THURSDAY, APRIL 30, 1903.

RADIUM.

THE discovery by Monsieur and Madame Curie that a sample of radium gives out sufficient energy to melt half its weight of ice per hour has attracted attention to the question of the source from which the radium derives the energy necessary to maintain the radiation; this problem has been before us ever since the original discovery by Becquerel of the radiation from uranium. It has been suggested that the radium derives its energy from the air surrounding it, that the atoms of radium possess the faculty of abstracting the kinetic energy from the more rapidly moving air-molecules while they are able to retain their own energy when in collision with the slowly moving molecules of air. I cannot see, however, that even the possession of this property would explain the behaviour of radium; for imagine a portion of radium placed in a cavity in a block of ice; the ice around the radium gets melted; where does the energy for this come from? By the hypothesis there is no change in the energy of the air-radium system in the cavity, for the energy gained by the radium is lost by the air, while heat cannot flow into the cavity from outside, for the melted ice around the cavity is hotter than the ice surrounding it.

Another suggestion which has been made is that the air is traversed by a very penetrating kind of Becquerel radiation, and that it is the absorption of this radiation that gives the energy to the radium. We have direct evidence of the existence of such radiation, for McClennan and Burton have recently shown that the ionisation of a gas inside a closed vessel is diminished by immersing the vessel in a large tank full of water, suggesting that part, at any rate, of the ionisation of the gas is due to a radiation which could penetrate the walls of the vessel, but which was stopped to an appreciable extent by the water. To explain the heating effect observed with radium, the absorption of this radiation by radium must be on an altogether different scale from its absorption by other metals. As no direct experiments have been made on radium, it is possible that this may be the case; it is not, however, what we should expect from the experiments which have been made on the absorption of this radiation by other metals, for these experiments have shown that the absorption depends solely upon the density of the absorbing substance, and not upon its chemical nature or physical state; if this law hold for radium, the absorption by it would be on the same scale as the absorption by lead or gold, and altogether too small to explain the observed effects. We are thus led to seek for some other explanation. I think that the absence of change in the radium has been assumed without sufficient justification; all that the experiments justify us in concluding is that the rate of change is not sufficiently rapid to be appreciable in a few months. There is, on the other hand, very strong evidence that the substances actually engaged in emitting these radiations can only keep up the process for a short time; then they die out, and the subsequent radiation is due to a different set of radiators. Take, for example, Becquerel's experiment when he precipitated barium from a radio-active solution containing uranium, and found that the radio-activity was transferred to the precipitate, the solution not being radio-active; after a time, however, the radio-active precipitate lost its radio-activity, while the solution of uranium regained its original vigour. The same thing is very strikingly shown by the remarkable and suggestive experiments made by Rutherford and Soddy on thorium; they separated ordinary radio-active thoria into two parts, transferring practically all the radio-activity to a body called by them thorium X, the mass of which was infinitesimal in comparison with that of the original thoria; the thorium X thus separated lost in a few days its radio-activity, while the original thoria in the same time again became radio-active. This seems as clear a proof as we could wish for that the radio-activity of a given set of molecules is not permanent. The same want of permanence is shown by the radio-active emanations from thorium and radium, and by the induced radio-activity exhibited by bodies which have been negatively electrified and exposed to these emanations or to the open air; in all these cases the radio-activity ceases after a few days. I have recently found that the water from deep wells in Cambridge contains a radio-active gas, and that this gas, after being liberated from the water, gradually loses its radio-activity; the radio-activity of polonium, too, is known not to be permanent.

The view that seems to me to be suggested by these results is that the atom of radium is not stable under all conditions, and that among the large number of atoms contained in any specimen of radium, there are a few which are in the condition in which stability ceases, and which pass into some other configuration, giving out as they do so a large quantity of energy. I may, perhaps, make my meaning clearer by considering a hypothetical case. Suppose that the atoms of a gas X become unstable when they possess an amount of kinetic energy 100 times, say, the average kinetic energy of the atoms at the temperature of the room. There would, according to the Maxwell-Boltzmann law of distribution, always be a few atoms in the gas possessing this amount of kinetic energy; these would by hypothesis break up; if in doing so they gave out a large amount of energy in the form of Becquerel radiation, the gas would be radio-active, and would continue to be so until all its atoms had passed through the phase in which they possessed enough energy to make them unstable; if this energy were 100 times the average energy it would probably take hundreds of thousands of years before the radio-activity of the gas was sensibly diminished. Now in the case of radium, just as in the gas, the atoms are not all in identical physical circumstances, and if there is any law of distribution like the Maxwell-Boltzmann law, there will, on the above hypothesis, be a very slow transformation of the atoms accompanied by a liberation of energy. In the hypothetical case we have taken the possession of a certain amount of kinetic energy as the criterion for instability; the argument will apply if any other test is taken.

It may be objected to this explanation that if the rate at which the atoms are being transformed is very slow, the energy liberated by the transformation of a given number of atoms must be very much greater than that set free when the same number of atoms are concerned in any known chemical combination. It must be remembered, however, that the changes contemplated on this hypothesis are of a different kind from those occurring in ordinary chemical combination. The changes we are considering are changes in the configuration of the atom, and it is possible that changes of this kind may be accompanied by the liberation of very large quantities of energy. Thus, taking the atomic weight of radium as 225, if the mass of the atom of radium were due to the presence in it of a large number of corpuscles, each carrying the charge of $3 \cdot 4 \times 10^{-10}$ electrostatic units of negative electricity, and if this charge of negative electricity were associated with an equal charge of positive, so as to make the atom electrically neutral, then if these positive and negative charges were separated by a distance of 10^{-8} cm., the intrinsic energy possessed by the atom would be so great that a diminution of it by 1 per cent. would be able to maintain the radiation from radium as measured by Curie for 30,000 years.

