He estimates the pecuniary value of this labour in a first-class observatory as at least 200*l.* annually.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, DECEMBER 6–12

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

At Greenwich on December 6

Sun rises, 7h. 53m.; souths, 11h. 51m. 22·3s.; sets, 15h. 50m.; decl. on meridian, 22° 34′ S.: Sidereal Time at Sunset, 20h. 52m.

Moon (New) rises, 7h. 18m.; souths, 11h. 51m.; sets, 16h. 21m.; decl. on meridian, 17° 34′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	9 36	13 18	17 0	24 55 S.
Venus	11 16	15 17	19 18	22 12 S.
Mars	23 11*	6 0	12 49	8 48 N.
Jupiter	1 8	7 12	13 16	0 5 S.
Saturn	17 19*	1 28	9 37	22 25 N.

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

Occultations of Stars by the Moon

Dec.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
11	18 Aquarii	6	20 31	21 30	166 306
12	B.A.C. 7697	6½	17 56	18 56	88 355

Phenomena of Jupiter's Satellites

Dec.	h. m.		Dec.	h. m.	
6	5 19	I. tr. ing.	10	4 27	II. ecl. disap.
6	7 35	I. tr. egr.	10	5 26	IV. tr. ing.
7	1 31	I. ecl. disap.	10	7 30	IV. tr. egr.
7	4 56	I. occ. reap.	12	1 59	II. tr. ing.
8	2 4	I. tr. egr.	12	4 47	II. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, December 6.—Outer major axis of outer ring = 46″·2: outer minor axis of outer ring = 20″·1: southern surface visible.

Dec.	h.	
8	6	Mercury in conjunction with and 6° 3′ south of the Moon.
9	7	Venus at greatest elongation from the Sun, 47° east.
9	15	Mercury stationary.
10	23	Venus in conjunction with and 5° 56′ south of the Moon.

Variable Stars

Star	R.A. h. m. s.	Decl. ° ′	Epoch	h. m.	Phase
U Cephei	0 52 8	81 15·3 N.	Dec. 9,	2 46	*m*
Algol	3 0 41	40 30·7 N.	Dec. 7,	19 46	*m*
λ Tauri	3 54 19	12 9·9 N.	Dec. 9,	17 54	*m*
S Cancri	8 37 22	19 26·8 N.	Dec. 12,	4 52	*m*
X Sagittarii	17 40 19	27 47·1 S.	Dec. 8,	21 30	*m*
η Aquilæ	19 46 37	0 42·7 N.	Dec. 7,	7 0	*M*
			,, 12,	2 30	*m*
δ Cephei	22 24 54	57 49·6 N.	Dec. 7,	1 0	*M*
			,, 10,	20 30	*m*

M signifies maximum; *m* minimum.

Meteor Showers

The two principal showers of this week are the Taurids II., radiant R.A. 80°, Decl. 23° N., near ζ Tauri ; and the Geminids, radiant near α Geminorum ; the former should be specially looked for on December 6, the latter December 9-12. Fireballs have frequently been seen during the latter period. Another shower from Taurus, R.A. 56°, Decl. 6° N., near ν Tauri ; and another from Gemini, R.A. 108°, Decl. 20° N., near ζ Geminorum, have also been sometimes observed during this week.

Objects with Remarkable Spectra

257 Schj.—R.A. 21h. 50m. 58s., Decl. 49° 57′·2 N. Mag. 9·1 Secchi's fourth type. The dark band in the yellow is abnormally broad.

19 Piscium.—R.A. 23h. 40m. 31s., Decl. 2° 51′·0 N. Mag. 6·2. One of the finest examples of the fourth type of spectrum.

Mr. Marth has called attention to the following conjunction of Saturn with DM. 22° 1383, which should be watched, as it may possibly prove to be an occultation :—

	h.			
Dec. 9 ...	16·4	* δ	with *p* edge of ring,	$y = -\ 8''{\cdot}0$
	18·4	* δ	with centre of Saturn,	$y = -\ 12''{\cdot}2$
	20·5	* δ	with *f* edge of ring,	$y = -\ 16''{\cdot}4$

The magnitude of the star is 8·7.

GEOGRAPHICAL NOTES

THE *Invalide Russe* publishes the following telegram from Col. Prjevalsky from Pishpek, but dated Karakol, 2nd (N.S. 14th) November :—"Our voyage has ended happily, and with the most encouraging scientific results."

AT the meeting of the Paris Geographical Society on the 20th ult., M. Alphonse Milne-Edwards in the chair, the return of M. de Brazza was announced, as well as his promise to read a paper before the Society on his journeys in the Congo. The President also reported the return of M. Aubry from more than two years' exploration in Choa and part of the country of the Gallas, Danakils, and Somalis. During that time he determined the course of the Haouach River and its affluents, the Mongueur, Goudredet, and Ganjad, as well as the heights of various mountains. He was also able to make numerous observations on the geology, palæontology, and mineralogy of the region. M. Duveyrier stated that the altitude of Fez, which has never before been determined, is about to be calculated by M. Feraud, by the barometer, to within 10 metres. He has found it necessary to make no fewer than 127 observations in order to obtain this result. M. Coudreau referred to the latest stage of the dispute between France and Brazil with regard to the territory lying between French Guiana and Para.

THE *Bulletin* (1885, No. 5) of the Belgian Society of Geography contains a long paper by M. Leclercq on Mexico, which is really a translation and *résumé* of a recent Mexican publication. The present paper is arranged under the following heads :—Situation and boundaries, institutions, political divisions and population, ethnography, with an approximate census of the Indian tribes, industries, railways, and other methods of communication, orography, climate, and productions. It is thus, it will be perceived, a tolerably complete account of the Mexican States.

THE *Boletin* of the Geographical Society of Madrid for October (vol. xix. No. 4), is, as might be expected, mainly occupied with the Caroline Island question. The only map attached to the number is one of the Western Pacific from the Philippines on the west and New Guinea on the south, including the Pelew, Caroline, Marshall, Gilbert, and Ladrone or Marianne groups. The first contribution is a letter from the Society by its authorised officers to the Government on the question, and claiming the islands as belonging historically to Spain.

IT is stated that an accurate survey of the Island of Yezo, and the neighbouring islands (especially the Kuriles), is to be made by the Japanese Naval Department. It is anticipated that the work will occupy four years.

AN Exhibition of Appliances used in Geographical Education in England and on the Continent will be opened by the Royal Geographical Society at 53, Great Marlborough Street, on December 9, and will remain open till January 31.

THE latest numbers of the *Verhandlungen* of the Berlin Geographical Society (Band xii. Nos. 7 and 8) contain papers by Dr. Penck, on the mountain systems of Central Germany ; and by Dr. Schulz, on a journey from Port Natal to the Kalahari, and especially the exploration of the Rivers Chobe and Cubango. Dr. Rath (in No. 8) contributes a geographico-geological study of the Pacific regions of North America, and the substance of a lecture by Dr. Buchner on the Cameroons is also given.

A CORRESPONDENT with General Scratchley in New Guinea reports that Mr. H. O. Forbes is going to attempt to reach the summit of Mount Owen Stanley, 13,205 feet high, and hitherto untrodden by the foot of man. Mr. Forbes will form a depôt camp at Sogeri, 25 miles inland, and survey, collect specimens, &c., in the neighbourhood of the lower ranges. Next spring, when the weather will be suitable, he will make the attempt to climb to the highest point. He may, the correspondent says, spend several years in New Guinea, for his wife is following him, and his heart is thoroughly in his work.

THE Swedish Society of Anthropology and Geography has commissioned Baron Schwerin, Professor of Geography at the University of Lund, to proceed on a scientific expedition to the Congo, the chief objects being to make geographical, meteorological, botanical, and zoological studies in the new State, and to collect ethnographical objects. Barons Nordenskjöld and Dickson have lent the Expedition a number of valuable instruments. The Swedish Government have requested Prof. Schwerin to report on the commercial opportunities afforded on the Congo and the position of Scandinavian subjects there.

EXPLOSIONS IN COAL MINES[1]

THE address to which the members of the Society of Arts were so good as to afford a favourable reception at the opening meeting of last Session, was in great measure devoted to topics suggested by the International Health Exhibition of that year. Wide as was the scope of that Exhibition, which dealt not only with the necessaries and comforts of life, and the promotion of bodily health in the feeding, clothing, and housing of all classes, but also with the all-important subjects of physical and mental training, the Exhibition of Inventions—which has just terminated a prosperous and, I believe, a very useful career—embraced a wealth of material for study which could bear comparison, as regards extent and interest, with that presented by any one of the great International Exhibitions of former years, the initiation of which we owe to that illustrious Prince whose memory the Society of Arts delights to honour.

I have resisted the temptation to devote this evening to a brief review of some of the chief matters of interest presented by the most prominent sections of the Exhibition, because I entertain a lively hope that a thorough examination of at any rate *many* of these will afford topics for important communications to this Society, and I consequently feel that it would be scarcely just to those who may consent to devote themselves to their preparation, were I to cull specially attractive matter from the mass of information opened up to the student by the achievements demonstrated at the Exhibition. I therefore propose to limit myself in this address to the treatment of some matters relating to only one branch of a division of the Exhibition, namely, the class which deals with machinery and appliances *used in mines*.

I venture to think that this class of subjects has claims to special interest, *because* the mining industry ranks among the most important sources of the wealth and cosmopolitan influence of the Empire ; *because* its development and successful pursuit have involved the utilisation of the resources of many branches of applied science, and have taxed the talents and ingenuity of some of our greatest mechanics, and most accomplished physicists and chemists ; and, though last, not least, *because* the pursuit entails the encountering of dangers and vicissitudes which will aptly bear comparison with those involved in the careers of the soldier and the sailor. Thrilling and harrowing accounts of great disasters in coal mines direct public attention from time to time to certain special dangers which the miner has to encounter, but the annual reports of H.M. Inspectors of Mines show that there are yet others to which miners in general are daily exposed, which, although they do not attract public attention (partly because of the very circumstance of their constant occurrence, and partly because the sufferers by them meet their deaths in most cases

[1] Address of Sir Frederick Abel, Chairman of Council of the Society of Arts, delivered at the opening meeting, Nov. 18, 1885.—(Abstract by the Author.)

singly), are nevertheless far more formidable in regard to the gross extent of the fatalities attending them, than are coal-mine explosions.

