THURSDAY, FEBRUARY 8, 1894.

## A CRITIC CRITICISED.

*Darwinianism: Workmen and Work.* By James Hutchison Stirling, F.R.C.S., and LL.D. Edin. (Edinburgh: J. and J. Clark, 1894.)

DR. STIRLING begins his preface thus: "Perhaps it may be thought that, on the whole, I might very well have spared myself this small venture"; and such of his readers as know anything of Darwin's theories and works will most cordially agree with him. It has been the present writer's business to read most of the anti-Darwinian literature that has appeared in this country, and though much of it has exhibited extreme ignorance of the whole subject and a total inability to understand the theories and the arguments discussed, in both these respects the present volume fully equals the worst of its predecessors, while in the effort to belittle Darwin's intellect and to depreciate the value of his life's work it surpasses them all.

Considerably more than one-third of the volume is occupied with the lives of the three generations of Darwins, and though the animus is carefully veiled, there is an unmistakable attempt to show that, while there is much to admire in the moral and social aspects of the whole family, yet intellectually they have been greatly overpraised. In the very first chapter a number of opinions are quoted adverse to Dr. Erasmus Darwin; and after a chapter devoted to the glorification of Dr. Thomas Brown, the metaphysician, a third chapter is given up to his "Observations on Dr. Darwin's Zoonomia" and the correspondence between them, and we are led to understand that the young critic had by far the best of the argument, and that Dr. Darwin lost his temper.

The seventh to the twelfth chapters are devoted to Charles Darwin; and at the very commencement we find a passage that gives the keynote to the whole book. After saying that, of course, Mr. Charles Darwin will go down to posterity as one of the first of naturalists—an observer only to be classed with the Linnæuses and the Cuviers—we have this curious statement: "Mr. Francis Darwin—and in the circumstances it is not to disparage him to say so—will not, in all probability, precisely do that; but, with perhaps a more vigorous or more comprehensive general intellect, he is otherwise, we make bold to say, just about as good a man as his father was, than whom, for genuine worth, it would not be easy to find a better." What does this imply, if not that Darwin, though a preeminently good man, was, intellectually, not remarkable? And the whole of the succeeding chapters show that this is its meaning. Darwin's observing powers are dwelt on, and how much he thinks of technical *names* (p. 72). Then we are told that he was considered by all his masters and by his father to be below the common standard of intellect (p. 75), and this is repeated at p. 77, and again at p. 117. To enforce this, his own depreciatory phrases—that he learnt almost nothing at school and college, that he could never follow abstract trains of thought, that mathematics were repugnant to him, and that he was compelled to conclude that "his brain was never formed for much thinking"—are fully set forth. At the same time, Dr. Stirling reiterates, that though quite ordinary intellectually, he was "a very good young man," always trying to improve himself (p. 77); that at Cambridge he was "the steady well regulated young man" (p. 84); that he was "the good young man" who, for self-improvement, has interest in, and would have a try at, everything that gives marks. He actually "paid some attention to metaphysical subjects" (p. 105); and again—"he was the exemplarily good young man that sought self-improvement in all that was ticketed in society as right." (p. 119.)

While thus, with subtle ingenuity, "damning with faint praise" the man whose life-work he is striving to depreciate, Dr. Stirling impresses upon us what, in his opinion, is the intellectual faculty to which Darwin owes his reputation. It is, the love of observing movement! Thus—"The stir of a beetle in the dust was the first stir that arrested the interest of a Darwin: the convulsion of a continent was possibly the last." (p. 114.) "It was *stir* that alone claimed his attention, *stir* that alone woke his single natural life." (p. 113.) "Observation is an affair of the eyes—shallow, so far, and on the surface; but ideas and their expression no less, spring rather from the depth—the cerebral depth—of the ears." (p. 114.) Here, by the profound philosophy of a Stirling we are informed that because Darwin *was* an observer and was *not* a musician, therefore he was shallow and of few ideas! And for several pages this notion is harped upon—stir, movement, watching birds, observing facts, his very soul was "captivated, fascinated, mesmerised, by the enchantment of physical movement," the *Journal* shows that he was "only using his eyes there in every paragraph and almost every line"—and thus the general reader, for whom this book is clearly intended, will gain the idea that there is something trivial and weak in minute observation, and that this was what specially characterised Darwin.

Further matter for depreciation is found in Darwin's remarks on some of the eminent men with whom he associated. He thought Carlyle narrow, because he was utterly unable to appreciate science, and this evidently condemns Darwin in Dr. Stirling's opinion, who calls Mill "his shallow contemporary," and describes the group of eminent men who were more or less intimate with him in these terms:—"The truth is that a feebler general public has seldom existed than what was atmosphere to Carlyle"—of which Mill and the two Darwins, Tyndall, Huxley, and other eminent men were an important part. And when Darwin says of him—"I never met a man with a mind so ill-adapted for scientific research"—Dr. Stirling remarks, with crushing sarcasm, "Scientific research meant for Mr. Darwin only the observation of movement, as in beetles, say; and there was no such accomplishment in Carlyle." Darwin also knew Buckle, and read his books with great delight, though not accepting all his theoretical views; but even this limited admiration is too much for Dr. Stirling, who thereon pours out his wrath for seven pages on what he terms "the commonest, vulgarest, shallowest free-thinkingism."

Having thus prepared his readers by this fancy picture of the extremely limited range of Darwin's intellect, Dr. Stirling proceeds to deal with the "Origin of Species" as illustrated by the "Life and Letters." And the first point he brings forward is that Darwin was a compiler—a "not very sceptical" compiler, an "easy" compiler—and this idea is enforced throughout the first chapter of this second part of the work. Again and again this is recurred to, as the following passages show:—

"With all his experiences in pigeons, poultry, and seeds, Mr. Darwin supported his results mainly on a compilation. Had the public but known that!" (p. 190). "That all that—of the Descent of Man, say—should be supported, not on thirty years' actual observation, experiment, and insight—personally—of the greatest naturalist in existence, but only on little more than so many years' clippings and cuttings from articles in periodicals and other such, as—about 'Hearne the Hunter'!" (p. 212). "Now that is the pity of it! The success of the book depended on the belief of the public that it was the product of work at first hand, and not of compilation at second—work at first hand and of the greatest naturalist in existence. . . . . A compilation is always a dressing of facts for a purpose; and such a state of the case is simply glaring in every turn of the 'Origin.'" (p. 179.)

It is then clear that Dr. Stirling wishes to impress upon the public that Darwin's chief work was mainly a compilation, badly put together—for he tells us it is "dull" and "as heavy as lead"—put together to support a foregone conclusion, without caution or judgment, and yet so as to deceive the ignorant public and make them believe it was original work! Surely here is a Daniel come to judgment—though rather late in the day. Presently we shall have to inquire whether he who delivers this severe judgment is a competent as well as a just judge.

The next point is to show how it was that this dull compilation created such an excitement in the literary and scientific world, and made so many converts. We are told this was all owing to Darwin's habit—partly unconscious, partly designed—of thinking and speaking so highly of the work of his chief scientific correspondents—Hooker, Lyell, and Huxley. "Lyell is the biggest fish; and it is the hooking of him that is wished, and watched, and waited for with the intensest interest." (p. 166.) And after giving nearly two pages of extracts from Darwin's letters, we have the remark—"I suppose no one in this world has been more liberally or more lavishly thanked, flattered, and bepraised than the recipients of the above." (p. 169.) Referring to the preliminary papers read before the Linnean Society, Dr. Stirling remarks:—

"The way being so conspicuously prepared for it, and its appearance ushered in and heralded by a trumpet-blowing so resonant and extraordinary, was it any wonder that the book itself was hailed with acclamation and received with even a rush of expectation? And we have now only to see how the proceedings of Mr. Huxley at the very first could but beat the excitement that, so to speak, already blazed into an absolute conflagration and a veritable fury." (p. 172.) "As we all know, all in England is done by parties, and everything that appears in England is of no use whatever until it is made an affair of party. It was not different with the origin of species." (p. 174.) "With all before it that has now been detailed what could the public be expected to think? The most powerful scientific trumpets that, in these islands, could be blown, were blown—before the book. The most powerful popular trumpets that, in these islands, could be blown, were blown—after the book. . . . What could be expected for such a book, if not all but a universal rush to buy? . . . . . . And how did the public find the book? I do not suppose that any one will pretend that it is read now; and I do not suppose that any one will pretend that it was read *through* then—unless by those, the few friends of science and the author, whom, in both respects, of course, it immediately and specially concerned." (p. 176.)

Dr. Stirling should, however, have explained to his readers how it was that a book which hardly anybody read should have gone through six editions in twelve years, have been translated into every European language, and should still be constantly quoted and referred to as the most classical and authoritative work on the subjects of which it treats.

Half the volume having been thus occupied in the insinuation, and attempted proof, that Darwin was a mere compiler with little reasoning power, that there was nothing in his book that was not anticipated by his grandfather (pp. 43–49), and that the book itself owed its success to the carefully-prepared trumpet-blowing of a few influential friends, Dr. Stirling proceeds to demolish the whole theory in detail in order to justify the conclusion he has arrived at. And it is clear that the value to be attached to his judgment, in this matter, must depend upon whether he has taken the trouble, or has the capacity, to understand the theory, or has acquired an adequate knowledge of the facts on which the theory is founded. I propose therefore to show, by a rather full account of his work and by a sufficient number of extracts, the almost incredible state of ignorance and misapprehension everywhere displayed by it.

Chapter v. deals wtih the Struggle for Existence, devoting to it twelve pages, and maintaining throughout that, in the sense in which Darwin and his followers understand it, there is no such thing! If this can be proved Darwinians must indeed tremble. Let us then see how it is done. The tameness of animals in uninhabited islands is first referred to, with the remark: "It is impossible to think of struggle and strife in such circumstances." Dr. Andrew Smith and Mr. Selous are quoted to show the vast profusion of life in South Africa, carnivora and herbivora—"Plentiful lion was not incompatible with more plentiful antelope." Then the *passenger pigeon* of North America is referred to, as described in one of Cooper's novels; and the conclusion after two pages of such facts is—"With nature so prolific of life, what call is there for a struggle? what need?" Then we have several pages given to descriptions of how animals enjoy their lives. Mark Twain is quoted for playful schools of whales; Bret Harte for squirrels and jays; Jules Verne for antelopes, zebras, buffaloes, and monkeys; two articles in *Temple Bar* on birds and otters amusing themselves. Darwin himself testifies to "the positive pleasures of existence, to the actual joys of nature," and, "it is perfectly within the limits of truth to say that his entire *Journal* disproves the struggle!" And this conclusion is reiterated to the end of the chapter:—"There is little sign of a struggle for life in such cases. These animals have evidently no need to struggle: they seem indifferent about their food, and can remove themselves carelessly from any supplies of it."

(p. 214.) The *Journal* says so little of the struggle that Dr. Stirling believes the idea to have been only an afterthought, following the reading of Malthus, and he concludes the chapter with the opinion of Goethe, that, "in whatever situation of life we are placed, and wherever we fall, we never want actual food"—and he adds—"This means, that however galling the straits of life may be, there is no struggle such that, failing to triumph, we must perish in defeat."

The next chapter—on the Survival of the Fittest—is a short one; and it might well have been shorter, since it begins thus:—

"As regards our other consideration at present, it is pretty evident that if struggle there is none, survival, in that it simply means result of foregone contest, can be, and must be, so far, only a dead letter."

This, though forcible, is cautious, but the next paragraph sets the thing in a still clearer light.

"But, just squarely to say it, the proposition itself, survival of the fittest, is as things are, preposterousness proper. It is simply absurdity's self—the absolutely false."

And then follows, quite unnecessarily, a metaphysical and scriptural demonstration of the same thing, in which comets, tides, wind, the earthquake of Lisbon, the Black Hole of Calcutta, contingency, time, and physical necessity, with a host of other things, are all dragged in to enforce the argument. This abstract argument was, however, felt to need support by a concrete example, as follows:—

"Survival of the Fittest! Of two lions that fight, *must* the strongest win? How about a thorn, or a stone, or an unlucky miss, and an unfortunate grapple, and a fatal strain—to say nothing of infinite contingencies of rest and fatigue, of sleep, and food, and health, that precede?"

And after a few more such illustrations we have the conclusion, that—

"The proposition, as we have seen in fact, is wholly false as it stands."

And after some more vain attempts to arrive at any meaning in this "absurdity's self," the argument is clenched with what is evidently felt to be a *reductio ad absurdum*, and which is indeed a very gem of logic, as follows:—

"Is it possible in such a struggle—a struggle that just constitutes existence—is it possible in such a struggle for even a single competitor to survive him who is the fittest to survive? If individual with individual, species with species, genus with genus, must struggle, how is it that the infinitude of time has not already reduced all life to a single unit?" (p. 222.)

Every biologist, every reader of NATURE, will now, I am sure, see that I was justified in speaking of the almost incredible ignorance and misapprehension exhibited in this book; but we have yet to find still more glaring examples of it. Two chapters, entitled "Determination of what the Darwinian Theory *Is*" and "Design," may be passed over, and then follow six chapters of "Natural Selection Criticised," from which a few illustrations of the capacity of the critic must be given.

After Dr. Stirling's confident assertion that there is no struggle and no survival, and that the very idea of there being any such phenomena is "absurdity's self," we shall not be surprised to find that he prides himself on having cleared up a subject which Darwin left vague, indefinite, and obscure. He says:—

"It is only through long, patient looking that the particular moments in the theory have reached the clearness which we should be glad to think they will be found to possess in these pages." (p. 342.)

This is in the last chapter, when the author can look back with satisfaction on his completed work.

One of the difficulties he has cleared up is the meaning of the word origin, in "Origin of Species." He says there is never a moment's question of the *origin* of a single species:

"There is not even a hint before us of such a thing as *origin*. Change there is, not origin. We have a middle, elastic enough it may be, but we have no beginning, no origin, no first." (p. 250.)

And a little further on, having previously referred to small living armadillos and the gigantic extinct species, and having asserted that "It was the obvious resemblance common to both that irresistibly convinced Mr. Darwin of the indubitable descent of the one from the other"—a statement for which he gives us no authority—for the good reason that none can be given—he deals with the question in the following brilliant style:—

"Origin! We are referred from the Galapagos to the South American Continent, and there again the problem stares us in the face, only harder than ever. What is the origin of these South Americans? Again origin! What is the origin of these pigmies? and you refer us to giants! Good heavens! To be contented that the whole problem of the pigmies was solved in the giants, and never once to have asked what of these! Surely the giants at once suggest an infinitely more instant question as to origin than the pigmies. That pigmies, too, could come out of giants—such pigmies out of such giants! Was it *selection*, natural selection, condescended to such a feat as that? . . . Is that what is meant by 'the preservation of favoured races in the struggle for existence'—these pigmies? The nine-foot Glyptodon dies, the six-inch armadillo lives—is that the survival of the fittest?" (p. 251.)

This may be called argument by exclamation and interrogation founded on misconception, and it goes on with wearisome monotony page after page. And at the very end of the book he still stumbles over the same difficulty:

"This is strange, too—in the whole 'Origin of Species' there is not a single word of origin! The very species which is to originate never originates, but, on the contrary, is always to the fore."

And again:

"It was only the word *origin* did all this; and the word *origin*, strictly was a misnomer; misleading, not novelists alone, but the general public as such, into anticipations of a beginning and a first that was to be, as it were, a new creation of all things; whereas Mr. Darwin himself exclaims, 'It is mere rubbish thinking at present of the origin of life!' Had Mr. Darwin but used, instead of the word origin, his own other word for the idea in his mind, 'modification' namely—had his title-page ran 'The Modification of Species by Means of Natural Selection,' I question whether Mr. Murray, with all his experience, would, for each of the thousand copies he did sell, actually have sold ten." (Last page.)

Poor novelists! Poor general public! For thirty-five years you have gone on reading and discussing this book, and helping to make it celebrated, and have only now found one candid and truthful friend to inform you that you have been flagitiously deceived by the title, without which you would never have read it, or made any fuss about it, or even have heard of it at all!

In order, perhaps, to enforce this conclusion—that it was the word origin that alone attracted readers, Dr. Stirling assures us that Lyell was too old a bird to be caught by such chaff. Huxley, he tells us, is in a state of doubt; Carpenter and Gray were only half-converted; Hooker is the only genuine convert; but—

"Lyell, from the moment he came properly to know the doctrine, was really, and in point of fact, that doctrine's absolute opponent."

It is to be supposed, of course, that Dr. Stirling believes this; but then what of his knowledge? In five long chapters of the last edition of the "Principles," Lyell expounds the whole theory in his own calm judicial style, and on every aspect of it pronounces in its favour.

The passages we have marked in this volume as examples of misconception, misstatement, or ignorance, are so numerous that it is difficult to know where to choose. Here for example is the way the author deals with natural selection, as being neither a law nor a discovery.

"But has there been a *discovery?* and actually of a *law?* We have seen an hypothesis—a gourd, as it were, that came up in a night to be a shadow over the land—but a discovery? Can what the Pampas suggested, or South America, or the Galapagos—can what the breeders or fanciers suggested, or what Malthus suggested, or what the split-up stock of horses suggested—can either or all of these suggestions be called a discovery? That the similarities in species (as in the beetles, say) should have struck him, and that he should have then asked, What, if naturally varying in time, and so naturally variously applied, they were all just naturally out of each other?—that is a mere supposition, it is no discovery. Even as a supposition, is it a credible one, unless we remove it, far out of sight, into the dark? Yes: variations, accidents, we know them well, we see them daily; but they come and go, they appear and disappear, they are born and they die out—they really do nothing; and as for forming new creatures, is not that an extraordinarily weighty complication to burden such simple, perishable, transitory accidents with?" (p. 284.)