Another point to be noted is that the radiation from a concentrated mass of radium may possibly be very much greater than that from the same mass when disseminated through a large volume of pitch blende; for it is possible that the radiation from one atom may tend to put the surrounding atoms in the unstable state; if this were so, more atoms would in a given time pass from the one state to the other if they were placed so as to receive the radiation from their neighbours than if they were disseminated through a matrix which shielded each radium atom from the radiation given out by its neighbours.

J. J. THOMSON.

ENTROPY.

The Thermodynamics of Heat Engines. By Sidney A. Reeve, Professor of Steam-Engineering at the Worcester Polytechnic Institute (U.S.A.). Pp. xiv+316 +42. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 10*s*. 6*d*. net.

THIS is a very good specimen of that sort of book which is an amplification of the lecture notes of a professor who has carefully prepared problems for students. We may not always like the way in which he introduces the subject to his pupils, and we may say that it is unphilosophical and even cryptic, and sometimes too brilliant, but such comments are often due to the fact that his way happens not to be the usual way of presenting the subject. The way of Prof. Reeve probably suits his particular class of unscientific pupils very well. He uses terms in senses somewhat different from those in common use. He is absolutely correct in many statements with which we would willingly find as much fault as Macaulay did with those of Robert Montgomery. For example:—

"The universe is eternal. In the face of its steadfast continuity man's momentary existence and evanescent will are as cloud-wreaths against a mountain side."

We do not know why it should be thought necessary when an engineer is presenting the usual useful application of the known laws of thermodynamics that he should introduce it in thirty-six pages of this style of writing.

When the author comes to the actual problems which may be worked out by a simple application of the t,ϕ diagram, he is a fairly safe guide to the student, although here and there we should have liked him to point out on what assumptions he is working.

Perhaps readers of NATURE will allow us to give a short description of the way in which even elementary engineering students are now able to solve what used to be considered very difficult problems.

We assume that at any instant a pound of stuff is all at the same pressure p and temperature t, and that it has a volume v. There is some law connecting p, v and t so that any two of these three will define the state of the stuff. During any infinitely small change of state, the stuff gives out mechanical energy or does work $p.dv$ if dv is its change of volume; let it receive the heat energy dH. Stating all energy in the same units, the net gain of energy by the stuff during the change is $dE = dH - p.dv$. This E is called the intrinsic energy of the stuff. We assume that there is no other kind of energy to be given to or taken from the stuff than heat and work. The first law of thermodynamics states that, if stuff is carried through a cyclic change and is brought back to its original state, the integral of dH is equal to the integral of $p.dv$, and E comes back to its original value. The integral of dH is not zero, the integral of the work $p.dv$ is not zero, but the integral of dE is zero. The gain of intrinsic energy in a closed cycle is zero. The second law of thermodynamics is that if we divide dH by t the absolute temperature (on a perfect gas thermometer) of the stuff and call dH/t a gain $d\phi$ of entropy, then the integral of $d\phi$ in a complete cycle is zero.

The mathematical statements of the first and second laws of thermodynamics are, therefore:—E and ϕ are properties of the stuff which are known if the state of the stuff is known. Or, dE and $d\phi$ are complete differentials.

Thus in any state of 1 lb. of stuff we know its

$$p, v, t, \text{E and } \phi,$$

and (except during change from solid to liquid, or liquid to vapour, when p and t are not independent) any two of these five enable all the others to be calculated. Hence, graphically, a diagram showing how any two of them alter, is a diagram which completely defines the changing stuff. This has been known ever since Rankine and Clausius discovered the second law of thermodynamics. It is owing to Mr. McFarlane Gray's persistency in advocating the use of the ϕ,t diagram in conjunction with the p,v diagram that engineering students are able so easily to work problems, especially in stuff which is in the liquid-vapour condition.

Since work is $p.dv$, the area of a p,v diagram represents the work done in any small or large change of state. Since $dH = t.d\phi$, the area of a t,ϕ diagram represents the heat received. If students have the use of two blackboards on which they can, without trouble, show by the coordinates of a point the p and v or the t and ϕ of a pound of stuff, the whole thermodynamic conditions are known. If the state of a pound of any kind of stuff is given in any way, it is good to be able quickly to show it by a point either on the p,v or on the t,ϕ diagram. Therefore these blackboards have equi-pressure and equi-volume curves permanently marked upon them. Thus on a *water stuff* blackboard a student can mark in chalk, without any trouble, such points as these :—

(1) A pound of water steam, 80 per cent. water, 10 per cent. steam at a pressure of 80 lb. per square inch.

(2) A pound of water steam at 80 lb. per square inch, its volume being 3 cubic feet (the volume of the part which is water is neglected).

Or he can quickly work such exercises as these :—

(3) The stuff of (2) is cooled at constant volume to 30 lb. per square inch, show how it changes its state; find the heat abstracted.

(4) The stuff of (2) is expanded adiabatically, make a table showing its p and v at every instant and draw a p,v diagram showing the adiabatic expansion. State the dryness of the stuff at each point.

But why go on? It is evident that with such a board, with chalk and a sponge an experimenter can work the most interesting problems. He sees at once the thermodynamic inefficiency when heat is given to boiler feed water; the small thermodynamic efficiency of superheating; the wetting effect of expansion of dry steam; the drying effect of expansion on very wet steam; the heat given and the work done in any change of state.

We have found that this practice with blackboards leads to the most exact quantitative and practical knowledge of what goes on in heat engines. But the student must really state the answers as to heat and work exactly, the scales to which energies are represented being familiarly known. After a little practice, the ghostly quantity entropy gets to be as well known as electrical potential now is to experimenters—in 1868 it was merely a mathematical expression to most students, just as entropy now must remain to anybody who will not experiment.