When the late Mr. MacDonald, M.P. for Stafford, made his remarkable speech in the House of Commons, in 1878, advocating the necessity for the more rigorous inspection of coal mines, and supported his arguments with the enumeration of an appalling list of disastrous colliery explosions, it was pointed out by Mr. Thomas Burt, and other members, that explosions did *not* constitute the chief element of danger which the miner had to encounter, and that, while out of 25,000 lives which had been lost in mines since 1851, over 6,000 deaths had been caused by explosions, there were more than 10,000 due to falls of stone and coal in the mine workings, which attracted little or no public attention. Mr. Cowen also pointed out that there was a still larger number of injuries, due to such causes as these, which were never heard of beyond the locality of the disasters, because they were not attended with fatal results at the time, although in the larger proportion of such cases the sufferers were either maimed for life, or died after more or less brief intervals. The Table below, which has been compiled from the annual reports of the Mine Inspectors for the past ten years, shows the total number of deaths annually due to accidents in mines, and the deaths due respectively to explosions, to the falls of roof or sides in mine workings, and to other miscellaneous causes; and it will be seen that even in those years when especially disastrous explosions had occured, the fatalities due to explosions were, with the exception of two years, considerably in the minority, compared with deaths from falls of roof and sides, while—comparing them with the deaths due to all other causes—the latter were invariably much in excess. It is not surprising, however, that the paralysing moral effect exercised upon small mining communities, and the heartrending local misery and suffering which suddenly and simultaneously fall upon many families, should cause coal-mine explosions to command special sympathy, and to call forth public expressions of regret and surprise that the resources of science and of legislative power should have failed utterly to prevent, or even very greatly diminish, such sad disasters, while, on the other hand, the daily occurrence of fatal accidents in the ordinary pursuit of the miner's vocation, attracts little public attention. It has been contended that the classes of constantly recurring accidents, which combine to cause a far more formidable

STATEMENT OF PROPORTION, AT COLUMN II., OF DEATHS FROM EXPLOSIONS IN COAL MINES, FROM FALLS OF ROOF AND SIDES, AND FROM OTHER MISCELLANEOUS CAUSES, TO TOTAL DEATHS IN MINES FROM ALL CAUSES DURING THE YEARS 1875–1884[1]

Year.	Total Number of Deaths from Accidents of all kinds.	No. of Deaths from: Explosions of Fire-damp.	Roof and Sides falling.	Other causes.	Results of some of the more disastrous Explosions in each year.
1875	1244	288	459	497	Explosion at the Swaithe Main Colliery, near Barnsley ... ... 143 lives lost.
					,, Bunker's Hill Colliery, Stoke-on-Trent ... ... 43 ,,
					,, New Tredegar Colliery, Monmouthmouth ... ... 23 ,,
					,, Llan Colliery, near Cardiff ... ... 16 ,,
1876	933	95	449	389	,, South Wales Collery, Abertillery ... ... 23 ,,
1877	1208	345	448	415	,, Blantyre Colliery ... ... 207 ,,
					,, Pemberton Colliery, near Wigan ... ... 36 ,,
1878	1413	586	469	358	,, Abercarn Colliery, Monmouthshire ... ... 268 ,,
					,, Wood Pit, Haydock ... ... 189 ,,
					,, Apedale Colliery ... . 23 ,,
					,, Barwood Colliery, Kilsyth, near Glasgow... ... ... 17 ,,
1879	973	184	426	363	,, Dinas Colliery, Pontypridd ... ... 63 ,,
					,, Blantyre Colliery ... ... 28 ,,
					,, Stanley Colliery, near Wakefield ... ... 21 ,,
1880	1318	499	462	357	,, Seaham Collery ... ... 164 ,,
					,, Risca Colliery ... ... 120 ,,
					,, Penygraig Colliery ... ... 101 ,,
					,, Leycett Colliery ... ... 62 ,,
1881	954	116	450	388	,, Abram Colliery, Wigan ... ... 48 ,,
					,, Whitfield Colliery, Tunstall ... ... 25 ,,
1882	1126	250	468	408	,, Trimdon Grange Colliery, Durham ... . 74 ,,
					,, Tudhoe Colliery, Durham .. .. 37 ,,
					,, Clay Cross Colliery, Derbyshire ... ... 45 ,,
					,, Baddesley Colliery, Warwickshire ... ... 23 ,,
					,, West Stanley Colliery, Chester-le-Street ... ... 13 ,,
1883	1054	134	469	451	,, Altham Colliery, Lancashire ... ... 68 ,,
					,, Wharncliffe Carlton Colliery, near Barnsley ... ... 20 ,,
1884	942	65	482	395	,, Pochin Colliery, near Tredegar, Monmouthshire ... ... 14 ,,
					,, Naval Steam Coal Colliery, Penygraig ... ... 14 ,,

[1] The facts embodied in the above Table have been long accessible to all who care to inform themselves correctly, by reference to the published annual reports of H. M. Mine Inspectors; it is, therefore, somewhat surprising to find that the Manchester Correspondent of the *Times*, to whose views that journal appears to attach much weight, and whose evident acquaintance with high authorities in matters relating to coal mines, such as Mr. Ellis Lever, should have, at any rate, assisted him to a knowledge of the existence of those reports, is ignorant of the truth relating to a subject with which he deals in a fashion somewhat over-authoritative for the representative of "unenlightened earnestness," which is "impatient" to learn the reason for "hesitation" on the part of a Royal Commission on mine accidents in promulgating its conclusions, is "incredulous of the difficulty of speaking out," and indignantly regards "the delay as a national scandal." In support of this somewhat strong expression of sentiment, "unenlightened earnestness" inquires whether it has "really needed so long to dispel any doubt that shot-firing, for instance, is the commonest cause of the loss of life in coal mines."

total of deaths than even an unusual succession of serious explosions, are to a great extent made up of unavoidable sources of danger to which the miner must be exposed; and that, on the other hand, the causes which lead to explosions have been long known, and can be readily grappled with and removed by the colliery owner or manager. But as a matter of fact the nature of some of the chief and most prevalent conditions favourable to mine explosions is only now being thoroughly made clear, and the same may be said of the nature of measures and appliances by which explosions may be avoided or diminished in magnitude.

From the foregoing considerations, it is evident that very great interest and importance must attach to any decided improvements in systems of working, or in appliances connected with mining, and bearing directly upon the safety, facility, and degree of comfort, with which subterranean operations can be carried on. The members of the Society of Arts will, therefore, I feel sure, take a lively and sympathetic interest in the statements and observations which I have to offer in connection with the Mining Section of the late Exhibition, and, in reference to the labours, now fast drawing to a close, of a Commission, appointed by Her Majesty about six and a half years ago, to inquire and report whether the resources of science could furnish any practical expedients, not then in use, calculated to prevent the occurrence of accidents in mines, or to limit their disastrous consequences; a Royal Commission whose earnest and disinterested labours have been patiently, steadily, and faithfully pursued to successful issues, in spite of engrossing official public and professional duties, and undeterred by the public censure and abuse with which the persevering efforts of its members to complete, as far as practicable, the heavy task allotted to them, have as yet been alone encouraged.

The display at the recent Exhibition of implements and appliances connected with mining, was sufficiently comprehensive to be fairly representative of the nature of improvements which have of late been accomplished in almost all directions. Some of the exhibits demonstrated very important progress made since the Accidents in Mines Commissioners commenced their labours, and are traceable in several instances to certain results of those labours, which, though not formally communicated to the public, have become known to many engaged in the management and supervision of mines.

An examination of the evidence taken by the Commission, and published with their Preliminary Report, showed that there were several important subjects connected with the safe and efficient working of mines upon which large differences of opinion prevailed. This was especially the case with reference to the employment of naked lights in mines—the relative merits of well-known safety lamps—the uses of gunpowder or other explosives underground—and the possible influence of coal-dust in the development or extension of explosions. It was, therefore, especially in these directions that the Commissioners considered it their paramount duty to pursue experimental inquiries, and, as those investigations proceeded, their importance and the useful results likely to emanate from them became the more apparent, while each succeeding step demonstrated the necessity for proceeding further in the inquiries, so that, even up to this, the period fixed by them for the completion of their final Report, the Commissioners have found themselves still engrossed in experiment.

Without presuming to deal in anticipation with the conclusions arrived at by my colleagues and myself as the results of our protracted investigation, I may venture to indicate the nature of some of those results sufficiently to illustrate the progress made in certain matters most vitally affecting the safety of the miner.

The important advances which have of late been made in the methods of operation, and mechanical appliances, provided for exploring and for breaking ground, were illustrated in the Exhibition by some of the most recent improvements in boring and drilling machines, and in the construction of the more ordinary hand tools. Without dwelling upon the marked advance which has been made in the operations of deep-boring and of tunnel-driving, by combining the utilisation of steam or compressed air with the method of continuous flushing, special reference must be made to the great improvement effected in mining operations by the use of drills or perforators driven by compressed air, of which several varieties were shown at South Kensington.

So-called coal-cutting machines, for holing or undercutting coal, of which many forms have constituted prominent features in the mining sections of former Exhibitions, were only represented by one variety on the present occasion, and appear to have hitherto made little way, although their use would seem to be attended with some decided advantages. Hydraulic pressure has been applied with some degree of success in connection with drilling machines and with the forcing down of coal; thus, Messrs. Dubois and François have applied a very efficient hydraulic arrangement, called the *Bossoyeuse*, with considerable practical success, to the removal of rock or stone in mines where fire-damp exists. As regards the different methods of working seams of coal, and the variety of circumstances which determine their expediency or relative merits in different cases, I must limit myself to the statement that the so-called *long wall* system, which consists in the continuous excavation of the coal throughout or along a considerable distance of the breadth of the seam, the excavated part being filled up, as the work advances, with stone and slack, or with material brought from the surface, presents facilities for securing efficient ventilation, and other advantages in regard especially to the safety of the workmen, by which it recommends itself for choice wherever it is applicable, and which, supplemented by the employment of wedges, have been used successfully for bringing down coal or rock in some localities where fire-damp is prevalent.

Large as is the proportion which accidents arising from falls of roof and sides in mine-workings bear to casualties of all other descriptions, an examination of the Mine Inspectors' Casualty Returns happily shows that a considerable improvement has actually taken place in the death-rate from falls during the last twenty years. This is unquestionably owing to bestowal of increased care upon the proper support, by timbering or arching, of the roof and sides of many workings, or upon improvements in the system upon which this most important work is carried out. Cheering as these results are, it cannot be doubted that much remains to be accomplished in order to reduce the proportion of casualties from these causes to some approach towards what might be reasonably accepted as unavoidable at the present day.

One great safeguard to the miner against accidents from falls of stone and coal would obviously be the provision of efficient illumination of the ways and working places. A powerful excuse for the use of naked lights, even where risk of producing explosions was known to be incurred thereby, has been sought, and even sometimes admitted, in the necessity for more light in insecure places than that furnished by the Davy, the Geordie, or the Clanny lamp; the argument against enforcing the general adoption of safety lamps, most strongly urged by Mr. Burt and others in the debate of 1878, was the miserable insufficiency of the light afforded by them, and the consequent increase in the number of accidents due to causes other than explosions. Among improvements of late effected in the construction of safety lamps, has been the increase of their illuminating power; and this subject of underground illumination is, I may confidently say, ripe for very great amelioration.

The simple modes of underground transport of coal by manual or horse labour have now, to a very considerable extent, given place to its haulage, along tramways, by means of wire ropes or chains actuated either by steam hauling engines placed near the pit bittom, or by compressed air-engines stationed in different parts of the main roads. Some good illustrations of hauling machinery of these kinds were included in the Exhibition, and members of the Society of Arts cannot fail to remember with interest that our late lamented chairman, Sir William Siemens, was the pioneer in the introduction of electric hauling arrangements for mining work.

A fruitful source of disaster connected with mines has been the descent or ascent of the men by the shafts, and many contrivances have been devised, and more or less extensively applied, for preventing accidents resulting from the overwinding of the cages in which the men and the coal are brought to the surface, or from the fracture of the rope with which these cages are worked.

Really efficient and trustworthy appliances of this class cannot fail to be important safeguards, equally perhaps with those afforded by great improvements which have been effected in the construction and quality of the hauling- or pit-ropes. It is impossible to overrate the necessity for the bestowal of the highest skill and care upon the manufacture, testing, and periodical inspection of these all-important adjuncts to mining work, to which many thousands have daily, in blind confidence, to trust their lives.

The great improvements which have been effected in the steam brakes and reversing gear applied to the powerful wind-

ing-engines which, as monuments of mechanical skill, merit the careful inspection of all interested in mining industry, are most important additions to the safety appliances provided in the present day in connection with the pit work of our mines. To these must be added the improvements made in signalling arrangements from the surface and underground, in connection with which electricity has of late commenced to play an important part.