Here we have an interrogative show of argument and of superior knowledge on a subject as to which it is quite clear that the writer knows nothing whatever, but hides his ignorance in vague involved words, from which it is impossible to extract any definite meaning. And when he attempts to deal with any definite facts, the ignorance becomes more glaring and the flood of wordy interrogations more ludicrous. One more quotation to show this, and we have done. He is attempting to deal with the theory of protective colouration, and after a couple of pages of misconception and interrogation, he thus proceeds:—

"But, seriously, why are canaries yellow? Why are larks and starlings spotted? Why has the robin the red breast that gives him his name? Selection! There is actually no selection. Neither on the part of nature, nor on the part of sex itself, is there the slightest proof of the necessary limit of selection. For selection, in the very idea that constitutes it, means a limit. And limit there is none. Blacks, and whites, and blues, and reds, and greens, and yellows, are to be seen indiscriminately mingled, almost everywhere—blacks, and whites, and reds, and greens, &c., in almost every possible shading—nay, in almost every possible variegation, too! All that pretty anecdotal rationalising—story-telling—in regard to the leopard, too (the grandfather has it), is it not of the same kind? There are so many leopards in existence because their spots, confounded with the interstitial light and dark of the jungle, save them. But if that is so, why are there quite as many tigers, animals that are not spotted, but striped? Oh, the ghauts, the ghauts, you cry. Well, yes, the ghauts are defiles; but how is a stripe like a defile, or how does it come from a defile, or as being like a defile how does it save them? But admitting that, and saying that leopards are saved by spots, and tigers by stripes, what of the lions? They can be saved by neither—neither by spots nor by stripes, and they are equally numerous, or supposably equally numerous—and *supposably so* is the vernacular of the region—why is there no call for either spots or stripes in their case? Or, after all, just as it is, spotless, stripeless, is not the lion quite as likely to escape detection in the jungle as either of the others, let it be leopard, let it be tiger?"

How clever is the jingle of words and interrogatives, yet how crammed with blunders and how devoid of sense! The writer evidently thinks that Darwin, or some authoritative writer on Darwinism, has stated that the tigers' stripes imitate the defiles in which they live, which defiles are the "ghauts"! He also is of opinion that leopards, tigers, and lions, all live together in the same "jungles," all have the same habits, and therefore all require the same protective colouring. But they are not coloured alike; therefore their colouring is not protective! That is a sample of Dr. Stirling's knowledge and of Dr. Stirling's argument.

Readers of NATURE may think that too much space has been given to so contemptible and worthless a book; but it must be remembered that the author has a considerable reputation in philosophy and literature, has published over a dozen works of more or less importance, and was the first Gifford Lecturer at Edinburgh University in 1888–90. It is certain that many purely literary critics, as ignorant of biology as is the author, will declare the work to be an important adverse critique of Darwin and Darwinism. If it were the work of an unknown man, it would, so far as its matter is concerned, be beneath contempt. But when a writer of established reputation goes out of his way to discuss a subject of which he shows himself to be grossly ignorant, and puts forth all his literary skill to depreciate the mental power and the life-work of one of the greatest men of science of the century, it is necessary and right that, in the pages of one scientific journal at least, the ignorance, the fatuity, and the carping littleness of the whole performance should be fully and unflinchingly exposed.

ALFRED R. WALLACE.

## DYNAMOS AND TRANSFORMERS.

*Dynamos, Alternators, and Transformers.* By Gisbert Kapp, M.Inst.C.E., M.Inst.E.E. (London: Biggs and Co.)

THE author of this work is well known as a successful designer of dynamos and transformers. In his preface he states his object to be "to place before the reader an exposition of the general principles underlying the construction of dynamo-electric apparatus, and to do this without the use of high mathematics and complicated methods of investigation." He further says, on p. 26: "In attempting to establish a working theory of dynamo-electric machinery, or rather in setting forth the rules and formulæ now used by the designers of such machines, we shall therefore not follow the lead of the pioneers in science so much as that of their more popular expounders, and that of practical experience. The treatment will thus necessarily lack that mathematical elegance of which the scholastic mind is so fond, but, on the other hand, it will be more easily grasped and adopted by the practical engineer who works as much by the aid of his mechanical instinct as by that of science."

This is the promise, and we may say at once that in our opinion there is plenty of room for mathematical elegance on the lines laid down. If the results of difficult investigations be assumed, and correct deductions be made and set forth in exact language and in appropriate notation, as required for the particular practical application, the exposition will be both elegant and scientific. Practical experience also is on the same footing as any experimental result in physics, and deductions made therefrom may be scientific in the highest degree. From the extracts above quoted, one would not expect to find one-third of the book occupied with a theoretical exposition of electro-magnetism on lines similar to those that may be found in a dozen or more existing works. But such is the case, and we regret to say that there is much in the exposition of the author that is open to severe criticism on the score of the inaccurate and frequently incorrect use of scientific and practical expressions, whose meanings are thoroughly well-established and generally understood. The word "energy" is employed in a sense with which, we imagine, theoretical and practical men will be alike unfamiliar. "Work" and "rate of doing work" are throughout the book employed as interchangeable expressions, the word "energy" having double duty thrust upon it. It is scarcely necessary to observe that "energy" is expressed in units of work, and that it is improper to use it in the sense of "rate of doing work" or "power." This is all the more extraordinary for the reason that the author defines "power" or "activity," and in one part of the book freely uses these terms to denote what he calls "energy" in another part.

More serious is the circumstance that the author thinks it proper to express "rate of doing work" in units of "work." On p. 42 we find the statement: "This is called the Watt, and is equivalent to 10,000,000 ergs." It is as if the distance between London and Brighton were described as being fifty miles per hour.

In the same context the C.G.S. unit of power is termed the erg-second. We have heard of the Watt-second, the volt-ampère, the ampère-second, &c., but never before of the erg-second, which has no meaning whatever as a hyphened expression built up in the manner customary with electricians.

On p. 141 electromotive force is under discussion by means of the well-known rail and slider; and on p. 142 occurs the following passage, which may be said to fairly beat the record:—

"It was shown in chapter iv. that the mechanical force, P, acting upon a conductor in a field of $\mathfrak{B}$ lines per square centimetre is (C.G.S. measure)

$$P = lc\mathfrak{B}$$

where $l$ is the length of conductor and $c$ the current. If we move the slider with a velocity of $v$ centimetres per second the energy required will be

$$Pv = lc\mathfrak{B}v \text{ ergs.}$$

The energy represented by the current is $ec$. if by $e$ we denote the electromotive force expressed in a suitable measure. We have therefore the equation

$$ec = lc\mathfrak{B}v \quad (28)$$

or,

$$e = l\mathfrak{B}v$$

from which we find that the induced electromotive force is given by the product of length of conductor, strength of field and velocity, all in C.G.S. measure.

Formula (28) gives the energy in ergs.

To obtain it in Watts, we divide by 10,000,000, and have

$$\text{Watts} = lc\mathfrak{B}v\,10^{-7}."$$

Herein we find almost every conceivable blunder. Power is termed "energy," and expressed in ergs; formula (28) is said to give the energy in ergs, whereas, of course, it gives the power in ergs per second; and to wind up the comedy of errors, an expression said to represent ergs is divided by the number $10^7$, and, magically, it appears as Watts.

Was confusion ever worse confounded?

The practical man—whose intellect the author considers robust enough for the expression, "line integral of magnetic force," and for the comprehension of the (freely employed) integral calculus—is very easily pleased if he finds this sort of information improving. Surely, above all things, he demands accurate statements, and resents having symbols thrown at his head in this contemptuous manner.

On p. 27 the north pole of a bar magnet is described as "the end which, if the bar were freely suspended would point to the geographical north."

Why the qualifying adjective "geographical"? If the author desired to evade a definition of the magnetic meridian, he surely might have preferred a "suppressio veri" to a "suggestio falsi."

Many examples might be given of the looseness of the language employed. We already possess a number of excellent books on electro-magnetism written by thoroughly practical men in precise and accurate language; and we must enter, for the reasons above given, a strong protest against the theoretical portion of this book.

It is a pleasure to turn to the really practical part of the work, where the reader will find valuable information concerning dynamo design. In the case of large machines, the author favours the multipolar type. He gives a detailed comparison of two-pole and four-pole machines of a power of 25 kilo-watts, and shows, it seems conclusively, that the latter can be made lighter, and to run at a lower speed than the former. We find a distinction made between the "static" and "dynamic" electromotive force of a dynamo; the former is defined to be the E.M.F. "generated in the armature, and directly measurable on the brushes if the machine is working on open circuit." This is always shown on the characteristic (volt and ampère) of a dynamo of whatever nature, and as there is no discontinuity between it and "dynamic" E.M.F. it is difficult to see the necessity either for separate discussion or for special nomenclature. The alternators chosen as examples are representative of the different systems in vogue. We find those of Siemens, Ferranti, Gulcher, Mordey, Kingdon, and also that of the author designed for Messrs. Johnson and Phillips.

There is not much set down about alternating current transformers, but some good working diagrams are given. There is no information about multiphasers. We have noticed some typographical errors. A serious one occurs on p. 46. P. A. M.

## GOLF.

*Golf: a Royal and Ancient Game.* Edited by Robert Clark, F.R.S.E., F.S.A. Scot. (London: Macmillan and Co.)

PROF. TAIT has recently pointed out how many scientific problems are involved in the flight of a golf ball, and many men of science have learned to find in the game of golf a never-failing and unsurpassed means of recreation from their arduous labours. It is fitting, then, that Mr. Clark's new edition of a golf classic should be noticed in these pages.

A writer, who was a famous cricketer, and is apparently a new humorist, has lately, in the pages of a serious *Review*, started a controversy on the question, "Is Golf a first-rate game?" The question must be here dismissed with the remark that it is absolutely irrelevant. Unless there is no grain of earnestness in his reasoning, internal evidence, often misleading, shows that the writer referred to is in the twilight of knowledge of his subject, and the twilight of the gloaming, not of the dawn. Let him hope that he may pass through the darkness, and that it may be as the brief gloom of a St. Andrews' summer night. Mere first-class games, like cricket and kindred, are light o' loves, who leave you the moment that you have lost your youth and your pace. Golf is like a mother—kind to you once; that is, all her life.

In the year 1875, "Golf: a Royal and Ancient Game," was edited and privately printed for a small circle of subscribers. It has long been out of print, and a new and slightly enlarged edition has now been published for the benefit of the world at large. It is a delightful book, and the reading of it is a pleasure. In it is found in all its quaintness the dear old fast-dying dialect of the Lowlands of Scotland, and here and there bits of the delicate humour indigenous to the same region. The atmosphere of the book is as breezy as that of the links which now dot our East Coast from John o' Groat's to the South Foreland. To class the book as a history is not quite accurate, for it is more a collection of the materials for history than history itself; but to any one interested in the subject, that is no drawback.

The introduction is excellent, and together with the old statutes bearing on the game, the extracts from burgh and parish records (much added to in the present edition), the extracts from private note-books and from old minutes, and the new notes, afford interesting glimpses of the social life of the kindly Scots of the olden time; of the difficulties of "the powers that were" in weaning the people from the game, in order to lead them to the archery butts and to the kirk; of the funeral ceremonies of a keen golfer, the father of the great Marquis of Montrose, lasting one month and nineteen days; of the consumption of wine during that period of mourning being reckoned in puncheons, and of the buckets of Easter ale being as numerous as the tears that fell; of Smollett's genial reflections upon seeing on Leith links a party of four playing Golf, the youngest of whom was turned of fourscore. Among those records are to be found also materials out of which a theory of the development of the Sabbatarianism peculiar to Scotland might be built, and of this something of interest might be said did space permit.

The gossip part of the book is too short. The story of John Patersone might be passed as a variant of the old tale of the king and the cobbler. It was at all events sufficiently interesting to inspire the celebrated Dr. Pitcairn to write for the mural tablet of John's new house—his reward from Royalty for his prowess at the Golf—four elegiac verses and a motto enigmatically telling to all time a tale and John Patersone's part therein. The verses and the motto may be worth quoting:—

> Cum victor ludo scotis qui proprius esset
> ter tres victores post redimitus avos
> patersonus humo tunc educebat in altum
> hanc quæ victores tot tulit una domum.
> I hate no persone.

The motto "I hate no persone" being an anagrammatical transposition of the letters in the words "John Patersone."

The verses in the book are not intended for criticism, but a "Ballade of Golf" and "A Voice from the Rhine" are welcome additions. The wood engravings and the plates appeal to the artist, and an addition to the number of the latter in place of the photographs that were, apart from their interest to contemporaries, out of all keeping with the pictorial part of the first edition, is a step in the right direction. The only serious objections that can be taken to the present edition, and that only in a spirit of gentle remonstrance, are pointed out in the prefatory note by the editor. Following the note in the order of its statements, it sets forth that since the publication of the first edition, Golf has advanced by leaps and bounds, that it is now as popular in England as it is in Scotland, that it has taken deep root in Ireland, yet in the body of the book not a sentence is devoted to Golf clubs furth of Scotland. No doubt this is partly explained by the fact that no existing club furth of Scotland except Blackheath is old enough to have a history. At the same time a few pages recording the facts of the introduction of Golf in recent years, not only to England

and Ireland, but also to America, India, Australia, Canada, and other parts of the world where Scotsmen have congregated, must have added to the value of the book. But, in this connection, the grave omission is that there is no reference to the history and records of the Blackheath Club, the oldest club in the United Kingdom. This is all the more remarkable, that a bright description of "Medal Day at Blackheath" has a place in the book.

The most serious complaint is left to the last, and that is that the editor should say in the note referred to that he has abandoned his intention of writing his own reminiscences. The reason assigned, that the books of his friends are a bar, will not bear examination. These books, clever and able as they are, were born of the high spirits of the hour, and were never thought of by their authors as anything but ephemeral. They served and are serving a good purpose; they amuse and instruct their generation, and it matters little that they have induced many to contort themselves into the oddest of attitudes. The editor and his friends might furnish an interesting chapter of the history of the game. They have seen the days, when the grand manner was not yet dead, when the style of the front rank Golfers was distinguished by something more than force and mammoth driving, when it was as graceful as that of the play of fence of a first-rate swordsman; the days when the social life of Golf was free from some of the irksome bonds which it now wears. How many now remember an incident that marked an epoch, the boys' tournament of the summer of 1860, organised at great expense of time and trouble by the late Sheriff Gordon! How few know anything of him! And yet he was as distinct a type of a Scotchman of a past generation as singing Jamie Balfour, whose effigy is one of the adornments of the book. It is to be hoped that the editor may reconsider his decision, and add a chapter on modern Golf, stopping short of the time when it became the fashion. As it stands, the book is the only book indispensable to the Golfer, and its wider circulation will no doubt lead many to the great house of Golf. There they will read, and feel the truth of, the legend inscribed in indelible letters upon the portals: *Inde Salus.*

Let the last words here on this subject be the words of an enthusiast:—

"Plaudere, non jubeo" (you may do that at cricket) "sed magna voce frementes,
Dicite: In æternum floreat alma domus.
Floreat."

W. RUTHERFORD.

## OUR BOOK SHELF.

*Celestial Objects for Common Telescopes.* Vol. i. By the Rev. T. W. Webb. Fifth edition, revised and enlarged, by the Rev. T. E. Espin, M.A., F.R.A.S. (London: Longmans, Green & Co., 1893.)

SINCE the original edition of Webb's "Celestial Objects" was published in 1859, no book has appeared which has found greater favour in the eyes of amateur astronomers. Written by one who had seen the wonders and glories of the heavens, the work has always been recognised as sounding the genuine ring that results from rich experience; and by entrusting the editing of the fifth edition to the Rev. T. E. Espin, the publishers have acted wisely, for he is an observer versed in both the old and the new astronomy.

The work has been divided into two volumes, the first of which is before us. This volume is concerned with the subjects of parts i. and ii. of the original work; the second, which will probably be published shortly, covers part iii. and is the book for the observatory. In some respects, this division of matter is an improvement, for descriptions of astronomical phenomena can very well be kept apart from lists of celestial sights. Mr. Espin is wholly responsible for the volume as yet unpublished, and as it has been entirely rewritten, we may confidently expect many important innovations. In the volume under review, very few alterations of the original text have been made. To bring the book up to date, workers in different branches of astronomy have contributed additional matter on the subjects in which they are specialists. One of the results arising from this division of labour is that the chapters are extremely unequal. The new matter is added in foot-notes, but we think the book would have gained in value if it had been incorporated in the text. Among these notes is one on celestial photography, and another on spectroscopy as applied to the telescope. In the latter we read that "Stellar spectra were divided by Secchi into five types," and closely following this remark is given a classification in which Type v. includes bright line stars and nebulæ. But Secchi only distinguished four types of stellar spectra, and it was not until 1891 that Pickering proposed to add a fifth type to Secchi's classification. There is another matter that might be more clearly expressed. In the brief statement of the use of the objective-prism for obtaining photographs of the spectra of stars, it is not mentioned that the prism must be fixed over the object-glass with its edges east and west. If the prism is arranged with its edges north and south, no amount of regulation of the driving-clock will expand the linear star-image into a band upon the photographic plate. These omissions are, however, very slight, and Mr. Espin will doubtless remedy them at the first opportunity. They certainly do not lessen the welcome we extend to this new edition of an excellent book.