An indicator diagram shows the pressure and the travel of the piston, and therefore we may say, the volume displaced behind the piston, but we do not call it a p,v diagram. Its value in enabling the indicated horse-power to be calculated, in telling how the valves and passages perform their duties, is, as we know, very great. But when we desire to use it in our study of the thermodynamics of the engine, we must first endeavour from our other measurements to find out how much stuff, water-steam or air or other gaseous mixture, is undergoing the changes of pressure and volume which are recorded. We must also know the actual volume of the stuff at every instant, and we get this by adding the volume of the clearance. We can now draw a p,v diagram, but it is not sufficiently noticed by students that it is only on certain assumptions being made that we can study the p,v diagram for a whole cycle of operations. For example, in a gas engine cylinder, we can draw the p,v diagram from the beginning of the compression, through the ignition and expansion parts until the exhaust valve opens, on the assumption that there has been no leakage past valves or piston. The p,v diagram of all the rest of the cycle is drawn on the assumption that something which is really occurring elsewhere is occurring in the cylinder itself. We consider that in the hands of elementary students the assumed p,v diagram for all other parts of the cycle may be very misleading. Unfortunately, it is seldom that one finds an author who is careful to explain these assumptions, which, when clearly understood, do enable most valuable calculations to be made. The idea underlying a p,v diagram is that any point shows the p and v of a certain quantity, say a pound, of the stuff. That is, it is all at a certain p. But during release, part of it is at one p and part at another, and during release, therefore, to speak of a p,v diagram is absurd. The assumption on which we usually proceed is that we shall let the area of what we call our p,v diagram represent the work done upon the actual piston.

Again, in a steam engine cylinder we can draw the real p,v diagram from cut off to release. All the rest of the cycle is drawn on the above assumption as to work. In drawing the t,ϕ diagram we assume that the stuff is all at the same temperature at any instant and every point on this diagram corresponds without ambiguity with a point on the p,v diagram, but it is on the assumption that we do actually know the weight of stuff we are dealing with. Given any p,v diagram for a given quantity of any kind of stuff, one, and only one, t,ϕ diagram can be drawn. The p,v diagram shows by its area the work done in every change, the other shows the heat given to the stuff in every change; the net area of any closed part of the one is equal to the net area (taking the same units for heat and work) of the corresponding closed part of the other.

It will be found that every engineer who has published speculations based on such diagrams has really kept in his recollection the assumptions on which they are drawn, but it seems a pity that for the sake of elementary students they should not specifically discuss these assumptions.

In refrigerating machines, in gas and oil engines, there is probably greater equality of temperature throughout the mass of stuff at each instant than there is in the water-steam of a steam engine cylinder. The state of things inside a steam engine cylinder is very complex on this account, but the p,v and t,ϕ diagrams, although based upon simple assumptions, really do lead us a long way in our study of what happens.

All engineering calculation is based on simple assumptions; the engineer knows that real problems are very much more complicated than any such assumptions suggest, and that experience and wisdom are needed by all men who are going to make use of such calculations. There are foolish men and foolish books which give students the notion that the simple assumption represents truly the real case, but the true engineering student soon emancipates himself from such pedantry. The student who does not believe in the worth of any kind of calculation or consideration of what is going on in the cylinder is in a permanently worse state, however, than even the unemancipated pedant. Whether he reaches this position through disgust or because he has never made any attempt to compute, it may be premised that he is, or is destined to be, a child of Gibeon. When he says he is *designing* a new engine, he means that he is copying an old engine, introducing changes in detail which may or may not be for the worse. Consciousness of his degraded condition causes him to inveigh continually against all knowledge (or, as he calls it, *theory*); all power to compute beyond that which is possessed by the housekeeper. To the man who practises the use of the t,ϕ diagram, exercising his common sense, bringing all his other experience to bear, the thermodynamics of heat engines is revealed as it can be revealed in no other way. What is the p,v adiabatic for any kind of wet or dry or superheated steam with any initial pressure? How small is the thermodynamic value of superheating, and how great is its value in giving a dry cylinder? What is the exact benefit of using high pressure steam? In what directions are we to work in gas and oil engines, distinguishing between efficiency as to energy and efficiency as to total money values? Compare the commercial values of ammonium anhydride and air as the stuff to be used in refrigerating machinery. It is really wonderful to see how a man almost illiterate, innocent of algebra, can use his t,ϕ diagram of water-steam or air or ammonium anhydride, obtaining in a few minutes answers to problems which the mathematical engineers of twenty years ago spent days in solving. We know men who pet and fondle their slide rules, but the delight of these men is nothing to that of the men who make a daily companion of their t,ϕ diagram.

It is sometimes asked, During a change in which the p or t is not the same for the whole of the stuff; we can calculate the ϕ at the beginning and end, can we speak of its value in the intermediate states?

Now we know of no practical problem in which there is need to speak of ϕ in the intermediate states; ϕ, as carefully defined for the whole stuff, has no meaning during the change any more than p or v or t. In the case of a perfect gas allowed to expand freely without doing work, say, to twice its volume, the vessels being non-conducting, a true p,v diagram of the change cannot be imagined, and a true t,ϕ diagram cannot be imagined. If, however, we are allowed to assume, as is usual, that kinetic energy in a gas is heat, it is probable that if for every infinitely small portion of stuff we find the heat received by it dH at the temperature t, then $d\mathrm{H}/t$ for this small portion is a complete differential, and is its entropy, and the sum of all the entropies of all the small portions may be called the entropy of the whole stuff at each instant, although this is outside the definition. From this point of view we may speak of the entropy of the whole as changing continuously from the initial to the final condition. It was no doubt from this point of view that Clausius, in the only place in which he speaks of entropy of a system in which the temperature is not the same throughout, said "the entropy of the universe tends to a maximum." However, it would seem that it is dangerous to go outside the actual definition in our use of the word entropy for the whole of the stuff, and if so we had better say that, as we cannot speak of the p or t of the stuff during such a change as having any meaning, so we ought not to speak of its ϕ as having any meaning. Stuff carried cyclically through the same series of changes over and over again, like water in a steam engine or ammonium anhydride in a refrigerator, returns again and again to its original ϕ; passes every cycle through the same changes of ϕ.