The great advance made in the *ventilation* of mines during the past half century is well known to all who have paid the least attention to these matters. Not only has the ventilating furnace been greatly improved in efficiency and power; the steam jet and compressed air have received important application within the last thirty-six years, and fans, and other mechanical ventilating agents of great power have come into extensive use during the past twenty-three years.

The proper distribution of the air which is drawn down into the pit, and the arrangements necessary for insuring the distribution of fresh air throughout the different roadways and workings in a mine, and its isolation from return- or foul air-currents which are passing to the upcast or exit shaft, are now carried out effectually in a large proportion of our coal mines.

Although we have long been familiar with the nature of fire-damp, and with the generally-accepted explanation of its origin in coal, considerable uncertainty and consequent diversity of opinion still prevail as to the condition in which the gas is pent up in coal, and in the associated strata. That the light carburetted hydrogen, which chiefly composes fire-damp, exists, with its associated gases, in a more or less condensed condition, in coal, even some time after removal from the pit; and, that the gradual escape of the condensed inflammable gas from coal has constituted a fruitful source of disaster to coal-laden ships, and to steam-vessels carrying a large provision of coal—such as our ships of war—are very well known facts; but, there are constantly-recurring phenomena connected with the escape of gas from coal, a really satisfactory explanation of which is still wanting, although patient inquiry has long been devoted to its discovery. Thus it has been demonstrated by experiment that, if cavities are bored into the coal and plugged, the gas will speedily accumulate so as to exercise a pressure of several hundred pounds upon the square inch, as indicated by pressure-gauges fixed into the cavities.

In some localities, the gas issues as a jet, or so-called "blower," and many of these furnish a continuous supply of gas under fairly uniform pressure, which may be conducted in a steady stream to the surface, and utilised for heating and even for illuminating purposes. Many explanations have been offered of the existence of these blowers, and of the maintenance and sudden cessation of the gas supply, but they have remained a mystery.

The systems of ventilation now in use in coal mines, and the powerful circulation of air maintained thereby, deal effectually with the removal of gas, as it exudes from *freshly-worked* coal even in very fiery mines, when it passes into the main ways and the workings which are actually in use; but, in *old workings*, recesses, or cavities, and in the so-called goaves, where the worked-out space has been filled up with stone and *débris*, the gas may lurk and lodge, and may at any time constitute a source of great danger, if special means are not adopted to favour its removal; and, even with the most efficient and searching ventilating arrangements, the almost unavoidable existence of some accumulations here and there in mines where fire-damp is prevalent, renders absolute freedom from it, of the air in the mine, practically unattainable in such cases, although the amount diffused through the atmosphere may seldom, under ordinary conditions, approach, even distantly, to the minimum proportion which, *per se*, might constitute a source of danger.

It is now generally admitted that variations of atmospheric pressure influence the tendency of fire-damp to escape from goaves or old workings in a mine where accumulations are liable to exist, and that when a reduction of pressure suddenly sets in, such an escape may take place even to some considerable extent before the barometer indicates the depression. Some even maintain that the emission of gas from the fresh face of coal is considerably promoted by such alterations of pressure; but although there are many undoubted instances of explosions having occurred during sudden and very considerable depressions of the barometer, different observers in this and other countries are by no means in accord as to the extent to which, in a properly-ventilated mine, the existence of fire-damp in the air is influenced by barometric changes.

There are some mines so free from fire-damp that naked lights may be used therein with perfect safety, and others where the use of safety lamps need apparently be only insisted upon in certain parts of the workings. There can be no doubt, on the other hand, that the adoption of even the most perfect ventilation cannot secure such absolute safety as to render the use of naked lights warrantable, where seams are worked in which fire-damp exists in any abundance,—because danger may there arise at any time, from some accidental stoppage or partial failure of the ventilating arrangements, from the effect of a reduction of atmospheric pressure in promoting the escape of gas from lurking places, or, from a liability to the sudden emission of gas in considerable quantity from coal. The very poor light furnished by the forms of safety lamp still chiefly in use, has afforded very strong temptation to the men to have recourse to naked lights, and to the managers of mines to regard such proceeding with indulgence, even where its danger is well recognised. Poor as the light is which the older forms of lamps furnish in a quiet atmosphere, it becomes even much worse when they are exposed to such currents as are now met with in properly ventilated mines.

Efficient lamps should therefore burn brightly and steadily even in strong currents of air, and they should be unable, under any circumstances at all likely to arise in coal mines, to ignite an inflammable mixture of fire-damp and air, even when this is passing at the highest velocities which can occur in any part of a mine.

The importance of determining how far modifications of existing lamps, or new kinds, fulfil these conditions, has led individuals specially interested in the subject, and associations of mining engineers, for many years past, to submit lamps to comparative experimental tests; and the first branch of inquiry which was taken up by the Royal Commission was the systematic comparison of the behaviour of different lamps under variously modified conditions in currents of explosive mixtures of gas and air, travelling at different and accurately-determined velocities.

As the experiments proceeded, and the results of tests applied to particular lamps became known to the makers, modifications in construction were introduced, or new arrangements devised. More than 200 lamps have been submitted to a variety of trials, and even up to the present day the Commission have continued to receive new lamps, with urgent requests that they should be included in the trials.

This investigation has also included a careful determination of the amount of light furnished, and of the burning qualities of all the more promising lamps, as well as an examination into their practical merits, in regard to construction, weight, and handiness.

The results of these extensive investigations will now very shortly be in the hands of the public: I must content myself with very briefly indicating their general nature.

Only three types of lamp were until recently in extensive use in this country: the original safety lamps, which the miners owe to the genius of Davy and of Stephenson, and a lamp not long afterwards devised by Dr. Clanny. When the safety lamp was first invented, the ventilating currents in mines were very moderate indeed, and under the then prevailing conditions these earliest lamps were fairly safe. But, at the present time, the air in the mine roadways often travels at a rate of 20 to 25 feet per second, and may even, in some special places, attain velocities of 30 to 35 feet. Under these conditions the Davy and Clanny lamps cease to afford any security in localities where fire-damp is prevalent. This had already been indicated by the results of previous experiments when the Commissioners commenced their work, but their own investigation so clearly established the great danger of these lamps, and the facts already known on the subject appeared to have received so little consideration, that the Commissioners regarded it as their imperative duty to direct the Home Secretary's attention officially and in strong terms to the fact, in the hope that most prominent publicity would be at once given to their warning.

After some delay, a circular embodying the substance of it was issued, but without any indication that it bore the authority of the Royal Commission. This action was taken not long after the appointment of the Commission, yet the Davy and Clanny lamps have continued in use in mines where the elements of danger insisted upon exist.

The Davy lamp had, some years back, been rendered much

less dangerous by the addition of a metal shield partially surrounding the gauze cylinder, or by the provision of an external glass cylinder extending up the gauze to various distances. The latter modification proved to be the most efficient safeguard of the two; but a much more important protection has been comparatively recently effected by inclosing the lamp in a case, which protects it to a great extent from the action of currents, though this considerably diminishes the already very meagre light afforded by this lamp.

A lamp of Belgian origin, termed the *Mueseler*, and which has for many years past been officially adopted in Belgian mines, presents important advantages over the lamps already referred to, which were, in part, recognised before the Commission existed, the lamp having since come into somewhat extensive use. Some experiments and certain results of practical experience had, however, already thrown doubt upon the wisdom of placing absolute reliance in the safety of this lamp; the Commissioners' experiments confirmed the validity of those doubts, and showed that, under particular conditions, the Mueseler lamp might cause an explosion when exposed to a current of fire-damp mixture of very moderate velocity. On the other hand, the *cased Davy* lamp was found perfectly safe, under much more severe conditions, and this important fact has led to the adaptation of cases in various ways to the old types of safety lamps—many so-called new safety lamps consisting, in fact, of the Davy and Clanny protected by inclosure from the direct action of the current.

The publication of the Commissioners' investigations will, I venture to affirm, convince even those who, although they have not cared to inform themselves of the character and extent of the work which was being done, have thought it right and just to publicly reproach the Commission with dilatoriness, that the curtailment of these researches would only have been detrimental to the conclusive, and therefore practically important, nature of the results arrived at. For, these have not only led to decisive conclusions regarding the defects of the best known types of lamps, and the degree of safety and other merits of a large variety of modifications of them, as well as of new forms of lamps, but they will also enable the Commissioners to indicate, with confidence, several lamps which combine a great degree of safety with other important merits, and to specify a few among these which, while ranking highest in point of safety, and leaving very little indeed to be desired in this respect, combine, with this first essential, the important adjuncts of simplicity of construction and fair illuminating power. It will, moreover, be possible to indicate some directions in which even these lamps are susceptible of improvement. It, therefore, only remains to be hoped that the results of the labour which the Commissioners have devoted to this branch of their inquiry will be accepted wtth the confidence they merit, and will be speedily utilised both by those who are responsible for the management of mines and by those who control the actions of the miner.

When the Commission's investigations were already considerably advanced, Mr. Ellis Lever publicly offered a premium of £500 for a miners' safety lamp, which, while being of convenient size for carrying about, would continue to give a useful amount of light for not less than twelve hours, *and which would not cause an explosion of gas under any circumstances at all likely to represent conditions which may occur in actual practice.* It was proposed that the judges to whom lamps submitted for competition were to be referred should include three scientists, nominated respectively by Mr. Lever, by the Royal Society, and by the Society of Arts. No less than 108 different lamps were sent in, and it need scarcely be said that the determination whether any among them fulfilled the prescribed conditions involved a very extensive series of experiments. The adjudicators who had to investigate the merits of the various lamps, included three scientists, and two were members of the Commission, who cheerfully consented to take upon themselves this very considerable addition to the voluntary labours already being carried on by them in the interests of the miners.

Only four electric lamps were submitted, and these altogether failed in fulfilling any one of the conditions laid down, excepting that of being self-contained lamps. Eventually, not one of the other lamps was found completely to fulfil the whole of the conditions under which the premium was offered, although several ranked very high as regards safety and efficiency; foremost among these being the lamp of M. Marsaut and that of Mr. N. Morgan, of Pontypridd, to whom gold medals have been awarded at the Inventions Exhibition, and whose lamps rank among those which the Commissioners are able to speak most highly of. But, the premium which Mr. Lever placed at the disposal of the adjudicators reverted to him, and those who have great experience of the behaviour of safety lamps of the various well-known and recently developed types, could scarcely have anticipated a different result. Mr. Lever has, since then, again offered a similar premium, this time for "the invention or discovery of an economical, efficient, and safe substitute for gunpowder and other dangerous explosives used in the getting of coal." The Council of the Society of Arts could not see their way to comply with the suggestions of Mr. Lever that they should award this premium, or appoint adjudicators for that purpose, as they did not feel themselves warranted in suggesting the great sacrifice of time, in the performance of the very laborious and exhaustive experiments indispensable in this case, to such as would be really competent to perform the work of adjudication, which Mr. Lever appears to think at least as lightly of as of the offer of these prizes. It borders upon the amusing to observe in the article by the Manchester Correspondent of the *Times*, to which such prominence was given on the 27th of last June, how the writer heralds offers of subscriptions and of premiums, as illustrating the way in which his hero "gallantly attacks the problem (of accidents in mines) at all points," while he has no encouraging word for the man of science whose disinterested devotion to very arduous work, for which his sole probable recognition would be hostile criticism, or worse, can alone give any point to the "gallant attacks" of philanthropists like Mr. Ellis Lever.