*Plane Trigonometry.* By S. L. Loney. (Cambridge: University Press, 1893.)

IN the 500 pages of which this volume consists, the author has placed before students of trigonometry an elementary text-book which only wants reading carefully to be thoroughly understood. One cannot do more than state in clear and plain language the various methods of expressing trigonometrical ratios, the applications of algebraic signs, ratios of multiple and sub-multiple angles, &c.; and this the author has done, interpolating neatly printed figures and concise explanations wherever they seem necessary for a clearer exposition. A great number of excellent examples is also given, the answers being collected at the end. No very marked deviations from the usual sequence of the subject-matter adopted in such text-books have been made, but it is noticeable that here and there are given at some length many pieces of book-work which are passed over in a few words in some books. The second of the two parts into which the book is divided deals more with the analytical side of trigonometry, that is, with exponential and logarithmic series, expansions of trigonometrical quantities, summations of series, &c. In this part the treatment of complex quantities has been so handled as to lead the student up to the methods of the more advanced treatises. The concluding two chapters deal briefly with errors of observations, some miscellaneous propositions, solution of a cubic equation, maximum and minimum values, &c. A very useful list of all the principal formulæ which the student should commit to memory is separately printed, and precedes the first chapter. Beginners will find it better on their first reading to omit the articles specially marked for this end, and also to make selections from the examples. It would be hard to find a better introduction to plane trigonometry book.

## 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 intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Music, Rhythm, and Muscle.

IN your issue of January 18, you refer (on p. 271) to an article by Dr. Wilks in the *Medical Magazine* (which I have not seen), in which the learned author points out that music is not to be regarded in its origin as a purely spiritual faculty, but that it admits of a physiological explanation. This discussion is in itself a most interesting one. Dr. Wallace, in his well-known discussion of the relations of music to the other faculties of man, has raised this very question, or one closely allied to it. Wallaschek, as quoted by Dr. Wilks and yourself, asserts that "rhythm, or keeping time, lies at the very foundation of the musical sense." Rhythm again, he says, "can be referred to muscular contraction and relaxation," the "muscular sense being the measure of time," so that the muscular sense is intimately bound up with the idea of music. "Not in the different passions of the mind, but in muscular action, therefore, music appears to have had its origin."

My purpose in addressing you is to point out that these opinions receive a remarkable and very beautiful illustration in the history of Greek dance and rhythm, so far as these are known to us. We know but little of Greek music in the stricter sense of this word, and this perhaps for the very reason that music was not then separated from choral intonation and movement. The strophé and antistrophé of the Greek chorus, which terms we usually apply to the musical phrases sung during a movement, are primarily, of course, not these strains but the evolutions themselves, the dancing towards the one side of the orchestra or the other. Now we do know from the metrical analysis of Greek dramas and odes what these rhythms were, and we can thus probably infer the character of the music proper. By the study of Greek rhythms we shall thus find a method of tracing the genesis of music in its most elaborate modern forms from dancing and footing it in any kind of measure. Dr. Wilks well points out that muscular movement is essentially rhythmical: we may go farther and say that all movement, even the rush of falling water, is rhythmical.

The monotony of the recurrence of identical periods or colons would soon be felt, and we find accordingly that efforts are made by all early people to vary the measures. The use of two and four simple feet would soon pall, and was accordingly broken up in the Greek drama by threefold and more complex metres, as, for instance, by Pindar in his Epinikian odes. This "threefold form," says a recent writer, finds an almost exact counterpart in most of the figures of Bach's "Wohltemperirtes Klavier," and the "modern sonata has the same form on a very extended scale," the first part and its repetition corresponding with the strophé and antistrophé of the Greeks, and the second part with the epode. These curious parallels and essential similarities may be traced much farther and into elaborate detail, as is shown in part by the writer I have quoted, Mr. Abdy Williams, in the *Classical Review* for 1893 (p. 295). Mr. Williams's article, which well deserves a careful reading, is based upon the important discovery of a treatise on rhythm by Aristoxenus of Tarentum. Aristoxenus was a favourite pupil of Aristotle, and flourished about 300 B.C.; he wrote also a treatise on harmony, which less concerns us here, and he was "not only a musician, but a man of the widest culture and knowledge." Soon after the time of Aristoxenus the dependence of music on metre, which in its turn is a notation of choral movement and but a regulation of the rhythms of various muscular movement—the dependence, I say, of music on metre gave way to the ascendancy of accent. Accent, and not quantity began to form the basis of the rhythm. Strict measure thus became less obviously the basis of music and poetical rhythm; but, says Mr. Williams, "upon the ruins of the ancient measured music arose a new and magnificent art, now known as 'Plain Song' or 'Gregorian Music,' the rhythmical construction of which is based on the natural laws of phrasing." (Compare strophé and antistrophé.)

With the disuse of plain song arose again the old metrical rhythms, but now so dissociated from choral evolutions that we have forgotten their muscular origin. The early modern composers recovered the elaborate rhythms once founded on choric phrases, but under the name of "form," and "by following the instincts of their genius, unconsciously brought about a renaissance of the natural rhythms and musical forms known to the ancient Greeks, developing them by the aid of modern resources, while adhering to certain definite principles which on examination are found to agree with those enunciated 2000 years ago by Aristoxenus of Tarentum." These, I need not repeat, were almost directly based not upon rhetorical, but upon muscular rhythms. The simpler and ruder the musical sense, the more brief and simply bipartite, or two-legged, must be the recurrent rhythms, as the popular tunes of our street organs and music halls tell us daily; the more relieved and elaborated rhythms of Bach and Beethoven need a more sustained attention and a more cultivated apprehension, while the rhythms of Wagner are so postponed in their resolutions, and so broken in their variety, that perhaps few even of good musicians can follow them with any consciousness of muscular measure, or even of "form." Therefore we call them "highly spiritualised," and forget whence they are originally derived.

Cambridge, January 28. T. CLIFFORD ALLBUTT.

P.S.—Since writing this letter, Prof. Roy has drawn my attention to the statement that if a pencil be taken in the right hand, a sheet of paper placed below it, and the hand thrown into a rapid automatic dotting action, as the paper is drawn forward the resulting row of dots will be found to be a uniform number per second—five or seven, I forget which—and thus for all persons alike there is the basis of rhythm.

### The Cloudy Condensation of Steam.

THE publication in your pages[1] of Mr. Shelford Bidwell's lecture on "The Cloudy Condensation of Steam," at the Royal Institution in May last, calls for a few remarks from me. As the points I have to refer to are principally personal, I shall be as brief as possible.

In discussing the effects of electrification on the condensation of a steam jet, Mr. Bidwell, after pointing out that though it has been shown that small particles of matter are thrown off by the electrical discharge, says that—"Yet it is remarkable that Mr. Aitken . . . gives no countenance to the nucleus theory." He then informs his hearers that he imagines I have abandoned my conclusions regarding the action of dust. It is very difficult to understand Mr. Bidwell's objection to me not countenancing the nucleus theory to explain the phenomena, as in the very next paragraph he shows I was correct in not ascribing the change in the jet when under electrification to dust particles, and gives an experiment to prove it. His experiment is different from the one on which I founded my conclusion. In some experiments made when working at this subject there did not seem to be a possibility of the dust produced by the electrical discharge getting to the jet. Take, for example, the following experiment:—The steam jet was allowed to issue from the side of a polished metal ball of about 3 c.m. diameter. This arrangement was adopted to prevent any discharge of electricity from the nozzle. At one side of the jet was placed an electrified body at a distance of about 10 c.m.; and at about the same distance on the other side of the jet was placed a flame. As no air passed either from the flame or from the electrified body to the jet, it seemed impossible the effect could be due either to particles of metal from the conductor or to particles of dust from the flame. The conclusion, therefore, was that the effect on the jet could be produced by electricity without the aid of dust. It, however, seems highly probable that the dust produced by the discharge of electricity may have some effect in such experiments as those described by Prof. Barus, in which the air from the terminals from which the discharge is taking place is carried to the jet. Prof. J. J. Thomson

[1] NATURE, December 28, 1893.

has since shown[1] that the increased density of the jet on electrification is only partly due to the cause to which I attribute it, namely, the electrical repulsion preventing the coalescence of the drops, as he proves that the electrification of the jet overpowers the surface tension, and so promotes the formation of small drops, and in this way assists in increasing the density of the condensation.

Mr. Bidwell's misunderstanding of my position is greatly due to an impression he seems to have that I attribute all cloudy condensation to the presence of dust particles. Now, if he will turn to my first paper on this subject,[2] he will find that the effect of the vapours of hydrochloric, sulphuric, and nitric acids, *active* vapours, mentioned in his lecture, have all been referred to, and experimented with, as well as many other substances, so that I was well aware of these causes of condensation. Further, he will find in the paper referred to, as well as in another of a later date,[3] that it is possible to produce cloudy condensation without the presence either of dust or a vapour capable of forming a nucleus with water vapour, or even the abnormal condition due to electrification, all that is necessary being a sufficiently high degree of supersaturation.

Darroch, Falkirk. JOHN AITKEN.

### The Os Pedis in Ungulates.

PROF. EWART, in a recent paper,[4] describes the os pedis or "coffin bone" of the horse as consisting to a large extent of a bony cap developed from connective tissue around, and quite independent of the terminal phalanx. This throws an entirely new light on one of the most remarkable bones of the horse's skeleton, and is especially interesting to veterinarians. Having a fœtal calf (about 6½ months) in my possession, I was led, on reading Ewart's paper, to examine the digits, and wish now, in a word, to state the result.

I found each digit provided with a bony cap similar to that figured by Ewart from his 35 c.m. horse embryo. On making a longitudinal vertical section of one of the digits, the investing cap could easily be distinguished from the phalanx proper; and, further, I noticed a large deposit of osseous matter in what may be termed the diaphysis (shaft) of the terminal phalanx, and an indication of a second ossific centre at its apex. This affords additional proof that the third phalanx in ungulates, as in man, consists partly of membrane bone and partly of cartilage bone, and that it in all probability develops from several centres.

I hope soon to publish a number of observations on the structure and development of the digits in ungulates.

A. E. METTAM.

Royal Veterinary College, Edinburgh.

### A Brilliant Meteor.

A METEOR of extraordinary splendour was seen here this evening at 7.45. It appeared vertically under the Pole star, at an elevation of 40°, and, after pursuing a path that sloped down to the west at an angle of 30°, disappeared silently under Cassiopeia.

The incandescent mass had an apparent volume equal to that of a good-sized orange. It gave out a bluish-white light that brilliantly lit up, for about four seconds, the grounds and buildings of the College.

The glowing mass was followed by a long, conical, crimson train ending in a wisp of condensed vapour resembling smoke.

The sky was clear, starlit, and moonless at the time.

M. F. O'REILLY.

The Training College, Waterford, January 31.

## *THE VATICAN OBSERVATORY.*

THE report recently issued by the Vatican Observatory (*Pubblicazioni della Specola Vaticana*, Fasciculus iii.) is the best that has been prepared by Father Denza, and in abundance of matter and fineness of execution, it compares favourably with that of any observatory. The first report was published in 1891, but neither that nor the one of 1892 contains so much evidence of work done as the bulky tome last issued. The observatory, as it is at present constituted, only dates back to 1889; but previous to that, it passed through so many vicissitudes that a brief outline of its history may be of interest.

It is recorded that an observatory tower was erected by Pope Gregory XIII. in connection with the reform of the calendar, some time previous to 1582. The tower was intended for astronomical observation, and there is every reason to suppose it was the first celestial watch-tower built in Rome. The following translation of an extract from the *Nautica Mediterranea* of B. Crescenzi, published in Rome in 1607, clearly shows that the room at the top of the tower was used for astronomical purposes:—"When the sun arrives at the tropic of Cancer its rays enter a little hole which Ignatius Danti has had made for that purpose in the roof of the apartment which Pope Gregory XIII. had erected upon the Belvedere Gallery, and the rays only enter the hole once a year, when the sun is furthest from the equinox, after which he turns and goes back." Danti appears to have marked a meridian line upon a marble table in the tower, and meridian observations were made until about 1644, but the observatory was afterwards neglected, and remained so for about a century and a half. It was only towards the end of the last century that an attempt was made to renew the astronomical work. Cardinal Zelada had a large meridian circle constructed, and furnished the observatory with some good astronomical instruments, among which was a telescope by Dollond. As the observatory was not available for public instruction, it was decided to establish another at the Roman College, and the new observatory was erected in 1787, though observations had been carried on at the College long before.

In 1789 the Vatican Observatory commenced a new epoch in its history. Philip Gili began his directorship in that year, and, in addition to making astronomical observations, initiated researches in magnetism and meteorology, and other branches of terrestrial physics. The observatory kept well apace with the times until the death of Gili in 1821, but after that it became quite disorganised. All the instruments and records were dispersed, and the observatory itself was entirely deserted until about 1870, when it was transformed into a residence.

Before passing to the third epoch in the "eventful history" of the Vatican Observatory, a few remarks upon the Observatory of the Roman College may be of interest, especially as the relations between the two institutions are not generally well understood among astronomers. According to Father Cortie, who has kindly furnished most of the following information upon this matter, the Roman College Observatory dates back at least to 1572. It belonged to the Society of Jesus, and consisted in the beginning of a few rooms set aside for astronomical studies. Scheiner, of sun-spot fame, Clavius, the author of the Gregorian reform of the calendar and the observer of Tycho Brahé's Nova of 1572, de Gottingues, who observed Jupiter's spots and the comets of 1664, 1665, and 1668, Boscovich, and other renowned astronomers were connected with it. There still exists in the Kircher Museum of the College a meridian line traced by Boscovich, and the same astronomer drew up the plans for a new observatory, but they were never carried into effect, on account of the troubles in France and Spain, during which the Society of Jesus was suppressed. During the period of the suppression, the observatory was directed at first by J. Callandrelli, who in 1773 built a square tower at the eastern angle of the facade of the College, and placed in it a zenith-sector and a meridian circle, the gifts of Cardinal Zelada and Pope Pius VII.

[1] *Phil. Mag.* October, 1893.
[2] "Dust, Fogs, and Clouds." (*Trans.* Roy. Soc. Edin., vol. xxx. part i.)
[3] "On the Numbers of Dust Particles in the Atmosphere." (*Trans.* Roy. Soc. Edin. vol. xxxv. part i.)
[4] "The Development of the Skeleton of the Limbs of the Horse." (*Journal of Anatomy and Physiology*, January, 1894.)

Fig. 1.—Alto-Cumulus.

Fig. 2.—Strato-Cumulus and Alto-Stratus.

FIG. 3.—Cumulus and Strato-Cumulus.

FIG. 4.—Nimbus.

After the restoration of the Society, however, the Jesuits gained possession of this observatory in 1824, and placed it under the direction of Dumouchel. De Vico, whose cometary discoveries and observations of Venus are so well known, was the next director, but with the troubles of 1848 came the expulsion of the Society of Jesus from Rome. De Vico died in London. In 1849, however, Secchi, who made his first observation when an exile at Stonyhurst, commenced to carry out the learned Boscovich's plans. The observatory was rebuilt, endowed, and instruments furnished at the expense of the Society of Jesus, and with the generous aid of Pope Piux IX. At the next expulsion of the Society, in 1870, Secchi remained at the observatory at the express wish of the Italian Government. At his death he bequeathed the property of the Society to Father Ferrari, but the Government appropriated the observatory and everything connected with it. Fortunately for astronomy, however, Signor Tacchini was appointed to the directorship of the observatory, and has well sustained its reputation. It may be added that the Observatory of the Capitol, in which Respighi did such good work, was founded by Leo XII., and attached to the University of Rome.

After the Vatican Exposition in 1888, in commemoration of the fiftieth anniversary of the priesthood of Pope Leo XIII., all the instruments and apparatus given by members of the Roman Catholic Church interested in celestial and terrestrial physics were brought together, and it occurred to the managers of the science sections of the Exposition that they would find a suitable home in the old Gregorian tower. The suggestion was warmly approved and carried into effect. Father Denza, a great friend of Secchi's, was appointed the director of the revived observatory, and he began his work in 1889 with a comprehensive programme, which he and his assistants Lais, Andreis, and Mannucci have well carried out. The investigations instituted relate to meteorology, terrestrial magnetism, geodynamics, and astronomy. The building is well situated for meteorological observations; it is equipped with instruments for the continuous record, as well as personal observation, of meteorological data. In terrestrial magnetism, also, instruments are provided for the determination of absolute values and the registration of variations of the usual elements. The chief astronomical engine of research included in the observatory's outfit is a photographic equatorial of the Henry pattern and mounting, for use in connection with the construction of the photographic star-chart which the Vatican Observatory is helping to bring to a successful termination.

Having now described the constitution of the observatory, it remains for us to state the nature of the work done, as evidenced by the reports. The first report contains a long article on the principles and progress of celestial photography, by Father Denza. Father Lais reports the details of stellar photography in connection with the chart, and the methods of obtaining photographic stellar spectra and solar pictures. He also summarises the observations made in Italy during the Perseid shower of August 1890, and during the Leonid shower of the same year.