Unpractical people, that is, people who dislike exact computation, occasionally exhibit annoyance when they are told that they cannot understand how to use the idea of entropy without a little study. This study may be mathematical or experimental, or better, both. If a non-mathematical person will accept in faith a few statements such as will enable him to perform exact computations with a t,ϕ diagram, it is astonishing how soon he can understand everything. This is how the late Mr. Willans was enabled to effect his great improvements in the steam engine. But the unpractical person who is not mathematical and refuses to experiment with diagrams makes the assumption that entropy is something he already knows about under some different name—it is some form of energy or a force or a pudding—and he writes great nonsense about teachers and writers on thermodynamics. If he is not quite ignorant he is more dangerous, for he speaks of the entropy of a quantity of heat in a furnace of a boiler, and traces the entropy of this heat as it passes to the condenser of a steam engine. Just as we say that two and three are not six, or that the world is not flat, so we say that to speak of the entropy of a quantity of heat is to talk nonsense exactly analogous with the volume of a quantity of work. We have exactly the same right to speak of the pressure or volume of a quantity of heat as of its entropy. We can easily speak of the total work obtainable in a perfect engine from a quantity of gas at high temperature in a furnace. We can also see how the energy received by it from fuel might have been received in a very much better way if it is to be made available for the doing of work in a perfect engine. All such problems are quite familiar to anyone who uses the t,ϕ diagram. It is Dr. Diesel's way of looking at this latter problem which is now so interesting. The heating and cooling of stuff must be performed by adiabatic compression and expansion. All heat must be given to the stuff at the highest temperature; all heat taken away at the lowest temperature. Not only is this quite clear to users of the t,ϕ diagram, but a thing of more importance—the practical need for departure from these perfect thermodynamic conditions in actual engines.

Thermodynamic efficiency is one thing, the efficiency of which we speak when we think of the commercial cost of large cylinders doing on the whole only a small amount of useful work, that is another thing. It is an excellent exercise for a physics student to assume that all energy is not equally valuable; thus, in an ordinary gas engine cycle, or that of the Diesel engine, let him assume that when energy has been given up to a crank shaft, and we now expend it in compressing the stuff in a pump, that each unit of it is five or ten times as *valuable* as mere heat energy; it is astonishing how much clearer his notions become concerning real practical efficiency of an engine. He is getting acquainted with the fact that all the problems of the engineer are much more complicated than those of the physicist or mathematician.

JOHN PERRY.

VERTEBRATE MORPHOLOGY.

Vergleichende Anatomie der Wirbelthiere, mit Berücksichtigung der Wirbellosen. Von Carl Gegenbaur. Vol. ii. Pp. viii + 696. (Leipzig: Engelmann, 1901.) Price 20s.

THE aged master and founder of modern comparative anatomy has completed his life's task, and he has retired from the busy world. The results of half a century's active research and incessant thought are embodied in his "Vergleichende Anatomie der Wirbelthiere," of which the second volume deals with the alimentary and respiratory, vascular and urinogenital organs. The plan of the work now needs no further comment;[1] it is the same as that of the first volume. Short, extremely condensed accounts of invertebrate conditions form a kind of introduction to each chapter, which then deals with the Vertebrata to a very full extent, certainly much more fully than any other general and comprehensive book.

On the whole, the present volume is more up-to-date. Naturally so, since the bulk of it has been written within the last few years, and the author was able to dismiss for ever from his mind the vast amount of matter embodied in the first volume. The whole stupendous work, about 1500 closely printed pages and nearly 1000 text-figures, will give an everlasting impetus to vertebrate morphology. Not only is there deposited in it an enormous amount of anatomical descriptive detail, not only is it full of grandly conceived ideas, but new lines of further inquiry are laid down plainly, with cautioning against lurking pitfalls. It contains all the features of a text-book in the true sense of the word. It is a guide how to study morphology. And still this grand work, although hailed with delight on its first appearance, is not exactly liked or loved. On the contrary, many of its readers are disappointed. Those who expected that the book would be a revelation of the whole of animal morphology would do well to take to heart the author's repeatedly emphasised confession, "dass wir in den meisten Fragen erst am Anfang der Erkenntniss stehen." We, who know little, demand a final solution, where the master himself, after his own dissections and having criticised the conflicting statements of other workers, is satisfied with opening out entirely new vistas which widen the problem. Examples of this are the chapters dealing with the tongue, palate and epiglottis, wherein are embodied some of the author's latest original researches.

[1] See review of vol. i., NATURE, December, 1898.

But there are several drawbacks which seriously detract from the value of the book as a readily accessible source of information; it is so difficult to understand. Every great writer has his own style, and that of our author is involved and heavy; there are hundreds of sentences the deep and sound sense of which does not reveal itself without much painful interpretation. This is felt and frequently admitted also in Germany. One of his foremost disciples, however, has written an indignant protest against this charge; the apologist points out that the subject-matter itself is difficult, that such a text-book must necessarily stand on another level than a novel, and that Goethe or Kant are likewise not always easy reading, &c.! Well, there are, and will be, many good morphologists and German scholars who will misunderstand our author, and that through no fault of their own. However serious and annoying, this defect of the book is a matter of form.