(*To be continued.*)

THE ROYAL SOCIETY[1]

AT the earliest opportunity after my return to England last spring I offered my very grateful acknowledgments to the Society for the kindness with which the Fellows had condoned my enforced absence from my post during the winter. And I should not venture to occupy your time by recurring to the subject, did not the return of St. Andrew's Day admonish me that duty and inclination alike require me to offer my especial thanks to the Treasurer for the cheerful readiness with which he took upon himself the burden of my duties, and the efficiency with which he discharged them on our last Anniversary.

On the last occasion on which I had the honour to address you, it was my painful duty to commence by lamenting the death of a very eminent member of the Society, who was, at the same time, one of my oldest and most intimate friends. I deeply regret to find myself once more in this position. The lamentable accident which has deprived the Society of one of its oldest and most distinguished Fellows, Dr. Carpenter, has robbed me of a friend, whose kindly sympathy and help were invaluable to me five-and-thirty years ago, and who has never failed me since.

You are all acquainted with Dr. Carpenter's great and long-continued services to science as an investigator and as an expositor of remarkable literary skill; and there must be many here who, having worked with him in the University of London, of which he was so long Registrar, are familiar with the high integrity, the energy, and the knowledge, which marked him as an administrator. He was a man of varied accomplishments outside the province of science, single-minded in aim, stainless in life, respected by all with whom he came in contact.

Within the last few days, Physics has lost an eminent representative in Dr. Thomas Andrews, of Belfast. Among the cultivators of Chemical Science we have to regret the decease of Mr. Field, who was one of the original members of the Chemical Society; of Mr. Weldon, and of Dr. Voelcker, whose names are well known in connexion with manufacturing and agricultural chemistry. In Biology, we have lost Dr. Davidson, whose elaborate monographs on the fossil Brachiopoda are remarkable examples of accurate malacological work combined with artistic skill; Dr. Gwyn Jeffries, the veteran explorer of our marine molluscous fauna, and a high authority on conchology; and Dr. Morrison Watson, whose early death has cut short the career of an anatomist of much promise. Mineralogy has suffered a similar loss by the premature death of Dr. Walter Flight. In Engineering Science, we have to lament the deaths of Mr. Barlow and Professor Fleeming Jenkin. I may be permitted to dwell for a moment upon the latter name, as that of a most genial and accomplished man and a valued personal

[1] Address of the President, Prof. T. H. Huxley, delivered at the Anniversary Meeting, November 30, 1885.

friend, with whom it had been my privilege to be associated for a time in his well-directed and successful efforts to improve the sanitary condition of our cities. The elder generation of English geologists will remember the keen interest which the Earl of Selkirk took in their pursuits. The death of Lord Houghton robs us of a connecting link with all the world.

Three very distinguished names have disappeared from the ranks of our Foreign Members: that of Henle, of Göttingen, among whose many merits must stand that of ranking next after Schwann among the founders of histology; that of the venerable Henry Milne-Edwards, of Paris, one of the most distinguished members of the school of Cuvier, and admirable no less for his contributions to zoological philosophy than for the extent and the precision of his additions to our knowledge of facts; and lastly, that of Von Siebold, of Münich, whose remarkable investigations into the phenomena of parasitism and of sexless reproduction brought about the solution of some of the most difficult problems of zoology, while it would be difficult to exaggerate the influence of his wonderfully accurate and comprehensive "Handbook" on the progress of invertebrate zoology forty years ago.

On the 1st of December last year the total number of Fellows of the Royal Society amounted to 519; of these 473 were on the home and 46 on the foreign list. Deducting Her Majesty, our Patron, and four other Royal personages, the number on the home list was 468. At the present moment, we have 49 foreign members, or within one of our full complement; while the total strength of the home list (deducting Royal personages) is 466, or two fewer than twelve months ago. The number of deaths in the home list during the past year is 20. This is a larger mortality than that of last year; and it still exceeds the number of Fellows added to the Society by election, which during the last part of the year was 16: namely, the statutory 15 Fellows elected in the ordinary way and 1 Privy Councillor.

As the Treasurer observed in his address on the last Anniversary, it is obvious that we are rapidly approaching a state of equilibrium between our losses and our gains; and, under the present conditions of election, the strength of the home list may be expected to remain somewhere between 460 and 470.

While our number thus tends to remain stationary, the list of candidates for the Fellowship, though it has fluctuated a good deal from year to year, has on the whole become longer, until, at present, the candidates are more than four times as numerous as the annual elections sanctioned by our rules. This state of things has given rise to comment, both within and without the Society, on more than one occasion. It has been said that any restriction upon the number of our Fellows is unwise, inasmuch as we narrow our influence and diminish our revenues thereby; and, by way of a still more unpleasant suggestion, it is hinted that, by such limitations, we lay ourselves open to the charge of a desire to arrogate to ourselves the position of the elect of science.

With respect to the first objection, I venture to point out that the influence of the Society upon the advancement of science is not by any means measured either by its numerical strength or by the amount of the funds at its disposal.

And, as to the second charge or insinuation, if it is worth while to meet it at all (which may be doubtful), I am disposed to think that, in another than the invidious sense of the words, it is highly desirable that the Fellows of the Royal Society should regard themselves, and be regarded by others, as the elect of science. An organisation which was the direct product of the new birth of science in the days of Gilbert, of Galileo, and of Harvey; which was one of the earliest of the associations founded for the sole purpose of promoting natural knowledge; and which has so faithfully performed its functions that it is inseparably associated with all the great strides which science has made for two centuries, has insensibly and without effort become a recognised representative of men of science in these islands: as such, on the one hand, it is consulted by the Government on scientific questions; and, on the other hand, it claims the right to be heard by the Government on all questions of scientific interest. I believe it to be impossible that the Society should discharge the functions which it has not sought, but which have thus devolved upon it, satisfactorily, unless it really does consist, in one sense, of the elect of science; that is to say, unless every care is taken to keep its scientific character at the level of its scientific reputation, and to ensure that it shall be not the mere figure-head of the scientific body, but a living association of representative men engaged in all branches of scientific activity.

Those among my hearers whose memories go back forty years will remember that, at that time, the Society was in great danger of losing its scientific character, though it would doubtless have taken it a long time, and a good deal of perversity, to get rid of its scientific reputation. It had become the fashion to append F.R.S. to a name, and the scientific members where in danger of being swamped by the invasion of *dilettanti*. The aim of our eminent colleague, Sir William Grove, and his friends, who fought the battle of 1847, and thereby, to my mind, earned the undying gratitude of all who have the interests of science at heart, was not to create an academy of immortals, but to save the Fellowship of the Society from becoming a sham and an imposture. And they succeeded in their object by carrying a measure of reform which embodied two principles—the first, that of the practical responsibility of the Council for the elections, the second, that of the limitation of the number of candidates annually elected. The result of the steady adherence of the Society to these principles for thirty-eight years is that, year by year, the Society has approached more and more closely to that representative character which, I cannot but think, it is eminently desirable it should possess.

During a great part of this time I have enjoyed more and closer opportunities than most people of watching the working of our system. Mistakes have been made now and then, no doubt, for even members of Council are fallible; but it is more than thirty years since the propriety of the selections made by the Council has been challenged at a general meeting; and I have never heard a question raised as to the conscientiousness with which the work is done, or as to the desire of the Council to mete out even-handed justice to the devotees of all branches of science. I am very strongly of opinion that if the Royal Society were a "Chamber of Science," subject to dissolution, and that after such dissolution a general election, by universal suffrage of the members of all scientific bodies in the kingdom, took place, an overwhelming majority of the present Fellows would be re-elected.

Such being my conviction, it is natural that I should express a fervent hope that the Society will never be tempted to depart from the principles of the method by which, at present, it recruits its strength. It is quite another question, however, whether it is desirable to retain the present limit to our annual addition or to increase it.

There is assuredly nothing sacred in the number 15; nor any good reason that I know of for restricting the total strength of our home list to 460 or 470; so long as our recruits approve themselves good soldiers of science the more we enrol the better. And if I may pursue the metaphor, I will add that I do not think it desirable that our corps should consist altogether of general officers. Any such exclusiveness would deprive us of much useful service, and seriously interfere with the representative character in which our strength lies. I think we ought to be in touch with the whole world of science in the country, and constitute a microcosm answering to that macrocosm. Those who are in favour of making a change observe that the limit of fifteen was fixed nearly forty years ago; that the number of those who occupy themselves seriously with science and attain a position which would undoubtedly have brought them into the Society at that time, has increased and is constantly increasing; and that it is undesirable that we should be compelled to leave out of our body, year after year, persons whom we should be very glad to see in it. On the other hand, it is to be recollected that a change once made can hardly be revoked, and that, in view of the importance of such a step, the Society will do well to make sure of the consequences before taking it.

I have thought it desirable to raise the question, not for the purpose of suggesting any immediate action—for my personal opinion is that, at present, no change is desirable—but in order that the attention of the Fellows may be directed to a matter which I think is sure to come before them in a practical shape before many anniversaries go by. And, whenever that time arrives, I think another problem may possibly offer itself for solution. Since this Society was founded, English-speaking communities have been planted and are increasing and multiplying in all quarters of the globe—to use a naturalist's phrase, their geographical distribution is "world wide." Wherever these communities have had time to develop, the instinct which led our forefathers to come together for the promotion of natural knowledge has worked in them and produced most notable

results. The quantity and quality of the scientific work now being done in the United States moves us all to hearty admiration; the Dominion of Canada, and our colonies in South Africa, New Zealand, and Australia, show that they do not mean to be left behind in the race; and the scientific activity of our countrymen in India needs no comment.

Whatever may be the practicability of political federation for more or fewer of the rapidly growing English-speaking peoples of the globe, some sort of scientific federation should surely be possible. Nothing is baser than scientific Chauvinism, but still blood is thicker than water; and I have often ventured to dream that the Royal Society might associate itself in some special way with all English-speaking men of science; that it might recognise their work in other ways than by the rare opportunities at present offered by election to our foreign Fellowship, or by the award of those medals which are open to everybody; and without imposing upon them the responsibilities of the ordinary Fellowship, while they must needs be deprived of a large part of its privileges. How far this aspiration of mine may be reciprocated by our scientific brethren in the United States and in our colonies I do not know: I make it public, on my own responsibility, for your and their consideration.

I am anxious to call the attention of the Fellows to an alteration in our rules, in virtue of which it is hoped that the valuable library of the Society will be made more extensively useful to them by being accessible up to a later hour than heretofore, and by better provision for the comfort and convenience of those who desire to read or write in the Society's rooms.

The funds of the Society have been augmented in various ways during the past year.

The value of the fee for the Croonian Lecture has been increased from 2*l.* 18*s.* 9*d.* to about 50*l.* a-year, by the falling in of certain leases.

Allusion was made in the Treasurer's address last year to the Darwin Memorial. I am happy to say that Mr. Boehm's admirable statue was formally and publicly accepted by H.R.H. the Prince of Wales, on behalf of the Trustees of the British Museum, last summer, and now adorns the entrance hall of the Natural History Museum at South Kensington. The balance of the sum raised, amounting to 200*l.*, has been handed over to the Royal Society, and the interest thereof will be employed under the name of the "Darwin Fund for the Promotion of Biological Research," in any way the President and Council may think fit. I sincerely trust that this fund may be increased from time to time, as the Donation Fund, founded by Dr. Wollaston, has been; and that its beneficent influence on the progress of biological science may thus keep green the memory of the great man whose name it bears, in the way which, assuredly, would have been most agreeable to himself.