Sig. Andreis describes the points to be investigated in the geodynamical work of the observatory, and there is a full account of the meteorological instruments and the observations made with them.

When the second report of the observatory was issued, it was seen that Father Denza and his assistants had carried on some useful observations during 1891. The geographical position of the observatory, eclipses of the sun and moon, the Perseid and Leonid meteor showers of the year, formed the subjects of important articles by the Director, while Father Lais and Sig. Mannucci described the work that had been done in celestial photography. Marvellous results were obtained with the Henry equatorial from the very beginning, and no stronger witness of this is necessary than that afforded by the beautiful plates which embellish the second report. The picture of the Ring Nebula in Lyra is certainly one of the best yet obtained, and that of the star-cluster M 15 is equally good. Other bits of celestial scenery included in the same volume are the Pleiades and neighbourhood, and a cluster in Sagittarius, while individual occupants of the heavens are represented by three portraits of Jupiter and two views of the lunar surface.

We pass now to the report issued in the latter half of last year, and which in point of excellence and abundance of matter even surpasses the one before it. Two remarkably fine portraits are given in this volume, one of Pope Leo XIII., the other of the late Admiral Mouchez; and the astronomical views include the region of Nova Aurigæ, that of the Praesepe cluster, the Orion nebula, and four sun-pictures. But none of these photographs are so striking as the fourteen reproductions of cloud photographs obtained by Sig. Mannucci, and of which we are able to give four specimens. Meteorologists will remember that a set of eighty cloud photographs taken at the Vatican Observatory were shown at the Royal Meteorological Society's Exhibition in 1890. Sig. Mannucci's experience indicates that in cloud photography very short exposures do not give the best results. Plates of medium rapidity, having a thin film, seem to give the boldest contrast between the blue of the sky and the masses of diaphanous haze that are sometimes projected upon it. Such plates also show the greatest amount of detail in large masses of cloud.

Sig. Mannucci gives a brief account of systems of cloud classification in the volume to which reference has been made. He practically accepts the classification proposed by Abercromby and Hildebrandsson at the International Conference held in Munich in 1891, and set forth in the Cloud-Atlas of Hilderbrandsson, Köppen, and Neumayer. The classification recognises ten different species arranged in five principal groups. The first group (A) comprises the highest clouds in our atmosphere; the second group (B) includes clouds at a medium height, and the third (C) low clouds. In the fourth (D) we have clouds in ascending currents, and finally, (E) contains the masses of vapour changing in form. In the first four groups the letter (*a*) is used to distinguish the forms of cloud usually accompanied by fine weather, and (*b*) for those characteristic of bad weather. The following is the grouping as given by Sig. Mannucci:—

GROUP A.

Clouds from medium altitudes up to an average of 9000 metres.

1. Cirrus (*a*)
2. Cirro-stratus (*b*)
3. Cirro-cumulus

GROUP B.

Clouds having altitudes from 3000 to 6000 metres.

4. Alto-cumulus (*a*
5. Alto-stratus (*b*)

GROUP C.

Clouds the bases of which have altitudes from 1000 to 2000 metres.

6. Strato-cumulus (*a*)
7. Nimbus (*b*)

GROUP D.

Clouds on ascending columns of air, with bases about 1400 metres high, and summits from 3000 to 5000 metres.

8. Cumulus (*a*)
9. Cumulo-nimbus (*b*)

GROUP E.

Fogbanks up to about 1,500 metres.

10. Stratus

We cannot conclude this account without referring to the magnetic work done at the observatory. Father Denza contributes to the third report a long discussion of the magnetic declination and inclination at Rome, and, by a comparison of observations, finds the secular variations. In the latter half of the seventeenth century, the declination was about two and one-half degrees West, and increasing. In 1806, Gili obtained a value of 17° 17′, and in 1824 a maximum of 18° seems to have been reached. The declination then began to decrease, and its value at the end of 1891 was 10° 45′·35. The first observation of the magnetic inclination at the Vatican was made in 1891. This element had been previously determined, however, in other parts of Italy by several observers. From 1859, when Secchi observed the inclination at the Roman College, up to the present time, the recorded values for various parts of Italy have been fairly numerous. Before 1859, however, very few observations were made. In 1640 an observer gave 65° 40′ as the inclination at Rome, and Humboldt obtained a value of 61° 57′ in 1806. Father Denza gives 58° 4′·6 as the inclination at the Vatican Observatory in 1891. A number of other matters are discussed in the volumes under notice, and many observations are included, upon which we have not been able to comment in this article. Enough has been said, however, to show that the observatory has furthered investigations in many branches of physical science, and, from the energetic character of the workers, we may confidently expect many more contributions to scientific knowledge.

R. A. GREGORY.

## NOTES.

THE Bakerian lecture is to be delivered before the Royal Society by Prof. T. E. Thorpe, on the 22nd inst., the subject of the lecture being a research carried out by Mr. J. W. Rodger and himself on the relations between the viscosity (internal friction) of liquids and their chemical nature.

WE are requested to state that Mrs. Tyndall would be much indebted to any correspondents of the late Prof. Tyndall who have preserved his letters, if they would kindly lend them to her for use in the preparation of his biography. Any letters thus lent should be sent to her at Hind Head House, Haslemere, and would be returned safely to their owners.

A HYGIENIC laboratory has been established in the University of Bonn. The new institution will be under the direction of Prof. Finkler. According to the *British Medical Journal*, there is now no university in Prussia without a hygienic laboratory. From the same authority we learn that the Bengal branch of the Pasteur Institute was successfully inaugurated on January 30, in the presence of a large company.

THE Duke of York visited King's Lynn on Friday, and opened a new technical school built by the Corporation at a cost of £3,000.

THE order of S.S. Maurice and Lazarus has been conferred upon Sir Joseph Lister, M. Pasteur, and Prof. Virchow, by the King of Italy.

MR. HENRY O. FORBES has been selected by the Library Committee of the Liverpool Corporation for appointment as Director of the Liverpool Museums.

THE late Dr. J. K. Hasskarl, whose death we announced on January 25, has, says the *Chemist and Druggist*, bequeathed his library to the University of Strassburg, and his herbarium to the University of Leyden.

PROF. BILLROTH died at Abbazia, on February 6, at sixty-five years of age. He principally devoted his attention to military surgery, and published a number of valuable papers on that branch of his profession. It is said that during the last few months of his life he was engaged in completing a work upon the physiology of music.

WE regret to announce the death of Mr. Peter Redpath, a generous benefactor to science in Canada. Mr. Redpath took an active interest in the McGill College and University, Montreal, and in 1880 built, at his sole expense, a museum in connection with the University. This building, known as the Peter Redpath Museum, is used for the exhibition and study of specimens in geology, mineralogy, palaeontology, zoology, botany, and archæology. In October last, a library, capable of holding 130,000 volumes, and added to the University buildings through the liberality of Mr. Redpath, was opened in the presence of a large and influential gathering. The sums spent in erecting the museum and library are said to amount to nearly £75,000. Mr. Redpath died at Chislehurst on February 1, in his seventy-third year.

PROF. EDMOND FRÉMY died on Saturday, at Paris. We are indebted to the *Times* for the chief points in the following sketch of his career. The son of a professor of chemistry at St. Cyr, he was born at Versailles on February 28, 1814, and after studying with his father, became a teacher at the École Polytechnique. In 1857 he was elected into the Paris Academy of Sciences as successor of Baron Thénard. The amount of Frémy's scientific work is enormous. His first publications date from 1835; they relate to the precious metals, and attracted the attention of the scientific world. His investigations on ozone (in conjunction with Becquerel), on the ammoniacal bases of chrome and cobalt, on fluor spar and the reproduction of minerals, will remain classical. In organic chemistry, also, he made numerous important researches, and as manager of the Saint Cobain Works he superintended the manufacture of soda and sulphuric acid, the tempering of glass and steel, the refining of castings, &c. Not long ago he published, jointly with one of his pupils, M. Verneuil, a work, which was the fruit of years of study, on the artificial production of rubies. He was the author, with Pelouze, of a treatise on chemistry in six volumes, and in 1881 began the publication of a chemical encyclopædia.

IN addition to the names we gave last week, the *Lancet* says that the following are some of the principal delegates who have been appointed to represent the various Governments at the International Sanitary Conference which opened in Paris yesterday. Great Britain: Mr. Constantine Phipps and Dr. Thorne Thorne, C.B., F.R.S. British India: Surgeon-General Cuningham. France: M. Barrère, M. Hanotaux, Prof. Brouardel, Prof. Proust, and M. Monod. Germany: Herr von Schoen and Herr Mordtmann. Holland: Dr. Ruysch and M. de Stuers. Russia: M. Michel de Giers, together with technical delegates. Austria-Hungary: Count Kuefstein, Dr. Hagel, and Dr. Karliuski. Greece: M. Criésis and M. Vafiades. Italy: the Marquis de Malaspina and Dr. Pagliani. Portugal: M. Navarro. Sweden and Norway: M. Due. Turkey: Tuskan Bey, Nouri Pasha, Boukowski Pasha, and Dr. Haindy Bey. Persia: A delegate yet to be appointed by the Persian Ministry in Paris. Egypt: Achmet Pasha Choukry, M. Mieville, and Sedky Pasha. The remaining countries—Belgium, Denmark, and Spain—have not yet announced their delegates.

THE Executive Committee of the City and Guilds of London Institute have changed the name of the Guilds Central Institution, in Exhibition Road, South Kensington, to the Guilds Central Technical College.

THE gold medal of the Royal Astronomical Society has been awarded to Mr. S. W. Burnham for his discoveries of binary stars and researches in connection with them. At the annual general meeting of the society, to be held to-morrow, the proposal will be made that henceforth the meetings be held at

4.30 p.m. instead of 8 p.m. At present the Royal Society is the only one that meets at 4.30 at Burlington House.

THE fourteenth general meeting of the Federated Institution of Mining Engineers will be held at Leeds on February 14, and a number of important papers will then be read. Arrangements have been made for visits to works, &c. on the following day.

AS an introduction to the summer excursions of the London Geological Field Class, Prof. H. G. Seeley, F.R.S., will deliver a course of four lectures on "The Shaping of the Earth," at Wortley Hall, Seven Sisters Road, beginning on February 22.

WE learn from the *Kew Bulletin* that Mr. W. Lunt has been appointed botanical collector for Kew to Mr. Theodore Bent's expedition to the Hadramant Valley, in South Arabia. The flora is only conjecturally known, and no botanical collections appear ever to have been made in it. The expedition left London on November 24, and is expected to return about April.

THE number of the *Kew Bulletin* for December, 1893, contains an important correspondence between the Colonial Office and the Directors of the Royal Gardens, Kew, on the root-disease of the sugar-cane; and an interesting account, by two of the gardening staff at Kew, of the subtropical horticulture in various gardens in Cornwall.

THE *Botanical Gazette* says that Mr. O. F. Cook sailed on October 25 for Western Africa, to make further observations and collections of the plants of that region, especially of cryptogams. He will be gone a year or more. His former voyage resulted in securing a large amount of botanical material, and the present visit is expected to yield even greater results.

AT the monthly meeting of the Malacological Society of London on January 12, Mr. G. B. Sowerby described a new species of the genus *Verticordia*, to which he gave the name of *V. optima*. The shell, which far exceeds in size and beauty any hitherto known, was taken off Port Blair, at a depth of 188 fathoms. The description and figure will appear in the forthcoming number of the *Proceedings* of the Malacological Society of London.

THE vertical distribution of the British Lepidoptera forms the subject of an article by Mr. W. H. Bath in the January and February numbers of the *Entomologist*. Too little attention is usually given to this interesting branch of entomology, though as a matter of fact vertical distribution is as important as horizontal or geographical distribution, for, as Mr. Bath points out, it not only estimates the affinities existing between the lowland species occurring in this country, and their relations in more elevated areas in the South of Europe, but shows the relationships between our mountain forms and their representatives found at higher altitudes in Alpine regions, and lower in Arctic and sub-Arctic latitudes. And further, vertical distribution gives a better index as to the range of temperature and other climatic phenomena which each species can endure than mere geographical distribution is capable of doing in anything like the same area. Mr. Bath has prepared a list of vertical zones in the British Isles, taking as its basis the divisions defined by the Brothers Speyer in their work on the distribution of Swiss and German Lepidoptera. His proposed list contains five zones, viz. the South Coast zone, the Lower Hill zone, the Upper Hill zone, the Lower Alpine zone, and the Upper Alpine zone. The limitations of these zones are fully described, besides being presented in a tabular form, so that any entomologist who desires to take up this mountaineering branch of his science will find that Mr. Bath has considerably smoothed the way of observation.

THE *Geographical Journal* for February contains a note of a journey up the Cross River, made by Sir Claude Macdonald, the Commissioner for the Niger Coast Protectorate. Since 1842 no vessel larger than a canoe had gone up the river as far as the rapids, but the stern-wheeler *Beecroft*, navigated by Captain Dundas, met with no difficulty, and in her Sir Claude passed the rapids, and would have gone on to some high falls spoken of by natives, but the rainy reason was almost over, and the river beginning to fall so rapidly that he had to return. The natives met with were friendly and anxious to have regular communication on the river.

WE have received a pamphlet from Mr. Robert Stein, setting forth his plan for the exploration of Ellesmere Land in a concise and practical form. His expedition is undertaken with the cordial approval of the National Geographic Society of Washington and of many of the leading British and American Arctic explorers. Mr. Stein retains full liberty for his conduct of the expedition, but is aided in organising it by an advisory committee consisting of Commodore G. W. Melville, Dr. T. C. Mendenhall, General Greely, and Mr. John Joy Edson, who acts as treasurer. The expedition is estimated to cost only 10,000 dollars, a large part of it being subscribed by the members already appointed, while the remainder was nearly made by private subscriptions. The proposed method of working bears every mark of having been carefully thought out. Twenty-two men at most will take part in it, and they will leave St. John's, Newfoundland, about May 1, 1894, in a whaler, which will land them at Cape Tennyson, in Ellesmere Land, or as near that point as possible. A house will be erected, provisioned for two years, and left in charge of four men. Eight men will follow the coast of Ellesmere Land westward, and establish an advanced depot about 100 miles from the base, and then make an attempt to reach Hayes Sound. A thorough search will be made eastward along the coast by a party of six for the missing Swedish naturalists Bjorling and Kalstennius. The whole party intended to spend the winter of 1894 at the base, where continuous meteorological observations will be carried on, and in the spring of 1895 they will endeavour to extend the exploration as far as Greely fjord, but will make their way by the end of September to Cape Warrender, on Lancaster Sound, where four men will be left at a depot in 1894 to await them. A whaler will meet them there by appointment, and bring the expedition back to Scotland or Newfoundland. Careful scientific observations will be made throughout, and collections in all departments of natural history are arranged for. Over sixty men had volunteered for the expedition up to January 9; of these, thirty were found to be suitable, but only three had been definitely engaged. The estimate of 10,000 dollars provides only for a party of ten; in order to establish the reserve station at Cape Warrender, and to search properly for the lost Swedes, a further sum must be raised. Should the first expedition prove successful, Mr. Stein's larger scheme of Arctic exploration will probably be proceeded with on his return.

IN the *Geological Magazine* for February, Miss M. M. Ogilvie continues her paper on "Coral in the 'Dolomites' of South Tyrol." The article is illustrated by a fine map and sections of the district discussed. Miss Ogilvie's conclusion with regard to coral formations in the dolomites strengthens "the position of those authorities who have contended that the immense thicknesses of 'Schlern Dolomite' rock were an ordinary marine deposit and not 'coral-reefs.'"

THE discovery of petroleum on the Mendip Hills has recently been announced. A well at Ashwick Court, two miles north of Shepton Mallet, has long been known to yield water slightly flavoured at times with petroleum. A considerable flow of oil is said to have taken place in July, 1892, when the water-level was low, and this has continued at intervals, but in smaller quantities, since that date. Ashwick is shown on the Geological Survey map to stand at the northern edge of the carboniferous limestone; the beds have a high dip to the north, passing under the millstone grit and the coal-measures of the Radstock area. Indications of petroleum are also known in other wells and springs in the neighbourhood. The matter is now being investigated by Mr. Boverton Redwood and Mr. W. Topley, under whose directions further explorations will be made.

THE phosphatic marls of New Jersey have long been known; they have been worked for fertilisers since 1768. Mr. W. Bullock Clark has published a paper "On the Cretaceous and Tertiary Formations of New Jersey." (Ann. Rep. of the State Geologist, 1892.) The origin of a glauconitic greensand is fully discussed, and reference made to recent deep-sea research. Coloured reproductions are given of Murray and Renard's plates in the *Challenger* Expedition Report, exhibiting phases in the formation of glauconite. The greensands occur most commonly near the boundary lines between the shallow and deep-water zones, but not opposite the mouths of large rivers, nor where strong currents prevail. In making the detailed survey in New Jersey, a small boring apparatus has been used, which seems, from the description given, to be simpler and more portable than that employed on the Belgian and English surveys. It is made of half-inch gas-piping, in lengths of 10 feet. This gives good results to a depth of 30 feet.