A much graver consideration is the following. The author begins a chapter with a continuous, needless to say logically coherent exposition of the structure, modifications, the phylo- and ontogenetic development of certain organs, and his own leading view appears clear and convincing until, without warning, he contradicts himself in what he has laid down previously, perhaps in some other chapter. Or worse still, there follow long passages in small print containing another hypothesis or new facts the merits of which are put so forcibly that the reader cannot doubt that this must, after all, be the view preferred by the author. In many of these cases only one interpretation can be right, but the text goes on as if no amendment had been carried. Frequently this upsetting mode of treatment is obviously due to more recent additions or interpolations. Of course, a fair-minded author gives every tenable hypothesis, and if he then states that the solution is not yet final, no more remains to be said. This our author does often, even as a rule, but not always, and, therefore, the exceptions are all the more jarring. *Jurare in verba magistri* may be a sign of unscientific weakness or laziness, but we have a right to learn the views of an acknowledged master.

But let us proceed from generalisations to crucial points.

Origin of Vertebrata.—The transformation of the anterior cephalic portion of the alimentary canal into a respiratory chamber is predominant in, and typical of, the Vertebrata. Resemblances in the formation of such a chamber, first and faintly indicated in Cephalodiscus, carried further in Enteropneusta and Tunicata, do not mean near relationship with the Vertebrata. Direct transitional stages are still unknown, perhaps because the creatures concerned have died out. Mouth and arms being secondary features indicate that the Vertebrata have a long ancestral history. Although Amphioxus resembles Tunicates in many respects (respiratory chamber, peribranchial cavity, hypophysis, &c.), the metamerism of its body is a feature of such importance that it forbids any closer connection of these two groups (p. 25). Thus we are told categorically that we need not look any further in this direction for the vertebrate ancestors. But in spite of this, on p. 338, the epithelial lining of the bloodvessels is spoken of "als ein erst den Tunicaten und von da den Vertebraten gewordener Erwerb." The remark on p. 25—that the origin of the Vertebrata is not quite strange to the Invertebrata, since the organisation of the former exhibits nothing absolutely new, nothing which does not crop up in some one of the other phyla—sounds rather flat, and conveys little comfort to him who is anxious to learn what the greatest authority has to say about their descent.

Lungs and Airbladders, p. 256.—Certain Selachians possess a dorsal blindsac opening into the œsophagus, perhaps the forerunner of the airbladder of other fishes. Since this diverticulum exists in Selachians only during their early life and vanishes in the adult,

"wird es als rudimentaeres Organ zu deuten sein, wobei nur fraglich bleibt, wie der ausgebildete Zustand sich verhielt, und ob es je einen solchen besessen hat."

Are here not mixed up the two opposites rudimentary and vestigial? If this organ never was in a complete, functional condition, it would be a rudiment in the sense of incipient evolution. But our author can only mean vestige or remnant.

Concerning the question of the homology of airbladders and lungs, a view still frequently advocated, we are told clearly, on p. 216, that

"from the low stage of the future lungs are derived other organs which do not yet have a respiratory function, namely, the so-called airbladders of the fishes. Consequently we do not meet with the lungs as such from their first beginning, but as air-receiving organs of other significance. Only gradually they become capable of competing with the primary respiratory organs (the gills) and are thereby turned into lungs."

But on p. 256 we are informed, upon the ground of want of proofs of the change of airbladders into lungs, that more likely the airbladders and lungs are akin to each other only in so far as both are evaginations of the gut, but that both have started very early upon opposite roads. In other words, the text is flatly contradicted by the small-printed later addition.

Gills.—On p. 239, the inner gills of the Anura are properly derived from their outer gills, a modification which has been studied by Maurer and others. On the next page, however, the outer gills of the Anura are derived, à la Boas, from the true inner gills of fishes, and on p. 341 we are told that the former, first, derivation means a gap in comparison with fishes. Of course there would be a gap, since the two statements, the first correct, the second a baseless assumption, are absolutely contradictory. This muddle could not have happened unless the small type of pp. 240-241 was a later addition to the text.

Vascular System, pp. 337-339.—The participation of the endoderm in the formation of the heart of Amphioxus is certain. Very valuable is the fact that the endoderm contributes to the vascular system, heart and vessels of certain Elasmobranchs, but it is gradually superseded by the mesoderm. It is doubtful whether the case of entirely mesodermal formation is a reversion to the original condition. Since the endodermal origin stands in opposition to what happens in almost all the bilateral invertebrates, we conclude that the change took place already in the Tunicata, viz. that endodermal growth has been acquired by them, whence the Vertebrata have taken it over. Now, having had to conclude that the endodermal origin of the vascular system of Tunicata and Vertebrata is a secondary feature, which is still preserved in but a few cases, the question arises whether the mesodermal origin is to be explained by a reversion to the original condition or whether it is (p. 339) once more (wiederum) a cænogenetic feature. We desist from answering these questions,

"da in den Thatsachen nichts geaendert wird, und durch Caenogenese auch etwas Altes entstehen kann, nach den Beziehungen die alt und neu besitzen."

He who understands the above sentence, to the exclusion of doubt, will be able to translate it.

Could the author not apply to the solution of the discrepancy the same principle of the suggestion which he makes on p. 416, apropos of

"the origin of the lymph-follicles reveals the lymph-cells as derivations of the endoderm. The primitive condition is lost in the Placentalia, not because the endoderm has handed over its function to other tissues, but because the latter have received their endodermal share at a much earlier ontogenetic period"?