I am sure that I may express your acknowledgments to Mr. James Budgett for the repetition of his liberal donation of 100*l.* in aid of the cost of publication of Prof. Parker's important and elaborate monographs on the vertebrate skull, one of which occupies a whole part of the *Transactions*, and is illustrated by thirty-nine quarto plates.

We are indebted to the subscribers to the Henry Smith Memorial for the marble replica of the bust by Mr. Boehm of that eminent mathematician and most accomplished scholar, which now ornaments our library. The Fine Art Society has presented Mr. Flameng's etching of the portrait of your President, painted by the Hon. John Collier.

Among the presents to the library, I may particularly mention the second volume of Prof. G. Retzius' valuable and splendidly illustrated work, "Das Gehör-organ der Wirbelthiere," and "Les Habitants de Surinam," by the Prince Roland Bonaparte, by their respective authors, and four volumes of the *Challenger* Report, by Her Majesty's Stationery Office.

Five numbers of the *Proceedings* (about 880 pages) have appeared since the last Anniversary. Only one part of the *Philosophical Transactions* has been as yet published; but two other parts (Parts I. and II. for 1885) are passing simultaneously through the press.

The possibility of devising means by which papers read before us may be published more rapidly, has seriously engaged the attention of the officers of the Society, and I trust that, before long, the Council may have some well-conceived plan for achieving that end brought under their consideration. While all will agree in deprecating unnecessary retardation, it must be remembered that a certain delay is absolutely necessary, if the Committee of Papers is to discharge with due care its important function of arriving at a sound judgment, after considering the opinions of responsible specialists on the merits of each paper submitted to it. In substance, I do not think that we can hope to better our present arrangements; all that can be asked is, that they should be improved in some details, and more especially that the time which necessarily intervenes between presentation and publication should be minimised.

The preparation of copy for the Catalogue of Scientific Papers, decade 1874—85, now approaches completion. A total of 290 series have been indexed, giving 85,000 title slips, written, checked, and distributed. This number, which is within 10,000 of that contained in the two volumes of the preceding decade, nearly exhausts the material in our own library; it remains to supplement this by reference to other libraries.

At the meeting on the 18th of June last, our Fellow, Prof. Roy, communicated to the Council the project entertained by himself, Dr. Graham Brown, of Edinburgh, and Mr. Sherington (G. H. Lewes Student, Cambridge), of proceeding to Spain with a view of investigating the nature of cholera, and requested the assistance of the Royal Society.

In view of the great practical importance of such an investigation, and the desirableness of making a new attempt to solve a problem about which highly competent inquirers have arrived at contradictory results, the President and Council resolved to do everything which lay in their power to assist Dr. Roy and his colleagues. The Secretary was instructed to inquire of the Spanish Minister whether the proposed investigations would be agreeable to the Spanish authorities, and whether Dr. Roy might expect to obtain facilities and assistance. On the receipt of a courteous and sympathetic letter from his Excellency, the Secretary was further instructed to inform the Foreign Office of Dr. Roy's expedition, and to request that Her Majesty's Government would afford him and his colleagues all the assistance in their power. Moreover, 150*l.* was granted from the Donation Fund in aid of the expenses of the undertaking, which were shared between the Royal Society and the Society for the Advancement of Medicine by Research.

I am sure the Fellows of the Society will join with me in congratulating Dr. Roy, Dr. Brown, and Mr. Sherington on having returned safe and sound from an adventure in which the interest of scientific inquiry must have been heightened by a considerable spice of personal danger. Dr. Roy has furnished me with a brief preliminary report of the work done, the substance of which I proceed to lay before the Society.

The members of the Commission met with very serious difficulties in their attempts to study the pathology of cholera in Spain, where they spent three months; but owing to the powerful support which was given them by the English Embassy in Madrid, they were able eventually to pursue their studies in a satisfactory manner. At Aranjuez and Madrid they obtained free access to the cholera hospitals, and made nearly thirty autopsies of typical cholera cases within very short periods after death. From all of these cases they were able to obtain material for cultivation and thus to make a large series of investigations on the different forms of micro-organisms which are found in the tissues and intestinal contents of cholera cases. Owing, however, to the impossibility of obtaining animals for inoculation, and reagents of various kinds, they were unable to complete their inquiry in Spain, and they were obliged to leave the investigations of certain points until their return to England. They have directed their attention chiefly to the relation which the comma bacillus, first described by Koch, bears to the cholera process, and they hope to be able to make important additions to our knowledge of this important subject. They are at present engaged in completing their work, and in the course of a few weeks they hope to be able to present their full report to the Royal Society.

The Marine Biological Association, to the funds of which the Royal Society made a substantial contribution last year, is making good progress. A site for building has been granted by the War Office, at Plymouth; plans have been prepared, and if the Treasury will follow the precedent which it has so largely and beneficially adopted in educational matters, of helping those who help themselves, as I am glad to say my lords seem inclined to do, I trust that, before long, the laboratory will be in working order.

The prosecution of the borings into the Delta of the Nile, which reference has been made on previous Anniversaries, have unfortunately been hindered by various obstacles. Quite recently I have been favoured by Col. H. Maitland, R.E., with an

account of the borings made near Rosetta, in which a depth of 84 feet was reached without apparently attaining the bottom of the fluviatile deposits; and I hope that circumstances may shortly permit the resumption of the original project of carrying a line of borings across the Valley of the Nile on the parallel of Tantah or thereabouts.

In the meanwhile the Committee in charge of the investigation has presented a report by Prof. Judd on the results of the examination of the borings already made. I have been favoured by Prof. Judd with the following brief summary of these results, which have been fully fully set forth in a paper read at the first meeting of the Society after the recess.

Although two of the recent borings in the Nile Delta have attained depths of 73 and 84 feet respectively, yet neither of them has reached the rocky floor of the old Nile Valley, nor, indeed, have they afforded any indications of an approach to the solid rock. The samples of the Delta deposits obtained by these boring operations are found to be in all cases mixtures in varying proportions of Nile mud, or material carried in suspension by the river, and desert sand, or particles swept up from the surrounding districts by the action of winds. The study of these materials by the aid of the microscope has revealed a number of facts which may be made the basis of generalisations of considerable interest to geologists.

The minerals present in these sands and muds are found to be such as characterise the granitic and highly crystalline metamorphic rocks; there can be little doubt, therefore, that the vast regions included within the Nile basin are in the main composed of rocks belonging to those classes, or of sedimentary deposits derived from them.

Of still greater interest is the fact that the fragments of felspars and other complex silicates in the Delta deposits exhibit but slight evidences of kaolinisation or other chemical change. This points to the conclusion that, in rainless districts drained by the Nile, the disintegration of rocks is effected by mechanical rather than by chemical agencies. A very striking confirmation of this conclusion is afforded by the study of the composition of the waters of the Nile, our knowledge of which has been greatly advanced by the recent researches by Dr. C. M. Tidy. In spite of the circumstance that the waters of the Nile must undergo great concentration during its passage of 1400 miles through regions of exceptional heat and drought, it is found that those waters actually hold in solution little more than one-half the percentage of mineral matter which is present in the river waters of temperate and rainy regions. The chemical disintegration of rocks being so largely due to the action of rain and vegetation, it is not surprising to find that where these agencies are almost entirely absent the rocks exhibit but few signs of chemical change.

The Krakatão Committee, which is now rather a large one, consisting of thirteen members, has been steadily at work during the year; and the discussion of the very varied and large mass of data has been undertaken by sub-committees, dealing respectively with the following branches:—

Geological—including eruption and earthquake phenomena, and the geological features of the distribution of dust and pumice.

Meteorological (A)—including air-waves, sounds, and the geographical distribution of dust and pumice.

Meteorological (B)—including twilight effects, coronal appearances, cloud haze, coloured sun, moon, &c.

Magnetic and electric phenomena.

Tidal waves.

With the exception of the last-named Sub-Committee, viz. that upon Tidal Waves, of which the work has been delayed by the illness of Sir F. Evans, all the reports are now in a forward state, and there seems to be every prospect of the work being concluded in the course of a very few months.

The question of the proper administration of the funds administered on behalf of the Government by the representatives of the Royal Society and of other scientific bodies, who constitute the Government Grant Committee, has frequently been debated with much care by the President and Council, who are held responsible for the final assignment of the grant by the Government.

On the 20th of May last the Council determined, once again, to devote special attention to the subject, and on the 25th June the minutes will inform you that the following resolutions were passed:—

"That in every case of renewed application for a personal grant, after such grant has been received by the applicant in two consecutive years, the application be made not less than three months before it is to be considered, accompanied by a full statement of the case from the applicant, and that before being presented to the Committee, it be referred by the Council to two referees, who shall report to the Council on its merits."

"That the Secretaries be instructed to return to the applicants for aid from the Government Grant such applications as do not in all particulars comply with the conditions laid down in the circular to applicants."

It is very desirable that our intention to enforce the latter resolution strictly should be widely promulgated. I may add that we have considerable reason to complain that too frequently those who have obtained grants through the Committee make no report of the work done to the Society, but leave information on that head to reach us as it may through the publications in which the results obtained by the grantee are made known.

Nineteen large royal quarto volumes of the Official Reports on the Scientific Results of the *Challenger* Expedition have now been issued from the press. These contain thirty-seven zoological, three botanical, and eight physical and chemical reports, together with the narrative of the voyage, which contains the general scientific results of the Expedition. Six more volumes are now passing through the press, a considerable part of each being already printed off. The work connected with the remaining memoirs is in a forward state. The whole of the investigations and the manuscript will be completed during the next financial year, and in the course of the year 1887 the whole of the Reports will be published, and the work connected with the Expedition brought to a close.

In the Treasurer's address last year the Society was fully informed of the action taken by the President and Council in the matter of the position of this country with respect to the international "Bureau des Poids et Mesures." I am happy to be able to report to the Society that, last December, we received a letter from the Treasury, stating that my Lords had asked the Secretary of State to instruct the British Ambassador at Paris to make known to the Comité International des Poids et Mesures that Her Majesty's Government were willing to join the Convention on the terms described in our Secretary's letter of the 18th August, 1884, and that the proposal had been accepted.

Your President is, *ex officio*, Chairman of the Board of Visitors of the Royal Observatory. As such, it was my duty to preside at a recent meeting of that body, when my colleagues agreed to recommend the adoption of a day, commencing at midnight, in all observatories and in the *Nautical Almanac*, from and after the commencement of the year 1891.

Much to my regret, I have been unable to take part in the work of the City and Guilds Institute during the past year, but I have reason to know that considerable progress has been made towards the attainment of its object—the advancement of technical education in London and in the provinces. The Finsbury Technical College is fulfilling its purpose in the most satisfactory manner, and its day and evening classes are so numerously attended that an extension of the building is under consideration. About 250 technical classes in different parts of the Kingdom are now affiliated to the Institute, and some of them are already developing into efficient technical schools. The assistance which the Institute is enabled to afford to these classes is restricted by want of means; but there can be no doubt that far larger opportunities of obtaining evening instruction in the application of the different branches of science to industry are afforded to the artisans of London now than was the case even four or five years ago.

Large additions have been made to the equipment of the Central Institution at South Kensington. The engineering laboratory and the extensive chemical and physical laboratories are organised, and the systematic instruction of students has commenced. Scholarships of the value of 30*l.* a year, tenable for three years, have been offered to, and accepted by, the Governors of a number of public and other schools. These scholarships are to be awarded by the head-master (not necessarily on the result of a competitive examination) to any pupil who is competent to pass the entrance examination of the Central Institution.