MR. CLARK'S paper is further illustrated by prints from photographs. Some of those, *e.g.* "View among the Navesink Highlands," suggest nothing so much as an ultra-"impressionist" daub, all blur and no colour! The professional photographer complains of the hypercritical eye of his fair sex constituency; one could wish that nature had a word to say for herself. The photographic camera is fast coming to be considered part of the equipment of the geologist. If men, whose movements in the field are already well burdened by hammer, compass, knapsack, and specimens, are willing to add to those the inconvenience of a camera, there must be great advantage to be got from photography. But what advantage will be derived from an occasional lucky hit? It would be difficult to name the science now that does not utilise photography. Clearly the time has come when another "optional" may be added to the subjects of the complete curriculum. At any rate, science must recognise photography at its professional value, and must refuse bad photographs and worse prints.

FOR some time past the United States Hydrographic Office has been collecting information about the meteorology of the North Pacific Ocean, with the intention of utilising it for the benefit of seamen, and it has recently issued an advance Pilot Chart of that ocean for the month of January, 1894, on the same principle as the Pilot Chart for the North Atlantic Ocean, which has often been referred to in our columns. The hydrographer states that, if Congress grants the necessary funds, it is proposed to issue on the first day of each month a chart showing for the succeeding month, by deduction from accumulated observations, the winds and currents to be expected, the regions of prevailing fog and rain, the most advantageous routes to be followed by sail and by steam, &c. The amount of information available for the Pacific is greatly inferior to that for the Atlantic, but if the support and cooperation sought for are freely given by those interested in enhancing the safety of navigation, the undertaking will undoubtedly become a very valuable contribution to maritime meteorology.

M. H. PARENTY has been investigating the forms of steam jets from various orifices, and has published his results in the last number of the *Comptes Rendus*. The diagrams accompanying the paper, in which regions of different pressures are shaded differently, exhibit some curious fluctuations, which may be described as a series of nodes and ventral segments proceeding outwards from the orifice. These fluctuations are due to the interference between the outgoing waves of steam pressure and those reflected back by the air. In the case of a convergent elliptical orifice of 13°, three nodes were found with pressures of 115, 165 and 138 c.m. respectively, that at the orifice being 285 c.m. or 3·75 atmospheres. All the nodes occurred within 2 c.m. of the orifice. They were found by means of an air-manometer provided with very finely-drawn glass tubes. It appears that the position and value of the nodes or condensations depend upon the difference of pressure between the boiler and the atmosphere, and the form of the orifice. At very high pressures the jet assumes an approximately paraboloidal shape, such as would be assumed by a liquid jet falling upon a disc of the size of the orifice. A further conclusion reached by M. Parenty is that the highest attainable velocity of efflux is the limiting velocity of sound in the medium concerned.

THE curious polarisation phenomena obtained with very small electrodes in a sulphuric acid voltameter through which a strong current passes, accounts of which have appeared in *Wiedemann's Annalen* for the winter of 1892, suggested to Dr. L. Arons the question as to what would take place at a very thin and small metallic partition in a voltameter. Some preliminary observations made by Dr. Arons showed that when a piece of gold-leaf was pasted over a hole 15 mm. in diameter bored through a glass partition in a voltameter, there was no visible development of gas at the partition; while with platinum foil ·02 mm. thick there was a profuse development of gas with the same current strength. A very thorough investigation of the polarisation phenomena upon thin metal partitions has been carried out by Mr. John Daniel, an account of which is published in the *Philosophical Magazine* for February. The author has examined partitions made of gold, platinum, silver, and aluminium, and finds that, in good conducting solutions of sulphuric acid, copper sulphate, and common salt, the critical thickness, below which there is no polarisation, is for gold between ·00009 mm. and ·0004 mm., while for plates more than ·004 mm. thick the polarisation is as great as for very thick plates. The author finds that the polarisation of "thick" plates is about the same for all currents between 0·2 ampere and 0·01 ampere, provided time be allowed in each case for the current to become constant. With "thin" plates, however, the polarisation depends upon the current. By thick plates we mean those with a thickness greater than 0·004 mm., and by thin plates those having a thickness less than this quantity.

THE same number of the *Philosophical Magazine* contains a paper by Mr. W. H. Steele, on the thermoelectric diagram for some pure metals. From some thermoelectric observations he had made, the author was led to suspect that the lines given by Prof. Tait in his thermoelectric diagram were not quite accurate, and he has therefore undertaken the measurements necessary to construct a diagram, using metals in as great a state of purity as possible. The metals used are aluminium, tin, lead, zinc, thallium, silver, gold, copper, cadmium, and antimony. The electromotive force for a temperature difference of about 100° C. was in each case compared with that of a standard Clark cell made according to Lord Rayleigh's instructions.

THE distribution of zymotic disease by sewer air is a question still *sub judice*, and in order to throw, if possible, some additional light on the subject the London County Council asked Mr. Laws to make some investigations on the air in some of the London sewers. The report has recently been presented and published. The principal experiments were made in a sewer running under the Green Park, and constructed some 120 years ago, and presumably having had ample opportunity for getting thoroughly contaminated. The percentage of carbonic acid gas present was estimated, and especial attention was given to the microbial contents of sewer air. For the detection of the latter Prof. Percy Frankland's method (*Phil. Trans.* 1887) was employed, and it is to be regretted that as this process enables large volumes of air to be sifted for micro-organisms in a short time, Mr. Laws did not examine more than ten litres. The results recorded confirm those obtained by previous observers, *i.e.* that sewer air contains generally very few organisms, and, as a rule, less than the air outside. Dr. Petri's observations on sewer air are not mentioned, but they are worth quoting, for he examined 100 litres of air in a Berlin sewer, and found on one occasion no organisms at all; and in another experiment only one bacterium and three moulds. It would appear, therefore, that drain air as regards freedom from microbes is very frequently superior to that which we inhale in our houses, and compares especially favourably in this respect with the air in crowded reception-rooms. Mr. Laws, however, concludes his report by remarking that although the organisms in sewer air do not probably constitute any source of danger, the latter may contain some highly poisonous chemical substance which may produce a profound effect upon the general vitality. But everyone agrees that sewer air is not a desirable addition to the atmosphere either of our streets or houses.

THE *Midland Naturalist* has ceased publication, owing to lack of support, after sixteen years' existence.

AMONG the papers in the *Actes de la Société Scientifique du Chili*, vol. iii. 1893, is one on the Coleoptera of Chili, by M. P. Germain, and another containing a description of a new method of determining the orbits of planets and comets, by M. A. Obrecht.

THE *University Correspondence College Calendar* (1893-4) has just been published. It contains answers to the questions set at the Matriculation Examination of last month, and articles on the special subjects for June, 1894, and January and June, 1895.

MR. R. H. SCOTT, F.R.S., has prepared an abridgment of his "Elementary Meteorology," in the form of a little book containing five hundred questions and answers on meteorology. The book, which is published by Messrs. Williams and Strahan, will be found useful to teachers and others.

ANOTHER of the Alembic Club Reprints (No. 5) has been published by Mr. W. F. Clay, Edinburgh. The volume contains extracts from the *Micrographia* of Hooke (1665), and a specially interesting paper in which his views on combustion are explained.

MESSRS. NALDER BROS. AND CO., Red Lion-street, Clerkenwell, have issued a price list of electrical testing, mathematical, optical, and other scientific instruments manufactured by them. The catalogue is very well illustrated, and each article named in it is given a telegraphic code word, so that in ordering any piece of apparatus it is simply necessary to transmit to the makers the code word allotted to it.

THREE representatives of the Lancashire County Council Technical Instruction Committee visited, last year, some of the chief continental schools which give technical instruction in horology, the silk industry, and mining. As a result of the inquiry a report has just been issued, in which the deputation recommends the establishment of schools in which all these subjects are thoroughly taught.

THE *Quarterly Journal of the Geological Society* (No. 197) contains, in addition to eight papers, eight plates illustrating the work of Mr. Rutley on the "Sequence of Perlitic and Spherulitic Structure," of Mr. E. A. Walford on "Inferior Oolite Bryozoa from Shipton Gorge, Dorset," and "Cheilostomatous Bryozoa from the Middle Lias," and of Dr. J. W. Evans on the "Geology of Matto Grosso, Brazil."

AN entirely new edition (the seventeenth) of "Johnston's Elements of Agricultural Chemistry" has been published by Messrs. W. Blackwood and Sons. Prof. C. M. Aikman has revised the whole of this well-known text-book, rewritten large portions of it, and added new matter, so as to bring the work up to the present position of agricultural chemistry. The fact that the book has survived unto the seventeenth edition is sufficient evidence of its usefulness.

A SERIES of coloured botanical diagrams, suited for class teaching, has been published by the Society for Promoting Christian Knowledge. The plants selected are chiefly indigenous, and the leaf, blossom, parts of the blossom, husk, and seed of each are very clearly shown in a greatly enlarged form. The diagrams thus exhibit to students the characteristic parts of plants, and will doubtless facilitate the study of some common specimens.

"A TEXT-BOOK of Solid or Descriptive Geometry," by Mr. A. B. Dobbie (Blackie and Son), is a little book possessing many good points, and one upon which great pains have evidently been spent. There are about 350 diagrams in the book, all of which have been carefully designed by the author. The diagrams and explanatory text are both extremely clear, and the problems well arranged. Elementary courses in plane geometry and graphic arithmetic are included, and add to the value of a book which we confidently recommend to the notice of teachers.

THE first part of the volume of the Proceedings of the Congrés International de Zoologie, held at Moscow during August, 1892, was reviewed in NATURE of January 5, 1893. The second part has just been published, and is of equal excellence with the one that preceded it. The volume contains thirty memoirs, occupying 287 pages altogether, and a supplement of 83 pages is devoted to the second report of Prof. Blanchard on the nomenclature of organisms. Prof. Blanchard presented his first report upon this subject to the International Zoological Congress that met at Paris in 1889.

THE first edition of "Electricity in the Service of Man" (Cassell and Co.) was published in 1888. Two years later a second edition appeared, and the third is now before us. The work has been revised and enlarged by Dr. R. M. Walmsley, and it has certainly benefited by his changes. Some 120 pages of the second edition have been excised, and new matter covering more than 200 pages has been inserted. It would be tedious to enumerate the numerous additions that have been made, both in the theoretical and technical sections of the subject. Suffice it to say that Dr. Walmsley has brought the book well up to date, and has largely increased its value by a thorough revision.

THE *Irish Naturalist* for February contains a list of all the known additions to the flora of the north-east of Ireland (except Musci and Hepaticæ) since the publication in 1888 of Stewart and Corry's work upon that subject. The list also embodies additional localities for many of the rarer species. Dr. Scharff concludes a paper on the Irish wood-lice, in which he gives descriptions of all the British species. Miss S. M. Thompson sets up a plea for Irish glaciology, and the Rev. Hilderis Friend describes a new Irish earthworm.

AN admirable review of the rapid progress which has been made during the last few years in the new domain of stereochemistry, which deals with the spacial arrangement of the atoms which compose a chemical molecule, is contributed to the *Chemiker Zeitung* by Prof. Victor Meyer. The literature of this most interesting branch of chemical study has so rapidly accumulated since the theory of Le Bel and Van't Hoff was promulgated in the year 1874, that a concise account of the important stages of progress which have led up to the present state of our knowledge is particularly welcome. The earlier portion of the memoir is devoted to the development of the idea of the asymmetric carbon atom, and the growth of the conviction that the occurrence of isomeric compounds represented by the same constitutional formula—which differ only in their action upon polarised light, and very slightly in other physical properties, such, for instance, as the three lactic acids—could only be accounted for by the different spacial arrangement of the atoms in the molecule. The fundamental assumptions of Van't Hoff are very clearly expressed, and the possibilities of isomerism by change in the relative positions of the various groups attached at the four corners of the hypothetical carbon tetrahedron are fully illustrated. A striking example is afforded in this connection by one of the results of the brilliant researches of Emil Fischer in the sugar group, whereby we are made acquainted with no less than thirteen distinct sugars, all of which are represented by the same constitutional formulæ $CH_2OH.(CHOH)_4.CH_2OH$. The second section is devoted to the stereo-isomerism of the derivatives of ethylene, so ably worked out by Wislicenus. The simple explanation of the remarkable and long-discussed case of the isomeric acids, maleic and fumaric, upon the lines of the new theory, is referred to, and a similar explanation extended to numerous other and more complicated of the derivatives of ethylene. The third section deals with the peculiar nature of the stereo-isomerism of closed-chain compounds, such as the polymerised tri-aldehydes. It is then shown in a further section that carbon is by no means peculiar in lending itself to stereo-isomerism, but that the pentavalent nitrogen atom is likewise capable of furnishing isomers which differ structurally merely in the relative positions occupied by the five attached atoms or groups. The stereo-isomerism of nitrogen compounds is shown, however, to be largely influenced by the weight and complexity of the five attached groups. The interesting discovery of a second di-oxim of benzil by Goldschmidt in Prof. Meyer's laboratory, gave a great impulse to the study of nitrogen compounds containing the group C = N, termed oxims, and the number of stereo-isomeric oxims which have subsequently been isolated bear remarkable testimony to the use of a theory in stimulating research.

THE additions to the Zoological Society's Gardens during the past week include two Swainson's Lorikeets (*Trichoglossus novæ-hollandiæ*) from Australia, presented by Mr. John Biehl; a Chilian Conure (*Conurus smaragdinus*) from Chili, presented by Mrs. Gibney; two Eyed Lizards (*Lacerta ocellata*) twenty European Tree Frogs (*Hyla arborea*) South European, presented by Mr. T. Keen; a Madagascar Porphyrio (*Porphyrio madagascariensis*) from Madagascar, a Waxwing (*Ampelis garrulus*), two Long-tailed Tits (*Parus caudatus*) European, purchased; a Hog Deer (*Cervus porcinus*) born in the Gardens

## OUR ASTRONOMICAL COLUMN.

ECLIPSE METEOROLOGY.—A very extensive series of meteorological observations was made during the total eclipse of the sun on January 1, 1889, at Willows, California. It appears that the temperature fell 6° F. from the commencement of totality to ten minutes after, while the variation of the barometer was so nearly identical with the daily fluctuation that no effect could with certainty be ascribed to the eclipse. The influence on the wind, however, was very marked, its previous velocity of twelve miles per hour being reduced almost to that of a calm. Observations with the solar radiation thermometer showed that some heat was received throughout totality. An attempt was also made to secure concerted observations of the so-called "shadow bands"—the long dark bands separated by white spaces which are seen in rapid motion on the ground and sides of buildings just before and after totality. The observations collected seem to give decisive evidence against the view that the bands are diffraction fringes in the shadow of the moon, the observed velocities being far less than that of the shadow; the fact that they were prominently seen at some stations, while at others they were hardly visible, indicates a local origin (*Ann. Harvard. Coll. Obs.* vol. xxix.).

In the same volume, Mr. Parkhurst gives an account of his photometric observations of some of the asteroids, and confirms the previous conclusion that there is a phase correction over and above that for the defect of illuminated surface, and that this correction is different for different asteroids; the idea that large errors may be introduced by rotation, however, is not confirmed. The same writer also gives the individual observations of a large number of variable stars, which furnish valuable data for the construction of light-curves.

A REMARKABLE COMETARY COLLISION.—Two striking photographs are reproduced in the February number of *Knowledge*, in illustration of an article, by Prof. E. E. Barnard, on the probable encounter of Brooks' Comet with a disturbing medium on October 21, 1893. The comet was discovered by Mr. Brooks, on October 16, but though it was kept under observation at the Lick Observatory, no phenomena of an extraordinary kind were observed until the 21st of that month. A photograph, then taken with a Willard photographic lens, presented a remarkable appearance, the tail appearing, to use Prof. Barnard's analogy, like a torch streaming in the wind. The reproductions of the photographs give the impression that the comet's tail swept into some dense medium, and was broken up by the encounter. Indeed, Prof. Barnard thinks it impossible to escape the conclusion that the tail did actually enter a disturbing medium which shattered it. This theory is supported by the photograph taken on October 22, where the tail is seen to hang in irregular cloudy masses, and a large fragment appears to be entirely separated from the main part. There is little doubt that the tail met a mass of meteoritic matter, and so had its symmetry destroyed; at any rate, this supposition must be accepted until a simpler and better one can supplant it. What we have to do, as Mr. Cowper Ranyard remarks in an article on the irregularities of comets' tails, is diligently to collect facts. The multiplication of such photographs as those obtained of Brooks' Comet, and of Swift's Comet (1892), by Prof. Barnard, will certainly revolutionise current opinion as to the development, and the types, of comets' tails.

MIRA CETI.—According to the *Companion to the Observatory*, this famous variable star will reach a maximum about the 17th inst. At the time of writing (February 3), the star is of a reddish tinge, and faintly visible to the naked eye; but, unfortunately, it is too near the sun to permit of long-continued observations on the same evening. The magnitude at maximum is very inconstant, and varies between 1·7 and 5·0 (Gore). Spectroscopic observations of the star are of the highest importance, and it is to be hoped that a satisfactory record of its phases will be secured. The general spectrum is one of Group II., but near a former maximum, Pickering photographed a number of bright lines, chiefly of hydrogen. Among the points on which information is desirable are: (1) at what phase of the variation the bright lines of hydrogen make their appearance; (2) the fluctuations in the bright flutings of carbon observed by Mr. Lockyer at the maximum of 1888 (NATURE, vol. xxxviii. p. 621).