Heart, p. 345.—The heart of reptiles, birds and mammals passes temporarily through the stage of a double tube. On p. 345 this is explained as an undoubtedly secondary feature, due to a special adaptation to nutritive arrangements, namely, the accumulation of foodyolk, on or in the wall of the gut. In the Mammalia the double anlage still occurs, in spite of the loss of the yolk. This is certainly an ingenious and possibly correct explanation, but the reader will miss any allusion to Elasmobranchs, with their unpaired heart-tube and great mass of yolk. He may further wonder from which class of animals the mammals have taken over this feature, if, as our author contends repeatedly, the reptiles are to be excluded from the mammalian line of descent.

Coecum and Vermiform Appendix.—On p. 171, speaking of the end-gut, he emphasises his former suggestion that the finger-shaped gland of Selachians is the forerunner of the cœcum; a complex of glands which pour their secretion by one duct into what marks the upper end of the end-gut. Such glands must necessarily have started from the endoderm, but on p. 174 we find the following perplexing statement:—

"The independence of the cœcum is (in Iguana) most strongly shown, and thereby we come to that organ which the Selachians possess as the finger-shaped gland, originally foreign to the gut-wall, but raised to permanent value by the connection with the latter."

As here expressed, this can only mean that once upon a time there existed a fluid-secreting gland in the neighbourhood of the gut, and which later on, becoming connected with the gut, laid the foundation of an important organ, the cœcum.

Excretory Organs, p. 437.—The author favours Boveri's hypothesis of the evolution of the archinephric duct, but with an almost fundamental modification. However, this explanation, being inapplicable to Cyclostomes, leads to new difficulties and further doubts, which partly undo what has been elaborated just previously.

H. Gadow.

THE WORK OF MARIGNAC.

Œuvres complètes de J. C. Galissard de Marignac. Tome ii., 1860–1887. Pp. 839. (Paris: Masson and Co., n.d.)

It is by no means an easy task to give an intelligible account of the labours of such an industrious and versatile worker as Marignac was. An outline of his life, written by M. Ador, his son-in-law, who edits the two large volumes of his republished work, has already been noticed in these columns. It now remains to deal with his researches, of which only a sketch has previously been given.

The three main lines of investigation treat of (1) the rare metals of their compounds, (2) crystallographic measurements, and (3) thermal chemistry. Under the first heading, we find memoirs on beryllium, lanthanum, didymium, yttrium, erbium, niobium, tantalum, "ilmenium," zirconium, mosandrum, and ytterbium, the last a discovery of his own. The final article in the book, published in 1887, is a criticism of Sir William Crookes's paper "On the Genesis of the Elements"; Marignac is not disposed to accept the interpretation which Crookes places on the different spectra of successive fractions of "yttrium," viz., that a gradual separation of an element into parts endowed with different properties has taken place; he rather inclines to attribute the varying spectra to the accumulation at each end of fractions of impurities, each of which has the power of profoundly influencing the spectrum of the real yttrium.

The equivalents of no fewer than twenty-eight elements were determined by Marignac; and at the end of the book a comparison is made between the values found by him and the table of the International Committee of 1903. The correspondence between the two is very striking; indeed, in no fewer than fourteen instances, the numbers are almost identical. It is strange, however, that Stas found for the atomic weight of iodine the number 126.85, while Marignac agrees more nearly with later determinations by Ladenburg and by Scott. In stating his results, Marignac is always modest. He writes:—

"Je puis bien reconnaître, après avoir étudié le beau travail de ce savant, qu'il a apporté, dans ses expériences, des soins infiniment plus minutieux que ceux que j'avais cru devoir prendre."

Nevertheless, in almost all cases, the agreement with Stas is a very close one. He is by no means convinced that Prout's hypothesis is put out of court by Stas's researches; he draws attention to the fact that while the mean variation from whole numbers of the atomic weights determined by Stas should be about 0.5, it is only 0.103, even if chlorine be included; and if chlorine be rejected, it is reduced to 0.068.

From time to time, Marignac wrote criticisms of notable papers recently published; and in many instances he repeated the work of the authors. His remarks were always gentle and kindly, hence he never was drawn into controversy. Yet he bore his share in attempting to solve the questions of his day; he published many papers relating to dissociation; the most noticeable deals with the specific heats of gaseous ammonium chloride, mercuric chloride, and sulphuric acid, and the heats of volatilisation of these bodies. The latter are naturally high, for they include the heat of dissociation. Marignac's criticisms are, however, sometimes a little naïve; for example, after drawing attention to Andrews's and Tait's observation that the volume of ozonised oxygen is increased permanently by raising its temperature to 230°, he remarks:—

"Or, une condensation aussi considérable que celle qui résulterait des expériences de MM. Andrews et Tait eut été un fait trop saillant et trop important pour échapper à ces habiles chimistes (MM. Fremy et Becquerel) ou qu'ils n'en fissent pas mention."

If this species of argument were permitted, the progress of science would be slow.

Marignac's crystallographic measurements are very numerous, and were evidently made with the greatest care; they should form a valuable storehouse of facts, when our knowledge of the relation between the forms of matter and its constitution has been further developed.

Among his researches on thermal chemistry, besides those relating to anomalous vapour-densities, Marignac devoted much time to the investigation of the specific heats, densities, and expansion of solutions. Like all his work, it is careful and exact, but led to no important conclusions.

Enough has been said to give the reader an idea of the enormous productivity of Marignac. In his own field, that of the rare earths, he is probably unsurpassed as an investigator, and in issuing this collection of his memoirs, M. Ador has erected to him a monument "aere perennius."

W. R.

IRRIGATION IN THE WESTERN STATES OF AMERICA.

Irrigation Institutions. A Discussion of the Economic and Legal Questions created by the Growth of Irrigated Agriculture in the West. By Elwood Mead, C.E. Pp. xi+392. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 5*s.* net.