The City and Guilds Institute is the outcome of the perception of the necessity for technical education, in the interests of industry, by the wealthiest city and the wealthiest guilds in the world; it may, therefore, seem singular that the chief obstacle to the proper development of the important schools which it has

founded is poverty. Such, however, I understand to be the case. The Central Institution requires an assured income of at least 15,000*l.* a year if it is to work properly; but the joint resources of the City and Guilds of London, at present, appear to be able to afford it only a precarious, annually-voted, subsidy of 9000*l.* a year—far less, that is to say, than the private income of scores of individual Londoners. In Germany, a similar institution would demand and receive 20,000*l.* a year as a matter of course; but Englishmen are famous for that which a perplexed Chancellor of the Exchequer (I think it was) once called their "ignorant impatience of taxation," and there is no occasion on which they so readily display that form of impatience as when they are asked for money for education, especially scientific education. I am bound to add, however, that my experience on the Council and Committees of the Institute has left no doubt on my mind that my colleagues have every desire to carry out the work they have commenced thoroughly; and that the money difficulty will disappear along with certain other difficulties which, I am disposed to think, need never have arisen.

Such are the chief matters of business, if I may so call them, which it is proper for me, in my Presidential capacity, to bring before the Society. But it has been not unusual, of late years, for the occupant of the Chair to offer some observations of a wider bearing for the consideration of the Society; and I am the more tempted to trespass upon your patience for this purpose, as it is the last occasion on which I shall be able to use, or abuse, the President's privileges.

So far as my own observations, with respect to some parts of the field of natural knowledge, and common report, with respect to others, enable me to form an opinion, the past year exhibits no slackening in the accelerated speed with which the physical sciences have been growing, alike in extent and in depth, during several decades. We are now so accustomed to this "unhasting but unresting" march of physical investigation; it has become so much a part of the customary course of events, that, with every day, I might almost say with every hour, something should be added to our store of information respecting the constitution of nature, some new insight into the order of the cosmos should be gained, that you would probably listen with incredulity to any account of the year's work which could not be summed up in this commonplace of Presidential addresses.

Nor shall I be chargeable with innovation if I add that there is no reason to suspect that the future will bring with it any retardation in the advance of science. The adverse influences, which, in the middle ages, arrested the work commenced by the older Greek philosophers, are so much weakened that they no longer offer any serious obstacle to the growth of natural knowledge; while they are powerless to prevent the extension of scientific methods of inquiry and the application of scientific conceptions to all the problems with which the human mind is confronted. If any prophecy is safe of fulfilment, it is that, in the twentieth century, the influence of these methods and conceptions will be incomparably greater than it is now; and that the inter-penetration of science with the common affairs of life, which is so marked a feature of our time, will be immeasurably closer. For good or for evil, we have passed into a new epoch of human history—the age of science.

It may seem superfluous that I should adduce evidence in support of propositions which must have so much of the nature of truisms to you who are sharers in the work of science and daily witnesses of the effects of its productive energy. But the proverbial tendency of familiarity to be incompatible with due respect is noticeable even in our appreciation of the most important truths, and our strongest convictions need furbishing up now and then, if they are to retain their proper influence. I certainly cannot accuse myself of ever having consciously entertained a low estimate of the past work or the future progress of science; but, a few months ago, enforced leisure and the attainment of an age when retrospection tends to become a habit, not to say a foible, led me to look at the facts anew; and I must confess that the spectacle of the marvellous development of science, alike in theory and practice, within my own life-time, appeared to me to justify a faith, even more robust than mine, in its future greatness.

For, if I do not greatly err, the greater part of the vast body of knowledge which constitutes the modern sciences of physics, chemistry, biology, and geology, has been acquired, and the widest generalisations therefrom have been deduced, within the last sixty years; and, furthermore, the majority of those applications of scientific knowledge to practical ends, which have brought about the most striking differences between our present civilisation and that of antiquity, have been made within that period of time.

To begin with the latter point—the practical achievements of science. The first railway for locomotives, which was constructed between Stockton and Darlington, was opened in September, 1825, so that I have the doubtful advantage of about four months' seniority over the ancestral representative of the vast reticulated fetching and carrying organism which now extends its meshes over the civilised world. I confess it fills me with astonishment to think that the time when no man could travel faster than horses could transport him, when our means of locomotion were no better than those of Achilles or of Ramses Maimun, lies within my memory. The electric telegraph, as a thing for practical use, is far my junior. So are arms of precision, unless the old rifle be regarded as such. Again, the application to hygiene, and to the medical and surgical treatment of men and animals, of our knowledge of the phenomena of parasitism, and the very discovery of the true order of these phenomena, is a long way within the compass of my personal knowledge.

It is unnecessary for me to enumerate more than these four of the many rich gifts made by science to mankind during the last sixty years. Arresting the survey here, I would ask if there is any corresponding period in previous history which can take credit for so many momentous applications of scientific knowledge to the wants of mankind? Depreciators of the value of natural knowledge are wont to speak somewhat scornfully of these and such-like benefactions as mere additions to material welfare. I must own to the weakness of believing that material welfare is highly desirable in itself, and I have yet to meet with the man who prefers material illfare. But even if this should be, as some may say, painful evidence of the materialistic tendencies incidental to scientific pursuits, it is surely possible, without much ingenuity, or any prejudice in favour of one or other view of the mutual relations of material and spiritual phenomena, to show that each of these four applications of science has exerted a prodigious influence on the moral, social, and political relations of mankind, and that such influence can only increase as time goes on.

If the senseless antipathies, born of isolation, which formerly converted neighbours, whether they belonged to adjacent families or to adjacent nations, into natural enemies, are dying away, improved means of communication deserve the chief credit of the change; if war becomes less frequent, it will be chiefly because its horrors are being intensified beyond bearing by the close interdependence and community of interest thus established between nations, no less than by the improvement of the means of destruction by scientific invention. Arms of precision have taken the mastery of the world out of the hands of brute force and given it into those of industry and intelligence. If railways and electric telegraphs have rendered it unnecessary that modern empires should fall to pieces by their own weight as ancient empires did, arms of precision have provided against the possibility of their being swept away by barbarous invasions. Health means not merely wealth, not merely bodily welfare, but intellectual and moral soundness; and I doubt if, since the time of the father of medicine, any discovery has contributed so much to the promotion of health and the cure of disease as that of the part played by fungoid parasites in the animal economy, and that of the means of checking them, even though, as yet, unfortunately it be only in a few cases.

But though these practical results of scientific work, during only two generations, are calculated to impress the imagination, the Fellows of this Society know well enough that they are of vastly less real importance than the additions which have been made to fact and theory and serviceable hypothesis in the region of pure science. But it is exactly in these respects that the record of the past half century is so exceptionally brilliant. It is sometimes said that our time is a day of small things—in science it has been a day of the greatest things, for, within this time, falls the establishment, on a safe basis, of the greatest of all the generalisations of science, the doctrines of the Conservation of Energy and of Evolution.

As for work of less wide scope, I speak in the hearing of those who can correct me if I am wrong, when I say that the larger moiety of our present knowledge of light, heat, electricity, and magnetism, has been acquired within the time to which I refer; and that our present chemistry has been in great part created, while the whole science has been remodelled from

foundation to roof. It may be natural that progress should appear most striking to me among those sciences to which my own attention has been directed, but I do not think this will wholly account for the apparent advance "by leaps and bounds" of the biological sciences within my recollection. The cell theory was the latest novelty when I began to work with the microscope, and I have watched the building of the whole vast fabric of histology; I can say almost as much of embryology, since Von Baer's great work was published in 1828. Our knowledge of the morphology of the lower animals and plants, and a great deal of that of the higher forms, has very largely been obtained in my time; while physiology has been put upon a totally new foundation, and, as it were reconstructed, by the thorough application of the experimental method to the study of the phenomena of life, and by the accurate determination of the purely physical and chemical components of these phenomena. The exact nature of the processes of sexual and non-sexual reproduction has been brought to light. Our knowledge of geographical and geological distribution, and of the extinct forms of life, has been increased a hundredfold. As for the progress of geological science, what more need be said than that the first volume of Lyell's "Principles" bears the date of 1830?

This brief enumeration of the salient achievements of science in the course of the last sixty years is sufficient not only to justify what I have said respecting their absolute value, but to show how much it excels, both in quantity and quality, the work produced in any corresponding period since the revival of science. It suggests, as I have said, that science is advancing and will continue to advance with accelerated velocity.

It seems to me, in fact, not only that this is so, but that there are obvious reasons why it must be so. In the first place, the interdependence of all the phenomena of nature is such that a seemingly unimportant discovery in one field of investigation may react in the most wonderful manner upon those which are most widely remote from it. The investments of science bear compound interest. Who could have imagined that a curious inquiry into the relations of electricity with magnetism would lead to the construction of the most delicate instruments for investigating the phenomena of heat; to means of measuring not only the smallest intervals of time, but the greatest depths of the ocean; to methods of exploring some of the most hidden secrets of life? What an enormous revolution would be made in biology, if physics or chemistry could supply the physiologist with a means of making out the molecular structure of living tissues comparable to that which the spectroscope affords to the inquirer into the nature of the heavenly bodies. At the present moment the constituents of our own bodies are more remote from our ken than those of Sirius, in this respect. In the next place, the vast practical importance of the applications of scientific knowledge has created a growing demand for technical education based upon science. If this is to be effective, it means the extension of scientific teaching to all classes of the community, and the encouragement and assistance of those who are fit for the work of scientific investigation to adopt that calling. Lastly, the attraction of the purely intellectual aspects of science and the rapid growth of a sense of the necessity of some knowledge of the phenomena of nature, and some discipline in scientific methods of inquiry, to every one who aspires to take part in, or even to understand, the tendencies of modern thought, have conferred a new status upon science in the seats of learning, no less than in public estimation.

Once more reverting to reminiscence, the present state of scientific education surely presents a marvellous and a most satisfactory contrast to the time, well within my memory, when no systematic practical instruction in any branch of experimental or observational science, except anatomy, was to be had in this country; and when there was no such thing as a physical, chemical, biological, or geological laboratory open to the students of any University, or to the pupils of any school, in the three kingdoms. Nor was there any University which recognised science as a faculty, nor a school, public or private, in which scientific instruction was represented by much more than the occasional visit of a vagrant orrery.

At the present moment, any one who desires to obtain a thoroughly scientific training has a choice among a dozen institutions; and elementary scientific instruction is, so to speak, brought to the doors of the poorer classes. If the rich are debarred from like advantages, it is their own affair; but even the most careful public school education does not now wholly exclude the knowledge that there is such a thing as science from the mind of a young English gentleman. If science is not allowed a fair share of the children's bread, it is at any rate permitted to pick up the crumbs which fall from the time-table, and that is a great deal more than I once hoped to see in my life-time.

I have followed precedent in leading you to the point at which it might be fair, as it certainly would be customary, to end by congratulating you, as Fellows of the Royal Society, on the past progress and the future prospects of the work which, for two centuries, it has been the aim of the Society to forward. But it will perhaps be more profitable to consider that which remains to be done for the advancement of science, than to "rest and be thankful" in the contemplation of that which has been done.