PROPER MOTIONS OF STARS. — The recently published volume (xxv.) of the *Annals* of the Harvard College Observatory contains values for the proper motions of a large number of stars in the zone 50°—55° north, the adopted values, however, being only at present regarded as provisional. The results are derived by Prof. Rogers from the comparison of his own positions for the stars in this zone, obtained with the meridian circle, with the positions given for corresponding stars by earlier catalogues. One section of the volume gives the values of $\alpha$ and $\delta$, referred to the system of the *Astronomische Gesellschaft*, for the stars included in the zone in question.

THE SYSTEM OF ALGOL.—An elaborate discussion of the inequalities in the period of Algol recently led Mr. Chandler to conclude that there is a distant dark body around which the bright star and the dark companion producing eclipses revolve in a period of 130 years (NATURE, vol. xlv. p. 446). This conclusion has been greatly strengthened by recent investigation by Mr. Searle, of the relative places of Algol and comparison stars from observations made with the meridian circle at Harvard College (*Annals*, vol. xxix. 1893). The right ascension of the star appears to be increasing in general conformity with Chandler's prediction.

## THE INSTITUTION OF MECHANICAL ENGINEERS.

THE forty-seventh annual general meeting of the Institution of Mechanical Engineers was held on the evenings of Thursday and Friday of last week, in the theatre of the Institution of Civil Engineers. There were two papers down for reading, as follows:—

"Research Committee on Marine Engine Trials. Abstract of results and experiments on six steamers, and conclusions drawn therefrom in regard to the efficiency of marine engines and boilers," by Prof. T. Hudson Beare.

"Description of the Grafton High Speed Steam Engine," by Edward W. Anderson, of Erith.

The reading and discussion of Prof. Beare's paper, together with the introductory proceedings, occupied both evenings, so Mr. Anderson's paper had to be adjourned until next meeting.

Upon the members assembling on Thursday evening, the 1st inst., the President, Dr. William Anderson, took the chair. Mr. Bache, the secretary, then read the annual report of the council, by which it appeared that the Institution continues to flourish, the income and membership having increased during the past year. After the reading of the report Dr. Anderson vacated the chair, his term of office of two years having expired, and the new President, Prof. Alexander B. W. Kennedy, F.R.S., was duly installed. After the usual votes of thanks, and a few complimentary speeches, the reading of Prof. Beare's paper was proceeded with.

As our readers are aware, the Research Committee on marine engine trials of this Institution has been for some time past engaged in making trials with different steam vessels. The reports of the committee on these trials have already been referred to in our accounts of former meetings of the Institution at which they have been read. Six vessels have been experimented upon altogether since the committee was formed. These ships have consisted of channel passenger vessels and cargo boats, the committee not having had yet an opportunity of experimenting upon an important ship of the ocean liner type.

The labours of the committee have been brought to a conclusion, for the present at any rate; and the paper of Prof. Hudson Beare was intended to give a summary of the results, and afford a basis of discussion thereupon. We are at a loss how to condense within the compass of space at our disposal the mass of data dealt with by the author of the paper. Perhaps the most lasting impression on one's mind, after going through the subject, is that no general conclusions, that can be compactly expressed, are to be drawn from the trials. The conditions of work required from marine engines in ships of different classes are so various that what is paramount virtue in one case becomes an unnecessary refinement in another. Thus in the cargo boats the first consideration is economy in fuel, to which nearly every other feature in the machinery is usually sacrificed. In order to carry cargo at a rate sufficiently low to enable the shipowner to compete, the coal bill must be light, and therefore we find in these vessels boilers lightly worked and speeds low. On the other hand, vessels that have to convey passengers must be speedy, and general economy has to be sacrificed to this end, the model of the vessels themselves being formed with the same purpose in view. Perhaps we cannot do better than quote some of the elements of design of the machinery, and some of the results attained during the trials, in order to illustrate these leading facts. We will take two of the ships tried—the *Iona*, a large cargo boat, and the *Ville de Douvres*, a paddle boat carrying mails and passengers between Dover and Ostend. The *Iona* is 275 feet long, 37.3 feet wide, 27 feet 7½ inches draught, and 4430 tons displacement. Her speed on trial was 8·6 knots. The *Ville de Douvres* is 271 feet long, 29 feet wide, 9 feet draught, and 1090 tons displacement. On her trial she made 17·1 knots. It will be seen, therefore, that the cargo boat is considerably over four times the displacement, and travels at about one-half the speed of the mail boat. As both craft are approximately the same length, the additional size and weight-carrying capacity of the *Iona* is made up by her greater beam, and also by her fuller ends. The engines of the *Iona* are of the three-stage compound, popularly, but erroneously, known as triple expansion engines. As a matter of fact the *Iona's* engines are 19-expansion, the steam being expanded nineteen times in passing through the three cylinders. The *Ville de Douvres* has ordinary two-cylinder compound engines, in which the steam is expanded but 5·7 times. The horse-power required to drive the 4430 tons of the bluff-ended *Iona* through the water was but 645·4 indicated, whilst the *Ville de Douvres*, modelled for speed, required 2977 indicated horse-power to enable her to get her 17 knots. Supposing each unit of power to be obtained in both ships at an equal expenditure of fuel, the figures quoted will show the price that has to be paid for speed; but there is a further item to the debit side of the coal bill in the case of the fast ship. In order to get high speed it is very desirable, indeed necessary, that machinery should be light, and light machinery, other things being equal, means a low figure of merit in regard to fuel economy. The *Iona* works, as stated, with 19 expansions, her boiler pressure being 165 lbs. above atmosphere; whilst the *Ville de Douvres* has boilers pressed only to 105 lbs. The result of this greater expansion of steam on the part of the cargo boat's engines, and the easy way in which her boilers are worked, enables each unit of power to be obtained on a consumption of 1·46 lbs. of coal per hour; whilst the *Ville de Douvres* required 2·32 lbs. of coal for each indicated horse-power exerted for an hour.

It is easy to see from these figures, which are fairly representative, that economy and speed cannot go hand in hand; the owner must select whether he would rather travel cheaply (in fuel) or quickly.

Pursuing the investigation of this branch of the subject, we find that the total weight of the machinery of the *Iona* is 202 tons, which gives 3·1 units of power per ton weight of machinery; whilst the total weight of the machinery of the *Ville de Douvres* was 361 tons, equal to 8·2 units of power per ton weight of machinery. With regard to space occupied, the engines of the two ships are not comparable, being paddle and screw engines respectively; but in boilers we find that the net volume required for each indicated horse-power with the *Iona* was 4·15 cubic feet, and with the *Ville de Douvres* 2·09 cubic feet; thus showing that space as well as weight may be gained by the sacrifice of fuel economy. In the discussion which followed the reading of the paper, Mr. Jeremiah Head, of Middlesborough, gave some interesting figures in regard to those cargo steamers generally known as "ocean tramps." He stated that the s.s. *Westoe*, a vessel of this class, had carried 3500 tons dead weight at a speed of 9 knots, the fuel burnt being at the rate of ·64 oz. per ton per nautical mile, or about one five-hundredth of a penny. Another ship, the *Oscar II.* of 4600 tons dead weight capacity, required a consumption of half an ounce of coal per ton per mile. Still another vessel steaming at 8·9 knots showed a similar fuel economy. The figures are striking, and easily remembered: half an ounce of coal for each ton carried one nautical mile.

The boilers of both the *Iona* and the *Ville de Douvres* are of a similar type, being the ordinary return tube marine boiler, but the proportions are somewhat different. Thus in the *Iona* the proportion of total heating surface to grate surface is 75·2 per cent; in the *Ville de Douvres* it is but 31·1 per cent. This large extension of the heating surface means both a heavier and more bulky boiler, as has been shown; but in the cargo boat this sacrifice of weight and space can be profitably made in order that the fullest amount of heat from the products of combustion may be absorbed by the water in the boiler. In the *Ville de Douvres* this heat is allowed to pass off by the chimney. If we turn to the record of funnel temperatures we find this fact borne out, the escaping gases in the *Iona* being 452° F. and in the *Ville de Douvres* 910° F., as far as could be ascertained. The coal consumed on a given area of grate in the two vessels does not vary greatly, it being 22·4 lbs. per hour in the *Iona*, and 31·3 lbs. per hour in the *Ville de Douvres*. The different proportions of grate to heating surface in the two ships will, however, be remembered. If we turn to the coal burnt per hour per square foot of heating surface we find it but 0·298 lbs. in the *Iona*, and 1·01 lbs. in the *Ville de Douvres*. With regard to evaporation, each square foot of heating surface in the *Iona's* boilers turned 2·73 lbs. of water into steam per hour; in the *Ville de Douvres* the corresponding figure was 9·02. The feed-water evaporated per lb. of fuel was 9·15 lbs. in the *Iona*, and 8·97 lbs. in the *Ville de Douvres*. Taking carbon values—that is, excluding incombustible ash—and reducing the results to an equivalent of evaporation from and at 212°, we find the corresponding figures to be 10·42 lbs. for the *Iona* and 9·94 lbs. for the *Ville de Douvres*, a by no means bad result for the latter vessel's boilers, considering the demand made upon them in other respects.

Turning to the engines of these two ships, we find that the efficiency of the *Iona's* engines was 17·1 per cent., whilst the *Ville de Douvres'* engines had an efficiency of 11·7 per cent. The weight of steam used in the main engines of the former vessel was 13·35 lbs. per indicated horse-power per hour, whilst in the *Ville de Douvres* there were required 20·77 lbs. of steam to produce one unit of power.

The figures we have quoted will be sufficient to give an idea of the scope of the paper. We have not space to go into the discussion upon the various causes of the variations in results; for these we must refer our readers to the Proceedings of the Institution, where also will be found an account of the long and interesting discussion which followed the reading of the paper.

The summer meeting will be held this year in Manchester, at the beginning of August.

## ON THE MOTION OF BUBBLES IN TUBES.

EVERY student of physics has observed the motion of bubbles in tubes. Which of them has not used a big bubble to show the little ones their duty in clearing out the air when filling a barometer tube? Who has not spent his time and patience in whisking a spirit thermometer to drive a bubble out of the column? Mr. Trouton has recently communicated to the Royal Society the result of some researches on this subject. He has studied the behaviour of big bubbles and of little ones, of bubbles in large and small tubes, of bubbles of air in a liquid, and of one liquid in another, of bubbles in heavy and in light liquids, of bubbles in liquids of various degrees of viscosity and with various degrees of surface tension at their surfaces. From this enumeration it is evident that the number of different magnitudes involved is very great, and at the start it seemed almost hopeless to disentangle the effects due to each. The first matter to observe was that, as in other cases of fluid motion, two cases must be distinguished. These are the cases of slow motion and of quick motion. When the motion is slow the viscosity of the liquid causes the flow to be very simple. It entirely stops all whirling and swirling, such as is seen in the water behind a boat. When the motion is quick, on the other hand, the flow is very complicated. Whirls and swirls are set up, and the resistance is increased, owing to the increased energy that has to be communicated to the whirling and swirling liquid for each centimetre that the bubble moves. The slow kind may be described as viscous flow, and the quick as turbulent flow. The most interesting point observed in connection with the turbulent flow was that it was sometimes possible to *increase* the rate of flow by *increasing* the viscosity. Increasing the viscosity of a liquid generally makes it flow more slowly, but in some critical cases the increase of viscosity may produce more effect in decreasing the turbulence than in increasing the viscous resistance, and the result is to, on the whole, reduce the combined resistance so that the bubble moves more rapidly in the liquid of greater viscosity. Another matter that was of interest was the question of the size of the bubbles, and how it affected their rate of motion. Very long bubbles moved all at nearly the same rate, but short bubbles had a great variety of rates. Very small bubbles ran along ever so fast, while ones only a little larger went very much more slowly. These latter blocked up the tube much in the same way that a crowd blocks its own egress through a doorway. However, bubbles a little larger seemed to have more sense, for they shape themselves into a sharpish head, with the result that they can make their way along the tube more rapidly than smaller ones. Those a little larger again take up a dumb-bell sort of shape, and block the tube, and go more slowly again, though not so slowly as the smaller blocking bubbles. A little larger go somewhat more rapidly again, but as the bubbles are made longer the differences between the rates of the quick and slow sizes become rapidly less and less until pretty soon all go at the same rate, no matter how long they are. This alternation of speeds is evidently connected with the ripples that are formed at the head of the bubble as it passes through the liquid, much as a stick moving through water makes a series of ripples upon the surface. If the ripples are so long that the bubble has a pointed head it goes fast, if it has a blunt head it goes slowly. These ripples are in some cases very marked. Mr. Trouton found that when a bubble of oil was allowed to rise through water with which one fifty-thousandth part of caustic soda was mixed the ripples became quite a feature of the figure of the bubble. They at first extended as a series of rings round it, which, however, soon coalesced into a spiral wave, when the bubble rose rapidly through the liquid with a sort of corkscrew motion. If the tube were inclined the ripples were only formed on the lower surface of the bubble, the top surface floating up against the containing tube, and the ripples then looked like the feet of a caterpillar walking up the tube. This is not the only case in which surface tension motions simulate muscular actions, and it is an important question whether some of these actions are similarities or simularities.

The surface tension between the air and liquid if the bubble is an air bubble, and between the two liquids if the bubble is a liquid one, has a very important bearing on the rate of motion of the bubble, for it is owing to this surface tension that the bubble swells out and presses against the sides of the tube. In consequence of this, when the surface tension is large the bubble moves more slowly than with a small surface tension. It would take too long to explain all the considerations by which Mr. Trouton was led to conclude, by the dimensions involved, that the velocity could be expressed in a series of powers of $S/g\delta D^2$ when S is the surface tension, $g$ the acceleration of gravity, $\delta$ the difference of density of the liquid and bubble, and D the diameter of the tube. This series is multiplied by $\mu/g\delta D^2$ where $\mu$ is the viscosity of the liquid. Two assumptions are made. First, that the viscosity of the material of which the bubble is made is negligible; and secondly, that the motion produced by the surface tension is negligible compared with the motion produced by gravity. The series he gets from his experiments represents the results as accurately as can be expected, considering that the bubbles varied in density from air to mercury, the viscosity of the liquid from 1 to 833, and the surface tensions from 2 to 370. The series Mr. Trouton gives for calculating the time, T, a bubble takes to move one centimetre is

$$T = \frac{A_1\mu}{g\delta D^2} + \frac{A_2\mu S}{g^2\delta^2 D^4} + \frac{A_2\mu S^2}{g^3\delta^3 D^6}$$

The values of the constants can be determined by the values he gives from experiments on glycerine whose density was 1·25 and superficial tension 63 dynes per centimetre.

$$\frac{A_1\mu}{g} = 1·308, \quad \frac{A_2\mu}{g^2} = ·02322$$

and

$$\frac{A_3\mu}{g^3} = ·0009108.$$

The formula is unfortunately a very inconvenient one for using to calculate the quantity that enters into it, and which is the most difficult to determine, namely, the surface tension between the bubble and liquid. This method of determining surface tension is one of the very few by which it can be determined without knowing angles of contact, which are so very difficult to determine at all accurately. In this way Mr. Trouton has determined the initial surface tension to be 6·5 between a bubble of water and glycerine that was pretty rapidly dissolving it. The ripple method could hardly be applied to this case, and it is doubtful whether the jet method could be applied to the surface between two liquids.

In connection with the high power to which $g$ is raised in the formula it is interesting to note how, by altering the acceleration on the liquid by impacts or by centrifugal force we can very much increase the rate at which a bubble passes along a tube. This seems to be part of the rationale of the methods by which a bubble in a spirit thermometer can be shaken or whirled up the column.

The whole subject is of considerable interest, and lends itself to experimental investigation with very simple apparatus. A few glass tubes and the liquids to be experimented with are almost the only things required in addition to a plentiful supply of care in cleaning. An investigation of the problem from purely dynamical considerations might well tax the powers of an ambitious mathematician, and provide tripos problems for many years.

## SCIENCE IN THE MAGAZINES.

THE *Fortnightly* again takes the first place, as regards scientific articles, in the magazines received by us. Mr. Herbert Spencer contributes to it a paper on the late Prof. Tyndall, Prof. Karl Pearson writes on "Science and Monte Carlo," and Mr. H. O. Forbes states the grounds of his belief in "Antarctica: a Vanished Austral Land." Mr. Spencer does not dwell upon the more conspicuous of Prof. Tyndall's intellectual traits, but upon a few characteristics concerning which little has been said. Chief among these powers of thought was "the scientific use of the imagination." Tyndall insisted upon the need for this. "There prevail, almost universally," Mr. Spencer points out, "very erroneous ideas concerning the nature of imagination. Superstitious people whose folk-lore is full of tales of fairies and the like, are said to be imaginative; while nobody ascribes imagination to the inventor of a new machine . . . . strange as the assertion will seem to most, it is nevertheless true that the mathematician who discloses to us some previous unknown order of space-relations does so by a greater effort of imagination than is implied by any poetic creation." The faculty with which Tyndall was largely endowed was that of constructive imagination, and he used that talent in all his work. Among other points upon which Mr. Spencer dwells in the eulogy of his dead friend, are Tyndall's intellectual vivacity, and the *x* Club described by Prof. Huxley. The influence that the Club eventually exercised in the scientific world is shown by the fact that it contained four presidents of the British Association, three presidents of the Royal Society, and presidents of the College of Surgeons, of the Mathematical Society, and of the Chemical Society. The number of members is now reduced to five, and the Club is practically dead. The object of Prof. Pearson's essay is to show that chance as it applies to the tossing of an unloaded coin has no application in Monte Carlo roulette. The discussion of records of the roulette-tables leads to the strange result that "the random spinning of a roulette manufactured and daily readjusted with extraordinary care is not obedient to the laws of chance." In the *Fortnightly* of May last, Mr. Forbes gave reasons for believing that "there must have existed in the Southern Seas an extensive continuous land similar to that in the Northern Hemisphere, on which the common ancestors of the forms unknown north of the equator, but confined to one or more of the southern extremities of the great continents, lived and multiplied, and whence they could disperse in all directions." He then remarked that this lost continent "lies in part beneath the southern ice-cap, and it approached to, or included, the Antarctic Islands, as well as extended northward to unite with the southern extremities of South America, perhaps with Africa, and with the Mascarene, the Australian, and the New Zealand continental islands." Mr. Forbes now brings forward a mass of evidence in support of his view, dealing in detail with the distribution of different divisions of the animal kingdom.