This work was originally prepared for a course of lectures on the institutions and practice of irrigation for the University of California. The author is of opinion that the land in the United States that has hitherto been relied on to meet the demands of the nation's growth will not much longer be available for this purpose, so rapid has been the increase [illegible] population during the last few years. It is anticipated that at the end of the next half century there will be 200 million people to feed. It has for some time past been recognised that the arid regions of the West, at the foot of the Rocky Mountains, consisting of enormous areas of barren sands broken only by patches of yuccas and sage bushes, becomes, if irrigated, capable of growing crops of all kinds and in the greatest luxuriance. Already where irrigation has been applied, the traveller almost suddenly passes from a desolate and an apparently worthless region to a land of plenty, and is confronted by orchards and gardens which resemble the century old creations of France and Italy, with homes rivalling in taste and convenience those of the eastern States. The climate, though arid, is remarkably healthy, the heat of the southern summers and the cold of the northern winters being mitigated by the dryness of the atmosphere. The mountains and valleys of this district are recognised as natural sanitaria, to which thousands of persons resort in order to live. The arid land, when irrigated, is capable of producing crops worth 20*l*. an acre. Oranges and grapes grow and ripen abundantly, and in Southern California an orange grove of twenty acres constitutes an estate.

The value of the land for raising crops when irrigated became first recognised by the flourishing condition of the colony established by Horace Greely in Colorado, and after his success numerous irrigation schemes were set on foot, both by single settlers and companies. The first step in the change from sage bush desert to fields of grain is the construction of a ditch by the small holder, or of a canal which shall be large enough to water several farms. These canals, in some cases, are large enough to supply from five hundred to a thousand eighty acre farms. The water is supplied to the farmers in fixed quantities, measured either by the miner's inch or the cubic foot, being the volume of water that will flow through an inch or foot square orifice under a designated pressure; or else by the acre foot, being the quantity required to cover an acre to a depth of one foot. The price paid for the water varies according to the locality and the cost of the works.

When the rivers and streams carried a surplus, water was diverted with lavish prodigality, and irrigators gave scant heed to their respective rights because, so long as each had all he needed, he was satisfied. When, however, irrigated agriculture became an assured success, and the area of the irrigated farms increased, innumerable quarrels and law suits as to water rights ensued, and as, according to the author's estimate, there is only a sufficient supply of water to irrigate one-tenth of the arid West, the right to obtain this will be guarded with greater jealousy as time goes on. The laws in the different States as to these rights vary considerably, and are set out with much detail by the author. This, together with the practical information given as to irrigation, will render this book of very great service to those engaged either as settlers on the irrigated lands or to hydraulic engineers engaged in laying out irrigation works.

OUR BOOK SHELF.

Algebra. Part i. By Kaliprasanna Chottoraj. Pp. vi+482. (Calcutta: The City Book Society, 1903.)

This book is "an elementary treatise on algebra intended for use in Indian high schools." "Each rule and each process are followed by a well-graduated and sufficiently large collection of examples." These quotations from the preface serve to characterise the book. It is intended for beginners, and includes the theory of indices, and proportion, but not quadratic equations. The book is too full of rules and processes, and the student is in danger of losing his grasp of the fundamental ideas through the bewildering number of special methods, and may be led to think that he must remember the many rules and artifices which can only be acquired by practice and experience. Thus, for instance, under the heading of the resolution of x^2+ax+b into factors, we find a first method, a second method, followed by two important hints and forty-five examples; then ax^2+bx+c is treated on the same lines and at the same length.

The explanations of fundamental principles are sound and clear, and seem designed to meet every conceivable difficulty, but there is a tendency to lay stress on unessential features and mere details of presentation. As an instance of exactness, it is shown how the lowest common multiple need not be the least in an arithmetical sense. We are glad to see a whole page devoted to the distinction between an equation and an identity.

An attempt is made to define the order of the operations in an expression such as $a \div b \times c$. This can only lead to confusion and mistake. The use of brackets should be taught from the beginning.

The book is poorly printed, but of a convenient size, and will doubtless prove useful to those for whom it is intended. R. W. H. T. H.

Practical Chemistry and Physics. By J. Young, A.R.C.S., F.C.S. Pp. 108. (Woolwich: Cattermole, 1903.)

The space allotted to "physics" is so very limited (9 pages out of 108) that the book may be considered as one on practical chemistry.

As a laboratory guide to chemical analysis there is little to distinguish it from many others dealing with the same subject. The individual reactions for the metals and acids are followed by analytical tables and a few exercises in gravimetric and volumetric analysis. A page is usefully devoted to the detection of impurities in common reagents.

The utility of a book of this kind depends in the first place on the student's previous training in practical chemistry, for it would be out of the question to put a beginner through a course which deals almost exclusively with inorganic analysis; in the second place, it depends on the amount of supervision exercised by the demonstrator, for there are neither drawings of apparatus nor details of manipulation. Granted the necessary training and supervision, one is nevertheless led to suspect from observations dropped here and there that it is not a quickening spirit of philosophic inquiry which pervades the book, but the heavy atmosphere of the examination room. "The test is too delicate for ordinary use." "Be careful always to add excess of the group reagent. Any less is quite useless; the ppt. not only fails to come, but afterwards appears in the wrong place, besides giving rise to other complications." "When the number of bases known to be present has been found, the analysis can be stopped."

A reminiscence of the old stock question of the

Science and Art elementary paper is contained on p. 73 under the heading of "How to construct chemical equations." The expression "two thicknesses of blue glass" might be more explicit, and the same may be said of the term "injurious" applied to an excess of barium chloride. Many of the pages are unnumbered, and there are numerous misprints. J. B. C.

Elements of Physics. By Ernest J. Andrews and H. N. Howland; to which is added a Manual of Experiments. Pp. xi+386+53. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1903.) Price 6*s*.