In all human affairs the irony of fate plays a part, and in the midst of our greatest satisfactions, "surgit amari aliquid." I should have been disposed to account for the particular drop of bitterness to which I am about to refer, by the sexagenarian state of mind, where it not that I find the same complaint in the mouths of the young and vigorous. Of late years it has struck me, with constantly increasing force, that those who have toiled for the advancement of science are in a fair way of being overwhelmed by the realisation of their wishes. We are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science. If he were to attempt to do so, his mental faculties would be crushed by the multitudes of journals and of voluminous monographs which a too fertile press casts upon him. This was not the case in my young days. A diligent reader might then keep fairly informed of all that was going on, without robbing himself of leisure for original work, and without demoralising his faculties by the accumulation of unassimilated information. It looks as if the scientific, like other revolutions, meant to devour its own children; as if the growth of science tended to overwhelm its votaries; as if the man of science of the future were condemned to diminish into a narrower and narrower specialist, as time goes on.

I am happy to say that I do not think any such catastrophe a necessary consequence of the growth of science; but I do think it is a tendency to be feared, and an evil to be most carefully provided against. The man who works away at one corner of nature, shutting his eyes to all the rest, diminishes his chances of seeing what is to be seen in that corner; for, as I need hardly remind my present hearers, that which the investigator perceives depends much more on that which lies behind his sense-organs than on the object in front of them.

It appears to me that the only defence against this tendency to the degeneration of scientific workers, lies in the organisation and extension of scientific education, in such a manner as to secure breadth of culture without superficiality; and, on the other hand, depth and precision of knowledge without narrowness.

I think it is quite possible to meet these requirements. There is no reason, in the nature of things, why the student who is destined for a scientific career should not, in the first place, go through a course of instruction such as would insure him a real, that is to say, a practical acquaintance with the elements of each of the great divisions of mathematical and physical science; nor why this instruction in what (if I may borrow a phrase from medicine) I may call the institutes of science, should not be followed up by more special instruction, covering the whole field of that particular division in which the student eventually proposes to become a specialist. I say not only that there is no reason why this should not be done, but, on the ground of practical experience, I venture to add that there is no difficulty in doing it. Some thirty years ago, my colleagues and I framed a scheme of instruction on the lines just indicated, for the students of the institution which has grown into what is now known as the Normal School of Science and Royal School of Mines. We have found no obstacles in the way of carrying the scheme into practice except such as arise, partly, from the limitations of time forced upon us from without; and, partly, from the extremely defective character of ordinary education. With respect to the first difficulty, we ought, in my judgment, to bestow at least four, or better five, years on the work which has, at present, to be got through in three. And, as regards the second difficulty, we are hampered not only by the ignorance of even the rudiments of physical science, on the part of the students who come to us

from ordinary schools, and by their very poor mathematical acquirements, but by the miserable character of the so-called literary training which they have undergone.

Nothing would help the man of science of the future to rise to the level of his great enterprise more effectually than certain modifications, on the one hand, of primary and secondary school education, and, on the other, of the conditions which are attached by the Universities to the attainment of their degrees and their rewards. As I ventured to remark some years ago, we want a most favoured nation clause inserted in our treaty with educators. We have a right to claim that science shall be put upon the same footing as any other great subject of instruction, that it shall have an equal share in the schools, an equal share in the recognised qualification for degrees, and in University honours and rewards. It must be recognised that science, as intellectual discipline, is at least as valuable, and, as knowledge, is at least as important, as literature, and that the scientific student must no longer be handicapped by a linguistic (I will not call it literary) burden, the equivalent of which is not imposed upon his classical compeer.

Let me repeat that I say this, not as a depreciator of literature, but in the interests of literature. The reason why our young people are so often scandalously and lamentably deficient in literary knowledge, and still more in the feeling and the desire for literary excellence, lies in the fact that they have been withheld from a true literary training by the pretence of it, which too often passes under the name of classical instruction. Nothing is of more importance to the man of science than that he should appreciate the value of style, and the literary work of the school would be of infinite value to him if it taught him this one thing. But I do not believe that this is to be done by what is called forming one's self on classical models, or that the advice to give one's days and nights to the study of any great writer, is of much value. "Le style est l'homme même," as a man of science who was a master of style has profoundly said; and aping somebody else does not help one to express one's self. A good style is the vivid expression of clear thinking, and it can be attained only by those who will take infinite pains, in the first place, to purge their own minds of ignorance and half knowledge, and, in the second, to clothe their thoughts in the words which will most fitly convey them to the minds of others. I can conceive no greater help to our scientific students than that they should bring to their work the habit of mind which is implied in the power to write their own language in a good style. But this is exactly what our present so-called literary education so often fails to confer, even on those who have enjoyed its fullest advantages; while the ordinary schoolboy has rarely been even made aware that its attainment is a thing to be desired.

I venture to lay these last observations before you, because we have heard a good deal lately of schemes for the remodelling of the University of London, which has done so much, through its Faculties of Science and Medicine, to promote scientific instruction. As a member of the Senate of the University I am necessarily greatly interested in such projects, and I greatly regret that I have been unable to take part in the recent action concerning them. This is not the time or the place for the discussion of any of these proposals, but many of my hearers must be as warmly interested in them as I am myself, and it may not be out of place to submit two questions for their serious consideration.

In the interests of science, will any change be satisfactory which does not lighten the linguistic burden at present imposed on students of science and of medicine by the matriculation examination?

And again, in the interests of science, will any change be satisfactory which does not convert the examining University into a teaching University? And, by that last term, I do not mean a mere co-operative society of teacher-examiners, but a corporation which shall embrace a professoriate charged with the exposition and the advancement of the higher forms of knowledge in all its branches.

The future both of pure science and of medicine in this country is, I think, greatly interested in the answer which Fellows of this Society, after due meditation, may be disposed to give to these questions.

I have to announce an unusually large number of changes in the staff of the Society.

Last December we regretted to receive the resignation of Mr. Walter White, so long our Assistant Secretary, whose faithful and efficient services, continued for more than forty years, are well known to all the Fellows of the Society. The minutes of the Council record our appreciation of Mr. White's services, and our endeavour to give as substantial a form as possible to our hearty recognition of his deserts. The vacancy thus caused has been filled up by the appointment of Mr. Herbert Rix, whose work since he has held the office of clerk has been such as to justify the confidence of the officers, not only that the functions hitherto discharged by the Assistant Secretary will be as well performed as heretofore; but that, if the interest of the Society should demand it, we may throw still more important duties upon him. I receive the most favourable reports of the efficiency of Mr. James, who has been appointed to the office of clerk in place of Mr. Rix.

Notwithstanding my release from all serious work, my health remained so very indifferent for some months after my return to England that I felt it my duty to the Society to bring the question of my resignation of the Presidency, on the present Anniversary, before the Council which met on May 20. My colleagues were kind enough to wish that my final decision should be deferred, and I need hardly say how willing I should have been to retain my honourable office if I could have done so with due regard to the interests of the Society, and, perhaps I may add, of self-preservation.

I am happy to say that I have good reason to believe that, with prolonged rest—by which I do not mean idleness, but release from distraction and complete freedom from those lethal agencies which are commonly known as the pleasures of society—I may yet regain so much strength as is compatible with advancing years. But, in order to do so, I must, for a long time yet, be content to lead a more or less anchoritic life. Now it is not fitting that your President should be a hermit, and it becomes me, who have received so much kindness and consideration from the Society, to be particularly careful that no sense of personal gratification should delude me into holding the office of its representative one moment after reason and conscience have pointed out my incapacity to discharge the serious duties which devolve upon the President, with some approach to efficiency.

I beg leave, therefore, with much gratitude for the crowning honour of my life which you have conferred upon me, to be permitted to vacate the chair of the Society as soon as the business of this meeting is at an end.

As I am of opinion that it is very undesirable that the President should even seem to wish to exert any influence, direct or indirect, on the action of the Fellows assembled in General Meeting, I am silent respecting the proposals embodied in the new list of the officers of the Society which my colleagues and I have unanimously agreed to submit for your consideration.

The President then proceeded to the presentation of the Medals:—

The Copley Medal is awarded to Prof. August Kekulé of Bonn, whose researches in organic chemistry, extended over the last five-and-thirty years, have been fruitful of results of high importance in chemical science. The great work of Prof. Kekulé's life, that which has raised him to the highest rank among the investigators of the day, is his general theory of the constitution of carbon compounds, in which the now universally accepted conception of the constitution of those compounds was first clearly and definitely stated.

A development of the fundamental theory led Kekulé to the discovery of the constitution of an exceedingly numerous and very complex class of compounds, which he has named the aromatic compounds, and his theory of the constitution of the aromatic compounds has suggested and guided innumerable investigations. The marvellous success obtained by many of his followers and pupils in building up artificially complex substances which had defied the efforts of all previous investigators, affords tangible evidence that Kekulé's labours have given us a deeper insight into the order of nature.

One of the Royal Medals is awarded to Prof. Hughes, F.R.S., for a series of experimental investigations in electricity and magnetism, which are remarkable alike for ingenuity of contrivance, for the simplicity of the apparatus employed, for the delicacy of the indications afforded, and for the wide applicability of the instruments invented to researches other than those for which they were originally designed.

The microphone, the induction balance, and the sonometer, are instruments by which inconceivably minute electrical and magnetic disturbances not only make themselves loudly audible, but may be definitely measured; and their application has opened up new lines of inquiry.

The other Royal Medal is awarded to Prof. E. Ray Lankester, F.R.S., for his labours, now extending over more than twenty years, in the field of animal morphology (especially invertebrate anatomy and embryology) and of palæontology.

Prof. Lankester has been active in many directions, and has everywhere left his mark, not only as an energetic teacher and accurate worker and a philosophical thinker; but as one who, in times when the example is more than ever valuable, has always been careful to remember that speculation should be the servant and not the master of the biologist.

The Davy Medal is awarded to Prof. Stas of Brussels.

Prof. Stas's great research, for which it is proposed that the Davy Medal be awarded to him, is that on atomic weights. There are probably no researches in chemistry, the results of which appeal so little to the imagination, and which are so little applauded, as those on atomic weights, yet for difficulty and importance they are hardly surpassed by any. The determination of these fundamental constants of chemistry has engaged the attention of many of the leading chemists, and before the time of M. Stas's experiments, an immense amount of careful labour had been bestowed on finding methods for the more accurate and complete purification of the compounds employed for the purpose.

The indefatigable and conscientious care which M. Stas has devoted to the re-determination of a certain number of the most important atomic weights, and the marvellous skill with which he has overcome the various difficulties which successively presented themselves, render his memoir on the subject one of the most remarkable and valuable of chemical monographs.

I regret to say that the state of M. Stas's health has not permitted him to be with us to-day, but the representative of his Sovereign, the King of the Belgians, in this country, has kindly consented to receive the medal for him.

M. le Baron Solvyns, I request your Excellency to be so good as to receive the medal awarded to M. Stas; and to assure him of the pleasure which it gives the Royal Society to show their sense of his high merits, by asking his acceptance of this memorial of his illustrious predecessor, Humphry Davy.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—In the Examination for Chemistry and Physics for 1st M.B. last June, an unusually large proportion of candidates were rejected. At the request of the Special Board for Medicine, the Examiners, Messrs. Pattison Muir, A. Scott, A. Schuster, and W. N. Shaw, have stated their opinion that the candidates showed very little mental training; they had almost no power of expressing clearly what they knew, whether facts, or conclusions from facts. Prof. Michael Foster has written a letter to Prof. Paget on this subject, partly derived from his recent experience in examining in Physiology in the 2nd M.B., and deploring the condition in which men enter the University, not only ignorant of Chemistry and Physics, but unprepared by any adequate discipline to receive the truths of experimental science. He believes no proper reform can come until the University makes such a change in the Previous or Preliminary Examination as shall permit a lad at school to study Chemistry and Physics, and give him time to do so by relieving him of some other subjects. The last clause is most important, and we are glad Prof. Foster emphasised it. The University requirements in the Preliminary Examinations determine the whole current of school work, and to move them in the direction of requiring, or at any rate permitting, Chemistry and Physics to be adequately taught at schools, should be a foremost object of scientific educationists.