The *Century* contains a biographical sketch of Mr. Nikola Tesla, by Mr. T. C. Martin, illustrated by an excellent portrait of that investigator. Mr. Tesla comes of an old Servian stock, and is but thirty-six years of age. His electrical work began in the Polytechnic School at Gratz, where he distinguished himself in experimentation. He afterwards became an assistant in the Government Telegraph Engineering Department at Buda-Pest, from which he passed into an electric-lighting establishment in Paris. A little later he crossed the Atlantic, and entered one of Mr. Edison's workshops. When his term of apprenticeship there had ended, he struck out for himself, his investigations eventually leading him to the brilliant phenomena produced with currents of high potential and high frequency. "Recently," says Mr. Martin, "the high-frequency generators with which he had done so much of this advanced work have been laid aside in discontent for an oscillator, which he thinks may not only replace the steam-engine with its ponderous fly-wheels and governors, but embodies the simplest possible form of efficient mechanical generator of electricity."

Orchid lovers—and who are not lovers of those marvellous plants?—will find pleasure in reading an article on "Orchids," contributed by Mr. W. A. Styles to *Scribner*. The article is embellished by M. Paul de Longpré, with fourteen illustrations of the beautiful and fantastic forms of orchid flowers. Mr. Styles gives an account of a collector, who, when offering his plants for sale, explained that they had a special value, inasmuch as he had taken pains to destroy all that remained in their native woods. "This ingenuous avowal," continues Mr. Styles, "suggests a new danger to the orchid supply. It has already been necessary to pass laws in Switzerland to protect the endelweiss from tourists; there are societies in many European countries to rescue rare and native plants from extinction by amateur botanists and others. In our own country a few extremely local ferns and wild flowers are already in danger of extermination, and in the case of certain species of orchids of a limited range, each one of which has a money value regulated by the scarcity of the plants, the greed of man furnishes a motive for the wholesale destruction of all which cannot be carried away. The beautiful *Disa grandiflora* has already become scarce on Table Mountain, and the authorities at the Cape of Good Hope have found it necessary to forbid collecting it in order to prevent its total destruction. Rajah Sir Charles Brooke, of Sarawak, in Borneo, has issued an order to forbid the collection of plants in the country under his control, and if restrictions like this come to be enforced throughout the tropical regions tributary to the British Empire, it will cause consternation among the importers, who are receiving more than half a million orchids every year." *Scribner* also contains a striking article by Mr. J. C. Harris, on the terrible storm that devastated the Sea Islands and the coast of the United States from Charleston to Savannah last August.

A long discussion of Sir Henry Howorth's "Glacial Nightmare" appears in the *Quarterly Review* (No. 355). In conclusion the reviewer remarks: "We venture to record the opinion that in his treatment of the rival claims of ice and of water, as to which was the chief factor in producing the great Drift at the close of the Pleistocene epoch, our author has succeeded in shifting the balance of probability, and transferring it to the action of the latter."

Among other contributions of scientific interest in the magazines received by us is an interview with Dr. A. R. Wallace, F.R.S., on "Heredity and Pre-natal Influence," published in the *Humanitarian*; an article in *Longman's*, in which Mr. J. G. McPherson brings together a number of elementary facts relating to "Colour," and a paper on "Vegetable Monsters," by Mr. Edward Step, in *Good Words*. Mr. Step describes the current fictions concerning the so-called Devil-tree, the Upas-tree, the manchineel (*Hippomane mancinella*), and the Scythian Lamb (*Agnus Scythicus*). We have received the *Contemporary*, but it does not contain any articles on scientific topics.

## UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—The voting for the board of the Faculty of Natural Science last week resulted in the election of Messrs. J. E. Marsh, H. Balfour, A. G. Vernon Harcourt, W. Esson, G. C. Bourne, and R. E. Baynes. Mr. R. H. Bremridge has been elected to a Senior Demyship at Magdalen College. Mr. Bremridge obtained a first class in the Honour School of Natural Science (Physiology) last year. Mr. R. T. Günther has been chosen as science tutor at Magdalen College, to succeed Mr. E. Chapman, who is leaving Oxford at the end of the Summer Term.

Professor Ray Lankester is issuing a volume of studies made in the Linacre Department since his election to the Professorship. The volume, which bears on its cover a medallion with a likeness of Linacre, contains papers by Dr. W. B. Benham, and Messrs. Minchin, R. T. Günther, Goodrich, Pycraft, and others.

CAMBRIDGE.—The electors to the Downing Professorship of Medicine, vacant by Dr. Latham's resignation, will meet for the purpose of electing his successor on March 3. Candidates are to send twelve copies of their testimonials (if any) to the vice-chancellor (the Rev. A. Austen Leigh, Provost of King's) by Monday, February 26.

The Council of the Senate have published, in the *Uni-*

*versity Reporter* for February 6, a very important proposal, which may lead to a considerable increase in the number of students resorting to Cambridge for advanced study or research. The Council recommends that statutory powers be obtained for the establishment of two new degrees, Bachelor of Science and Bachelor of Letters, to be conferred on graduates only, whether of Cambridge or of some recognised University, British or foreign. The conditions suggested are (1) matriculation, (2) residence for one academical year (three terms), (3) evidence of advanced study or research in Cambridge, (4) an original dissertation on some subject, literary or scientific, coming under the cognisance of one of the Special Boards of Studies. Hitherto only graduates of the Universities of Oxford and Dublin, who have fulfilled conditions as to residence equivalent to those in force at Cambridge, have been admissible to *ad eundem* degrees. The new proposal is much more liberal, and is calculated to attract some of those maturer students who now, after graduating in their own University, seek opportunities for higher work in the continental schools. As Cambridge graduates can qualify for the B.Sc. and B.Litt. degrees only if they have passed one of the higher Honours Examinations, and then only on submitting an approved original dissertation, it is plainly intended that these degrees shall imply a real distinction. It is interesting to note that literary or scientific research, and not the faculty of passing examinations, is a condition for the new "post-graduate" degree. At Oxford similar proposals are said to be afoot, and if the two older Universities carry through their scheme, a great step will have been taken towards making them once more the resort of scholars from all parts of the world.

The *Times* published on Tuesday a summary of the recommendations of the Gresham Commission on a Teaching University for London, embodying a scheme for its constitution, with visitor, chancellor, vice-chancellor, senate, academic council, convocation, and schools, and regulations as to examinations, faculties, boards of studies, and degrees.

## SOCIETIES AND ACADEMIES.

### LONDON.

**Royal Society**, December 14.—"Action of Light on Bacteria.—Bacterial Photographs of the Solar and Electric Spectra." By Prof. H. M. Ward, F.R.S.

A thin film of gelatine or agar, in which spores or bacteria are evenly distributed, is spread over the flat bottom of a shallow glass dish. The lid of the dish is a plate of ground-glass, in which one or more slots, about $\frac{1}{2}$ inch wide and $2\frac{1}{2}$ inches long, are pierced. The spectrum is so arranged that the light-rays fall perpendicularly on the film carrying the spores &c., and can only reach the latter through the slots, all other parts of the plate being covered by tin foil and black paper.

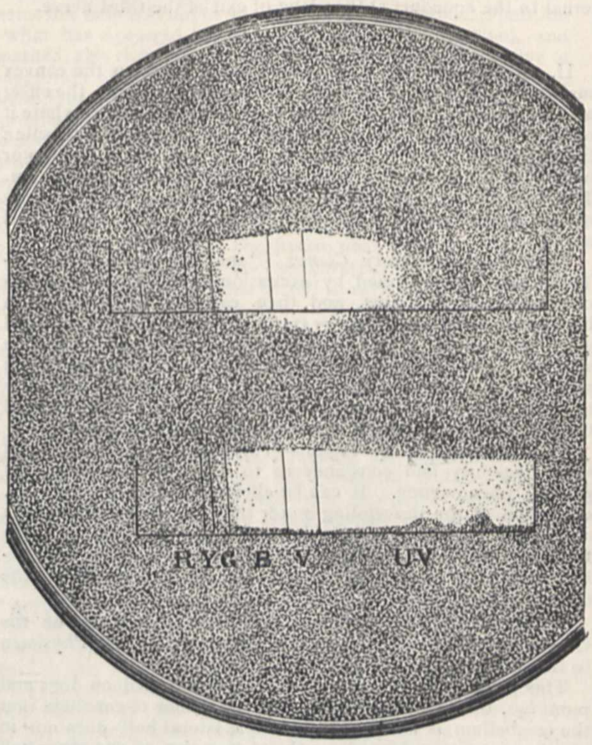
When the film has been thus locally exposed for a certain number of hours to the spectral rays, the culture is put into the incubator. All those parts protected from the light entirely, behave as in any ordinary culture—the spores germinate out and develop colonies, and the previously transparent film (transparent because the spores are too minute to affect it) becomes opaque.

Under the slot, however, the spores were exposed to the various rays of the successive regions of the spectrum. On one part of the exposed area the infra-red rays fall; on another the red; on another the orange; and so on with the yellow, green, blue, violet and ultra-violet rays.

If any of these rays kill or injure the spores they fall on, obviously the latter will show the effect by not germinating at all in the incubator, after exposure, or by germinating more or less slowly and feebly in comparison with the uninjured spores.

Wherever the spores do not germinate at all, the gelatine remains transparent; where they only germinate and develop into slowly growing, feeble colonies, the transparency of the gelatine film is merely clouded more or less; whereas, where they germinate and develop as vigorously as on the unexposed parts of the film, the latter is rendered quite opaque.

Obviously these differences, or contrast effects, can be photographed, and the following is a photograph of a plate treated as described.




In all cases so far examined, both the solar and electric spectra show that no action whatever is perceptible in the infra-red, red, orange, or yellow region, while all are injured or destroyed in the blue and violet regions.

The exact point when the action begins and ends is not the same in all the experiments, though very nearly so, but it must be reserved for the detailed memoir to discuss the various cases.

Broadly speaking, the action begins at the blue end of the green, rises to a maximum as we pass to the violet end of the blue, and diminishes as we proceed in the violet to the ultra-violet regions.

Some especially interesting results were obtained with the electric spectrum. In the first place, the results with glass prisms, lenses, &c., were so feeble that it was necessary to employ quartz throughout.

Secondly, the bactericidal effect is found to extend far into the ultra-violet. The intervention of a thin piece of glass results in the cutting off of a large proportion of effective rays.

These results suggest evidently that the naked arc light may prove to be a very efficient disinfecting agent in hospital wards, railway carriages, or anywhere where the rays can be projected directly on to the organism.

January 25.—"The Effect produced upon Respiration by Faradic Excitation of the Cerebrum in the Monkey, Dog, Cat, and Rabbit." By W. G. Spencer.

The effect upon respiration of exciting the cerebrum in a non-anæsthetised animal is probably a complex one, yet, by careful regulation of the anæsthetic state, four constant effects can be obtained upon respiration by stimulation of the cortex, and these can be traced down each in a course of its own from the cortex to the medulla oblongata.

A. *Diminution of Action.*

I. *Slowing and Arrest of the Respiratory Rhythm.*—The cortical area where this result was obtained is situated just outside the olfactory tract in front of the point where the tract joins the temporosphenoidal lobe. On exposing successive and vertical sectional surfaces of the hemisphere the same result was obtained by exciting in the line of the strand of fibres known as the olfactory limb of the anterior commissure. After decussating at the anterior commissure, the tract is continued backwards on either side of the infundibulum into the red nucleus below and external to the aqueduct at the plane of exit of the third nerve.

B. *Increased Action.*

II. *Acceleration.*—Commencing from a point on the convex surface of the cortex within the "sensori-motor" area, the effect may be followed back just below the lenticular nucleus where it borders on the outer and ventral portion of the internal capsule; the strand runs at first external and then ventral to the motor portion of the internal capsule, and so reaches the tegmentum. The lines from the two sides meet in the interpeduncular grey matter at the level of and just behind the exit of the third nerve.

III. *Hyperinspiratory Clonus* ("snuffing movements").—This effect was obtained by excitation at the junction of the olfactory bulb and tract, and then carrying the stimulation backwards along the olfactory tract; the same result was found when the uncinate convolution of the temporo-sphenoidal lobe was irritated. Followed from the uncus this excitable region passed behind the optic tract to the crus, and then lay ventrally to the crusta. The excitable tract on each side thus converged towards the middle line at the upper border of the pons.

IV. *Hyperinspiratory Tonus.*—This experimental result is of such frequency and constancy as to be clearly an important general phenomenon. It can be elicited in various ways: *e.g.* excitation of the descending motor tract in the corona radiata and internal capsule yielded this result; so did excitation of the fifth nerve and dura mater, as well as the sciatic nerve, both before and after complete removal of the cerebrum at the tentorium cerebelli.

"Experimental Researches into the Functions of the Cerebellum." By Dr. J. S. Risien Russell, Assistant Physician to the Metropolitan Hospital.

This paper is based on experiments performed on dogs and monkeys, the results of which lead the author to conclude that the cerebellum is an organ whose one lateral half does not in any great measure depend on the cooperation of the other half for the proper performance of its functions. The bulk of the impulses pass from one half of the organ to the cerebrum, or spinal cord, without passing to the other half. Three factors are responsible for the defective movements which result on ablation of different parts of the organ—incoordination, rigidity, and motor paresis. The last of these is probably directly due to the withdrawal of the cerebellar influence from the muscles, while the exalted excitability of the opposite cortex cerebri, which results after unilateral ablation of the cerebellum, is probably a provision for compensation in this and other connections. The alteration in the excitability of the cerebral cortex was the most striking result obtained, for both as tested by the induced current directly applied to the cortex, and from the characters of the curves obtained from muscles on the two sides of the body, during general convulsions evoked by absinthe, the opposite cortex showed a greater degree of excitability than did that on the same side, owing, it appears, to an increased state of excitability of the cortical cells of the opposite cerebral hemisphere, and a diminished state of excitability of those on the same side. Further, the curves obtained from limb muscles showed that there was a marked alteration in the second stage of the convulsive seizure, on the side of a unilateral ablation of the cerebellum, or on both sides after total ablation of the organ, for the tonus characteristic of this stage of similar convulsions evoked in dogs whose central nervous system was intact was either replaced by clonic spasms, or a large element of clonus was superimposed on the tonus.

There is evidence that the one half of the cerebellum controls the cells of the cortex of the opposite cerebral hemisphere, and those of the anterior horns of the spinal cord on the same side chiefly, and on the opposite side to a slight extent. It is further suggested that either the cerebral hemisphere whose excitability is increased inhibits the opposite hemisphere, or that, under normal conditions, one half of the cerebellum inhibits the other half, which inhibition being no longer operative, owing to ablation of half of the organ, allows the remaining half to exert an increased control on the opposite cortex cerebri, or on the spinal centres of the same side, or possibly in both directions; but which is the most probable explanation of the phenomena observed is at present left an open question.

The symptoms which characterise ablation of different parts of the cerebellum are detailed; and it is urged that instead of looking on it as a distinct organ which has a special function, distinct from those subserved by other parts of the central nervous system, it would be more correct to look on it as a part of that system, having many functions in common with other parts of it, the chief difference between one part of this great system and another being the degree in which different functions are represented in any given part: *e.g.* with regard to motor power, the anterior extremity is maximally represented in the cerebrum and minimally in the cerebellum, whereas the trunk muscles are minimally represented in the cerebrum and maximally in the cerebellum. Arguments are adduced in favour of looking on the ocular deviations which result from ablation of parts of the cerebellum as paralytic rather than irritative phenomena, and two forms of nystagmus are recognised as consequent on cerebellar lesions, one which is spontaneous, and the other which is only evoked on voluntary movements of the globes, and the probable difference in their ætiology discussed. Finally, the phenomena characteristic of unilateral ablation of the cerebellum are contrasted with those the result of extirpation of the labyrinth, and it is shown that no single phenomenon is the same in the two.

"The Pathology of the Œdema which accompanies Passive Congestion." By Walter S. Lazarus-Barlow.

**Physical Society**, January 26.—Prof. A. W. Rücker, F.R.S., President, in the chair.—Mr. J. W. Kearton read a note on a new mode of making magic mirrors. The author's first idea was that the magic properties were due to differences in reflecting power, but experiments showed this to be improbable, and indicated that the patterns visible by reflected light were due to slight concavities in the surfaces. Several methods of producing such changes of curvature were tried, such as electro-depositing and electrical etching, the plates being subsequently polished to remove sharp edges. The method found most satisfactory was to draw the figures on polished brass covered with wax, and etch them by immersing in nitric acid, subsequently scouring with charcoal, Sheffield lime, and swansdown calico, until all direct traces of the figures disappeared. The scouring rounds off the edges and makes the depressions concave, the two eventually forming one concave sweep, which makes itself visible when light is reflected from it on a screen. To obtain satisfactory results with figures having broad and narrow lines, it was found necessary to paint over with hot wax the fine lines, and the outer edges of the broad ones after the first immersion; a second immersion etched the middle parts of the broad lines deeper. By repeating the process the broad lines were etched roughly concave in steps, and the scouring made their curvature continuous. Figures in relief, showing the pattern in shade on reflection, were obtained by painting the pattern on the plate in sealing-wax dissolved in naphtha, and etching away the uncovered portions by an immersion of one or two seconds. A number of mirrors with patterns in intaglio and relief were exhibited to the meeting. Prof. S. P. Thompson said the chief interest of Mr. Kearton's work was that he had succeeded in producing mirrors by a process which Prof. Ayrton had found unsuccessful. The spherical polisher used by Mr. Kearton might have something to do with the result obtained. Some of the mirrors had been gilt after polishing, and the reflected pattern improved thereby. Prof. Ayrton said he was greatly interested to see that mirrors could be produced by the chemical method. The polisher used by the Japanese was the flat end of a tight bundle of special straw cut crosswise. When the true explanation of the magic properties was found out, the chemical method was not pursued further. The Rev. F. J. Smith mentioned that he had produced magic properties on silvered glass by the inductoscript method. Although no markings could be seen directly, the pattern showed itself when light was reflected from the surface to a screen.—Mr. W. B. Croft read a paper on some observations in diffraction, and exhibited a large number of photographs of diffraction figures obtained under different conditions. The first series exhibited, related to diffraction from parallel light (diffraction of Fraunhofer and Schwerd), and were obtained by placing various combinations of thin circular lines of light on a dark glass plate before the object-glass of a telescope focussed on a star. Spectral images of the star are formed by interference from the edges of the lines, thus giving diffraction patterns whose form depends on the shape of the aperture employed. The next series illustrated diffraction in shadow (Fresnel's diffraction), and were produced by condensing light on a minute pinhole, and placing the object between the hole and a microscope eyepiece. Beyond the eyepiece the camera used for photographing the phenomena was placed. Permanent records of remarkably good diffraction figures were obtained in this way, both of the combinations of circles above mentioned and of various other objects and geometrical forms. After showing geometrically that diffraction bands from narrow obstacles and openings were wider than those from broader ones, the author explained the conditions necessary for making the bands visible, and pointed out the distinction between internal and external bands. Prominent amongst the photographs were several showing "Arago's white spot" at the middle of a shadow, and, in particular, this well-known phenomenon was shown as produced by so large an object as a threepenny-piece. Speaking of diffraction in a microscope, the author said little doubt need exist as to whether an image represented the real object or a diffraction modification thereof, for the latter were usually of a more misty and complicated character. Departing somewhat from the subject of diffraction, an excellent photograph of conically refracted pencils was shown, consisting of circular lines of light produced by passing light from pinholes through a crystal of arragonite. Dr. Johnstone Stoney thought the obtaining of permanent records of diffraction phenomena of great importance, and was particularly interested in the photograph showing conical refraction. Prof. S. P. Thompson said he had never seen diffraction effects exhibited to an audience so well before. He had noticed that in several of the photographs Arago's spot was unintentionally shown to perfection in the shadow of dust particles. The President greatly appreciated the fact that the conical refraction photograph had been exhibited for the first time before the Physical Society.—A note on a new photometric method and a photometer for same, was read by Mr. J. B. Spurge. The method consists in using two diffusing screens (illuminated respectively by the lights to be compared) as secondary sources, and adjusting to equality the luminosity of equidistant internal surfaces by varying the apertures through which the light passes from the screens to those surfaces. By reducing the sizes of the apertures the author has been enabled to compare lights of different colour, for when of sufficiently feeble intensity coloured lights are indistinguishable from white or grey. The photometer is made up of two tubes mounted at 45° to an axis, about which one of them is capable of rotating. When in the same horizontal plane, the axes of the tubes form the sides of an isosceles right-angled tr angle, at the middle of whose hypothenuse the light to be tested is placed; this illuminates one of the screens, whilst the standard light shines on the other. These screens, used as secondary sources, are situated a short distance away from the outer ends of the tubes, whilst the inner surfaces of the near ends of the tubes are viewed by means of a mirror. By turning the movable tube about the inclined axis, and rotating the source about a vertical axis, the illuminating effect of the source in any direction can be tested. Capt. Abney said the law of inverse squares was not true for weak lights, for the proportions in which the light from sources of equal intensity had to be reduced to appear white or grey depended greatly on the colour; being much greater for violet than for red. Only for the yellow-green rays was the ordinary law of illumination true when the intensities were feeble. Mr. Blakesley, Prof. S. P. Thompson, and the President also took part in the discussion.

**Geological Society**, January 24.—W. H. Hudleston, F.R.S., President, in the chair.—The ossiferous fissures in the valley of the Shode, near Ightham, Kent, by W. J. Lewis Abbott. The fissures occur in a promontory of Kentish Rag between two tributaries of the Shode. There are four fissures in this promontory, striking at right angles to the valley. Details of the physiography of the area in which the fissures occur are given in the paper. Three of the fissures have obviously been in contact with the surface, and from these the bones appear to have been dissolved out. The fourth does not reach the top of the Rag, and further is sealed by an arragonite-lined chamber with stalactitic floor and ceiling. This fissure is from 2 to 6 feet wide and about 80 feet deep, and is filled with a heterogeneous collection such as constitutes the flotsam and jetsam of streams, along with materials derived from the rock in which the fissures occur. Several thousand bones were found, also twelve species of aquatic and land shells, an entomostracan, *Chara* and other vegetable remains have been procured. The author gave reasons for concluding that the fissures have never been reopened since they were first closed by the materials introduced into them by the river, and that all the contained fossils belong to one and the same geological period. He pointed to the discovery of species not before found in Pleistocene beds as only a repetition of what has occurred in other sections he had worked, and remarked also that the increase of species was corroborative of a suggestion of Mr. C. Reid that the more we discover of the smaller creatures of this and the preceding age, the more they approximate to those of our own times. Even if we were to exclude from the lists all the species not previously found fossil elsewhere, we still have an extensive assemblage of the older Pleistocene forms, which must have lived during the filling of the fissures, and this therefore fixes the filling operation as having occurred in Pleistocene times.—The vertebrate fauna collected by Mr. Lewis Abbott from the fissure near Ightham, Kent, by E. T. Newton, F.R.S. The vertebrate remains collected by Mr. Lewis Abbott have been passed in review by Mr. Newton, and as far as possible specifically identified: they represent mammals, birds, reptiles, and amphibians; but no fishes have been found. In all, 48 different forms have been recognised; 3 or perhaps 4 are extinct; 11 are extinct in Britain, but are still living elsewhere; 21 are living in Britain, but are known to be Pleistocene or forest-bed forms; and 12 are species now living in Britain which have not hitherto been recognised in Pleistocene or older deposits. Among the more important species found in this fissure, but extinct in Britain, may be noticed, besides *Elephas primigenius*, *Rhinoceros antiquitatis*, and *Hyæna*, the *Ursus arctos*, *Canis lagopus*, *Myodes torquatus*, *Myodes lemmus*, *Microtus gregalis*, *M. ratticeps*, *Lagomys pusillus*, *Spermophilus*, and *Cervus tarandus*. The name of *Mustela robusta* was proposed for some limb-bones intermediate between the polecat and marten, and the remains of an extremely small weasel are noticed as a variety of *Mustela vulgaris*. Although the large number of living species gives a recent aspect to this series of remains, the evidence, it is believed, points rather to their being all of Pleistocene age, and most nearly allied to the fauna of British caves. In the course of some remarks upon the paper, Mr. Topley compared the fissures filled with loam and gravel, and containing mammalian bones and land-shells, of the Maidstone district with the interesting example described, and explained that those of the Maidstone Rag country were connected with overlying deposits of drift, the material now filling the fissures having been let down into the rock by solution of the limestone along joints and cracks. Sir Henry Howorth and Dr. Henry Hicks also spoke, and Mr. E. T. Newton briefly replied.

PARIS.

**Academy of Sciences**, January 29.—M. Lœwy in the chair.—An account of the work of A. Scacchi, by M. Des Cloizeaux.—Integration of the equation of sound for an indefinite fluid in one, two, or three dimensions, when there are different resistances to the movement; physical consequences of this integration, by M. J. Boussinesq.—On the propagation of an electric current in a particular case, by M. A. Potier.—Anomalies in the force of gravity observed on the North American Continent, by M. Defforges. The value of $g$ for a number of stations between Washington and San Francisco is as follows:—Washington 980·167, Montreal 980·729, Chicago 980·345, Denver 979·684, Salt Lake City 979·816, Mt. Hamilton 979·683, and San Francisco 980·016. These values, reduced to sea-level and compared with the theoretical values calculated from Clairaut's law, show regular anomalies which are compared with anomalies exhibited by oceanic islands.—Theory of the elasticity of metals, by M. Félix Lucas.—On the new measurement of the area of France, by General Derrécagaix. A planimeter measurement, calculated on the assumption that the figure of the earth is a true ellipsoid of revolution. Supplementary remarks were made by M. E. Levasseur.—On the rapid summation of certain slightly convergent series (alternate harmonic series), by M. A. Janet.—On a common property of three particular classes of rectilinear congruences, by M. Alphonse Demoulin.—Joule's and Mariotte's laws in connection with existing gases, by M. Jules Andrade. The author shows that these laws are true for real gases within about the same limits of accuracy.—An electric alarm thermometer for laboratory ovens, by M. Barillé. Connection of an electric circuit is made when the mercury in the thermometer reaches a determined point on the scale by means of a platinum wire which is attached to a small iron tube (sliding along a fixed wire), of which the position can be regulated by a magnet attached to the supporting frame.—On synthesised borneols, by MM. G. Bouchardat and J. Lafont.—Thermal constants of some polyatomic bases, by MM. Albert Colson and Georges Darzens. For *ethylene-diamine* the observed values were :—Specific heat 0·84 between 12° and 45° ; heat of solution +7·6 cal. for 1 mol. in 4 litres of water at 15° ; heat of neutralisation +23·54 cal. (1 mol. normal salt in 5 litres of water) ; heat of solution of the normal chloride −7·55 cal. for 1 mol. in 4 litres of water. For quinine, observations gave :—Heat of solution for 1 mol. of $Q.SO_4H_2.6H_2O$ dissolved in 12 litres of water containing 1 mol. $H_2SO_4 = -6·7$ cal.; heat of neutralisation +15·5 cal. for freshly precipitated quinine.—On the adaptation of the alcoholic ferment to the conditions of living in media containing hydrofluoric acid, by M. E. Sorel. The lactic acid ferment is destroyed by the addition to the mash of a small quantity of hydrofluoric acid, and the yield of alcohol correspondingly increased. By cultivation in presence of increasing quantities of hydrofluoric acid the resisting properties of the alcoholic ferment may be considerably increased.—On the relation of the palisade tissue of leaves to transpiration, by M. Pierre Lesage. The palisade tissue appears to function as a means of protecting the leaves from excessive transpiration.—Main lines indicating directions of folds and contortions in the geology of France, by M. Marcel Bertrand.—On the composition of some calcareous marls, by M. H. le Chatelier.—On the forms of platinum in its bed rock, from the Ural district, by M. A. Inostranzeff.—On the age of the human skeleton discovered in the eruptive formation of Gravenoire (Puy-de-Dôme), by MM. Paul Girod and Paul Gautier.

BERLIN.

**Physical Society**, Dec. 15, 1893.—Prof. du Bois Reymond, President, in the chair.—Dr. A. du Bois Reymond spoke on Lilienthal's experiments on flying. As a starting-point he had chosen the study of the flight of birds, which may be divided into three distinct kinds—flapping, steering, and soaring. Of these the one demanding least expenditure of energy is soaring, and investigation showed that under certain conditions flight is possible if the wind possesses a vertical component. Experiments showed that surfaces can acquire a horizontal motion by the action of the wind only, when their curvature bears a certain relation to their superficies, and that this relation corresponds exactly to that which is observed in the wings of birds. Dr. Lilienthal's flying machine consists of a correctly curved surface whose area is 14 square metres, made by stretching linen over a light wooden frame, and having a weight of about 20 kilos. In its centre is an aperture for the experimenter's body, and the apparatus is held in position by the person's arms. On running rapidly down a gentle slope of a hill against the wind, the latter soon acquires a vertical component, which then carries the flying apparatus and propels it in a direction against the wind. The speaker had seen Dr. Lilienthal sail over a space of about 120 metres, at an altitude of some 30 metres, in a minute ; with a favourable wind it was possible to cover some 200 to 500 metres, and Dr. du Bois Reymond had himself taken leaps through the air of 20 to 30 metres under similar conditions. He was of opinion that by practice far better results may be obtained as regards soaring, and that then, by combining steering with soaring, it will be possible to fly even when the wind is unfavourable. It appears that the three essentials for the solution of the problem of flight are (1) correct utilisation of the wind ; (2) the correct shape of the supporting surfaces, and (3) correct handling of the apparatus.—Herr Haensch explained three different models of Nicol prisms, of which Glans' showed itself to be best as regards construction and efficiency.

January 5.—Prof. Kundt, President, in the chair.—Dr. Lummer gave a detailed account of the experiments he had made, before his journey to Chicago, on Siemen's and on Violle's unit of light. Both of these must be rejected as standard-units in cases where the platinum is melted in the blowpipe flame. Experiments made to establish the Violle unit by means of an electric current showed that in this case there were variations of from 10 to 12 per cent., which made it unsuitable as an absolute standard of light. Hefner's amylacetate lamp, which the speaker had been examining during the last four years, gives a unit which varies only by some 3 or 4 per cent. as long as the necessary conditions are strictly observed and allowance is made for varying meteorological conditions which affect the lamp. It appears, therefore, that a really reliable unit of light has still to be found.

January 19.—Prof. Kundt, President, in the chair.—Prof. Hale, of Chicago, exhibited and explained his lantern-slides of solar photographs.—Prof. Neesen communicated on behalf of Herr van Aubel, of Brussels, the latter's method of silvering aluminium. It consists in cleaning the plate of aluminium with benzol, then dipping it into a solution of sulphate of copper until a thin film of copper is formed on its surface. At this stage a layer of silver is deposited electrolytically on the plate. Prof. Neesen had found that the layer of silver thus formed does not adhere very firmly to the aluminium.

## BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—A Students' Text-Book of Botany : Dr. S. H. Vines, first half (Sonnenschein).—Johnston's Elements of Agricultural Chemistry, revised by C. M. Aikman, 17th edition (Blackwood).—Optical Experiments, revised and arranged after the directions of Dr. H. Zwick (Newmann).—The Inventions, Researches, and Writings of Nikola Tesla : T. C. Martin (New York, *Electrical Engineer* Office)—Electricity in the Service of Man : Dr. R. Wormell, revised and enlarged by Dr. R. M. Walmsley (Cassell).—A Text-book of Euclid's Elements : H. S. Hall and F. H. Stevens, Books 2 and 3 (Macmillan).—Pain, Pleasure, and Æsthetics : H. R. Marshall (Macmillan).—Primer of Philosophy : Dr. P. Carus (Chicago, Open Court Publishing Co.).—The Religion of Science : Dr. P. Carus, extra edition (Chicago, Open Court Publishing Co.).—Investigations on Microscopic Forms and on Protoplasm : Prof. O. Bütschli, translated by E. A. Minchin (Black).—Congrès Internationaux d'Anthropologie et d'Archéologie préhistorique et de Zoologie à Moscou, Matériaux, Deux Partie (Moscou). Two Great Scotsmen the Brothers William and John Hunter : Dr. G. R. Mather (Glasgow, J. Maclehose).

PAMPHLETS.—Report of J. P. Langley, Secretary of the Smithsonian Institution, for the year ending June 30, 1893 (Washington).—Seventh Annual Report of the Liverpool Marine Biological Committee and their Biological Station at Port Erin : Prof. Herdman (Liverpool, Dobb).—Über ein Interferenzrefractometer : L. Mach (Wien).—Physical Constants of Thallium : W. H. Steele (Melbourne).—A New Thermoelectric Phenomenon : W. H. Steele (Melbourne).—On the Conductivity of a Solution of Copper Sulphate : W. H. Steele (Melbourne).—Sulle Perturbazioni Magnetiche dell' Agosto 1893, &c. : Dr. L. Palazzo (Roma).

SERIALS.—Bulletin de l'Académie Royale des Sciences de Belgique, 63e Année, No. 12 (Bruxelles).—Dictionary of Political Economy, sixth part (Macmillan). Natural Science, February (Macmillan).—Botanical Gazette, January (Madison, Wis.). Proceedings of the Society for Psychical Research, January (K. Paul).—L'Anthropologie, Tome iv. No. 5 (Paris, Masson).—Geological Magazine, February (K. Paul).—Quarterly Journal of the Geological Society, Vol. l. part 1, No. 197 (Longmans).—Bulletin of the New York Mathematical Society, January (New York, Macmillan).—American Naturalist, January (Philadelphia).

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