Mr. R. G. Moulton, one of the most experienced lecturers on the University extension scheme, writes to advocate the establishing of a general organisation on a permanent basis. He points out that the best lecturers are lost when most valuable, owing to the lack of an assured position; also that the local committees need to be brought into connection with each other. A body also is needed which could seek and receive endowments. During the last ten years 50,000*l.* has been spent in the scheme, and 60,000 students have attended full courses of lectures.

The following Colleges offer Natural Science Scholarships or Exhibitions for open competition during the present and next month; the respective dates of examination being affixed:—Gonville and Caius, December 8; King's College, December 10; Jesus College, January 4; Christ's, Emmanuel, and Sidney-Sussex Colleges in common, January 5; St. John's College, December 10; Trinity College, December 10.

SCIENTIFIC SERIALS

Rivista Scientifico-Industriale, October 15.—On lateral atmospheric refraction, by Dr. G. Andries.—Transport and distribution of electricity by means of induced transformers: system of Zipernowsky, Deri, and Blathy, by Emilio Piazzolo.—On electric contrivances for illuminating fluids in scientific laboratories (four illustrations), by the editor.—On the microscopic organisms present in drinking-water: their life in waters charged with carbonic acid, by Dr. T. Leone.

THE *Journal of the Royal Microscopical Society*, vol. v. ser. ii part 5, October, contains:—On new British micro-fungi, by G. Massee (plate 13).—On erosion of the surface of glass when exposed to the joint action of carbonate of lime and colloids, by Dr. W. M. Ord.—On a septic microbe from a high altitude, by G. F. Dowdeswell.—On the use of the avicularian mandible in the determination of the chilostomatous Polyzoa, by Arthur W. Waters (plate 14).—The usual summary of current researches.

THE *American Naturalist* for October contains:—Mythic dry-paintings of the Novayos (illustrated), by W. Matthews.—The relations of mind and matter, by C. Morris.—A biography of the halibut, by G. B. Goode.—Traces of prehistoric man of the Watash, by John T. Campbell.—Editor's Table, Recent Literature, and General Notes.

THE *Victoria Royal Society Transactions*, vol. xxi. issued June 30, among other papers contains the following:—Evidences of a Glacial epoch in Victoria during post-Miocene times, by G. S. Griffiths.—The Phanerogama of the Mitta-Mitta Source Basin, II., by James Stirling.—Shingle on the east coasts of New Zealand, by W. W. Culcheth, M.Inst.C.E.—New or little-known Polyzoa, Part VII. (Plates 1 to 3), Part VIII. (Plates 1 to 5, by P. H. MacGillivray, M.A.—On the reproduction of the Ornithorhynchus, by P. H. MacGillivray, M.A.—On the Diabase rocks of the Buchan district; supplementary notes by A. W. Howett.—The meteorology of the Australian Alps, by James Stirling.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, November 19.—Prof. Moseley, F.R.S., in the chair.—Mr. A. D. Michael exhibited and described the remarkable nymphal stage of *Tegeocranus cephelformis*, a species of the Oribatidæ, which he lately discovered for the first time in England. He has furthermore succeeded in tracing the whole life-history of this animal. The creature in its nymphal stage is exceedingly strange and beautiful. It carries on its back as concentric shields the dorsal portions of all its cast-skins, and these are bordered by projections each bearing a rose-leaf-like cuticular process of transparent membrane with chitinous nervures. The drawing of the nymph was first sent to Mr. Michael, two years ago, by Herr Pappe, of Bremen.—Mr. C. Stewart demonstrated, under the microscope, the stridulating apparatus of a species of *Sphærotherium*, differing in some respects from that described by Mr. Bourne (*infra*).—Dr. J. Murie exhibited and made remarks on the caudal end of the spine of a haddock with an arched deformity, recalling what is recorded of the so-called hump-backed cod (*Morrhua macrocephala*).—Mr. G. J. Fookes called attention to some twin-apples, of teratological interest. These were grown at Shepherd's Bush, upon a tree eighty years old, which last year was nearly barren, but this year produced abundantly, many of the fruits being good examples of syncarpy.—Prof. P. M. Duncan read a paper on the perignathic girdle of the Echinoidea. The author maintained that as the structures which give attachment to the muscles that protrude and retract the jaws of the Echinoidea (which are parts of the test surrounding the peristome within) are not homologous in all the families of the group, therefore it is unadvisable to retain the old name of "auricles." He suggests to substitute the term "perignathic girdle." The girdle consists of processes usually united above (though occasionally disconnected), and of "ridges" which connect the processes on the side remote from the ambulacra. The ridges are modifications of the inter-radial

plates, the processes developments from the ambulacral plates. In the Cidaridæ, the muscular attachments are all on disconnected ridges, and there are no processes. In the Temnopleuridæ, Echinidæ, Echinometridæ, and Diadematidæ, the retractor muscles are attached to "processes" which are growths of the poriferous portions of the ambulacral plates; and the protractor muscles and ligament of the radiales are attached to the ridge which is developed on the inter-radial plates, and is united by suture to the base of the "process." In the Clypeastridæ there are disconnected growths which carry the jaws and have slight muscular attachments. In *Clypeaster* there are ten processes, each arising from an ambulacral plate; and there are no inter-radial structures like ridges. In *Laganum* there are five growths, each arising from a first inter-radial plate; hence these are the homologues of ridges. The Clypeastridæ may thus be divided into two groups, on account of the presence of processes in one, and of the homologues of ridges in the other.—Prof. Moseley communicated a paper on the anatomy of *Sphærotherium* by Mr. G. C. Bourne. The author mentioned that while the general exterior features and specific distinctions of the genus had been amply discussed, the internal structures had hitherto received scant attention. Among other anatomical peculiarities he describes a well-defined stridulating organ in the male. This consists of a prominent bolster-shaped swelling on the postero-external edge of the second joint of the second pair of copulatory appendages. The swelling occupies the entire margin of the joint, and shows a number of chitinous cross ridges and furrows. On the opposite interior surface of the last tergite are chitinous points. The former rasp-like organ of the second accessory appendages when rubbed rapidly against the latter produce a shrill note resembling that emitted by the house cricket. A true auditory organ exists in the antennary fossa beneath the eye. The tracheal system is unlike the majority of that of the Diplopoda, rather resembling that of Chilopoda and Insecta, though differing in the branched spiral filament not taking origin directly from the stigmata themselves. It appears that the tracheæ of *Sphærotherium* are a transition from those of the Julus type to those of the Scolopendra type. It would thus seem that the character of the tracheæ, the curved alimentary tract, the numerous chitinous pieces composing each segment, and the presence of a special hearing organ on the head, mark off the family Glomeridæ (to which *Sphærotherium* belongs) very sharply from the other families of the Diplopoda.—Prof. Moseley afterwards read extracts of letters from Mr. G. C. Bourne, who is now in the Chagos Archipelago, and from Mr. Sydney Hickson in the Celebes (Oxford graduates), and now investigating the natural history of the regions in question.—There followed a paper, contributions to South African botany, Orchideæ, part 2, by Mr. H. Bolus, with additional notes by Mr. N. E. Brown.

PARIS

Academy of Sciences, November 23.—M. Jurien de la Gravière, President, in the chair.—Observations of the minor planets made with the great meridian of the Paris Observatory during the third quarter of the year 1885, communicated by M. Mouchez.—Researches on the functions of Wrisberg's nerve, by M. Vulpian.—On a new theory of algebraic forms, by M. Sylvester.—On the sulphate of sparteine as a dynamic medicine and cure for the irregular action of the heart, by M. Germain Sée. This alkaloid (C_{15} or $C_{13},H_{26}N_2$), obtained in 1850 by Stenhouse from *Spartium scoparium*, is found to be a sovereign remedy for feeble, irregular, and abnormal pulsation. It also instantaneously restores enfeebled circulation, while preserving or increasing muscular vigour.—Action of lime (milk of lime) on the vine attacked by mildew, by the Duchess de Fitz-James. The author regards this preparation as the most practical, efficacious, and economical for vines attacked by mildew in the south of France.—Note on Lagrange's interpolating formula as presented by M. Hermite in *Crelle's Journal*, vol. lxxxiv., by M. Bendixson.—Note on Kœnig's theorem regarding the living force animating a material system at a given moment, by M. Ph. Gilbert.—Application of the cryoscopic method to the determination of molecular weights, by M. F. M. Raoult. It is shown that by this method the molecular weight of any substance may be determined with great certainty, provided such substance, or one of its compounds, or one of its derivatives obtained by substitution, be soluble either in water, acetic acid, or benzene. It presents the further advantage that the results thus obtained are susceptible of verification in several ways.—Researches on hypophosphoric acid ($PHO_4,2HO$ or $PH_2O_8,4HO$), by M. A. Joly.—Heat of combustion of some substances of the fat series, by M. Louguinine. The substances here studied with a view to determining their heat of combustion are: paraldehyde; normal propionic acid and anhydride; normal propionic acid purified and analysed by the author; aldol.—Note on a new method of chloridation, by MM. Albert Colson and Henri Gautier. Two points are established: (1) that the perchloride of phosphorus allows the introduction of a determined quantity of chlorine into the homologues of benzene; (2) that the chlorine liberated by the perchloride of phosphorus acts on the benzenic hydrogen only after being substituted for the hydrogen of the lateral series.—On the presence of methylic alcohol in the products derived from the distillation of plants with water, by M. Maquenne.—On the gutta-percha of *Bassia* (Butyrospermum) *parkii*, G. Don, and its chemical composition, by MM. Ed. Heckel and Fr. Schlagdenhauffen. The gutta-percha obtained from this plant is shown to be in every respect comparable to, and in structure almost identical with, that yielded by the better-known *Isonandra gutta*, Hooker.—On the pretended circulation in the ganglionar cells of animal organisms, by M. W. Vignal.—Remarks on the acicular apparatus of some Echinidæ of the Chalk and Tertiary epochs, by M. Munier-Chalmas.—Note on a meteor observed in Paris on November 18, by M. Stanislas Meunier.—On the shower of meteors which may, perhaps, accompany the transit of the earth through the descending nucleus of Biela's comet on November 27, by M. Zenker.—A second reply to M. Charpentier respecting the functions of the several elements of the retina producing the sensations of light, colour, and form, by M. H. Parinaud.—Observations on MM. Martel and de Launay's note on certain fragments of human crania and a fragment of pottery found in the cave of Nabriguas, and said to be contemporary with *Ursus spelæus*, by M. Emile Cartailhac. The author, who has several times visited this cave, is satisfied that it has been exposed to frequent inundations, and that, consequently, the ground has been disturbed even since the beginning of the Quaternary period. Hence, although man was certainly contemporary with *Ursus spelæus* in the west of Europe, he did not live in association with that animal, but probably took possession of the Nabriguas and other similar caves after its extinction in Neolithic times. The potsherd in question has been subjected to the action of fire, and is evidently of comparatively recent date, washed into the cave by the flood waters.

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