THE aim of the writers has been to present an account of physics suitable for secondary schools. With this aim in view, they have avoided everything of a purely academic character—with the exception of "little bits of history" which they make a point of inserting. The book is of a very elementary character, and is almost completely free from any mathematics except the simplest arithmetic. More attention is paid to a delivery of the facts with which a pupil is expected to be acquainted than with formal proofs of the relations between them. The authors' methods may be indicated by the constant recurrence of the two phrases "it is evident" and "just as." The latter phrase shows the reliance placed on the method of analogy; the former phrase sometimes means *it is easily proved by simple experiments*—and suitable experiments are then described; sometimes it appears to be used merely to help over a difficult point. Great emphasis is laid on a pupil learning a thing by observation, and this is as it should be. An adequate course of introductory experiments is given in the "Manual."

In general, the explanations given are clear and sufficiently accurate. It is true that the man who is clothed with the love of accuracy as with a garment will not take much pleasure therein. But there is a rapidly growing class of students—the product of county scholarships, &c.—who, owing to imperfect mental training, require knowledge to be served up in a simple if even somewhat loose way; and these requirements deserve to be satisfied.

In a few places there are unfortunate slips. The reference to "permeability" on p. 183 is quite misleading—it is confused with "retentivity." Again, in connection with the liquefaction of gases, it is explained how a little liquid air may liquefy a lot; this savours of the monthly magazines. These misconceptions should be cleared up in a future edition.

First Steps in Photo-Micrography. By F. Martin Duncan. Pp. 104. (London: Hazell, Watson and Viney, Ltd., 1902.) Price 1*s*. net.

THIS little work is intended, as its title implies, to be a guide for those who are beginners in a fascinating branch of photography. It is avowedly written for photographers, and not for microscopists, so that much that is passed over may be excused. The apparatus stated to be necessary is such that good work may be accomplished even with moderately high powers.

The tendency has been of late to advise beginners to attempt some photomicrographic work with the most meagre appliances, thereby increasing their difficulties at the beginning.

It is satisfactory to note that in this little book simple yet efficient appliances are advised. The portion devoted to the illumination of objects, perhaps the most important part of the whole subject, is treated all too briefly, but in other respects the book may be recommended to those who are commencing photomicrography, as a useful guide which will materially assist them in their earliest efforts.

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.*]

Radio-active Gas from Well Water.

I HAVE recently found that water from deep wells in Cambridge contains a radio-active gas, and I am anxious to see whether water from other sources possesses the same property. I should be greatly obliged if any of your readers who have access to deep level water would fill a clean two-gallon can with it and forward it to the Cavendish Laboratory. I should, of course, pay the carriage and return the can. I may say that I have already had samples of water from Birmingham and Ipswich, each of which contained the gas. J. J. THOMSON.

Cavendish Laboratory, Cambridge, April 25.

Can Dogs Reason?

DR. HILL has recently asked the question, "Can dogs reason?" The following analogy has always appeared to me to be a sufficient reply. In ordinary circumstances, few human beings make use of their sense of smell; to excite it, the odour must be fairly strong, and also unusual. It may be regarded as probable that few dogs make habitual use of any power of inference, but have only vague sensory impressions, to which an almost automatic response is given. Yet under sufficient stimulus, they may perform acts involving an exertion of a considerable amount of "thought." Whereas, then, dogs rarely "think," but frequently make use of their delicate sense of smell, human beings seldom make use of that sense, but constantly exercise their reasoning faculties.

Again, is not the opening of a box somewhat akin to the exercise of an inventive faculty? Teach a man how to operate a complicated machine of which he does not understand the mechanism, and it may be doubted whether he will connect the process of setting it in motion with some desire to gain an advantage which is not obviously attained by doing so.

I am tempted to describe an occurrence which reveals in a dog which I have at present the possession of two rather rare qualities of mind for a dog. One is the accumulation of brightly coloured objects. This dog sleeps on a mat in a basket. On taking out the mat to clean it, a strange collection of articles is generally neatly arranged below it; I remember, for instance, large pieces of red sealing-wax attached to strings, a comb, a piece of whalebone, a Brussels sprout, some lumps of coal showing pyrites, a polished dry rib bone, some kindling sticks with resin, &c. These objects had not been gnawed, but merely placed under the mat as valued possessions.

Again, this dog has a keen sense of a joke. Some days ago, a small dog with a loose chain was wandering in the garden. Its owner came out and called it. My dog caught the chain, dragged the little dog away, and waited events. As soon as the owner approached, the small dog was dragged out of reach, and it was not until after a long chase that the little dog was captured. These small incidents show, I think, that it is as impossible to classify all dogs together as it is to classify human beings; their minds naturally run in very different directions, and, just as there are inventive or artistic men, so dogs may show leanings towards special developments of their minds. WILLIAM RAMSAY.

Bullfinch and Canary.

THAT a bullfinch can be trained to pipe a whole tune, or more, to perfection, that is to say, do it, so far as intonation and rhythm are concerned, as well as any skilled musician, everybody knows. It is also a fact, though perhaps less common, that a canary, placed in an adjoining room and hearing the tune of such a piping bullfinch over and over again, may, quite by himself, *i.e.* without being trained for it, acquire the same accomplishment to the minutest detail.

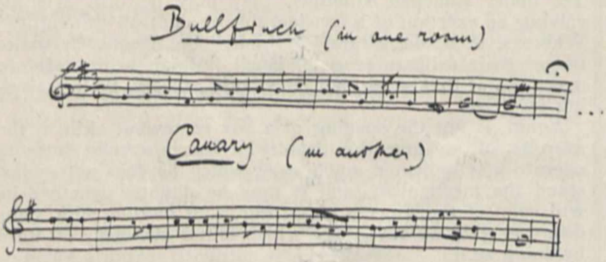
An experience, however, which I have had during a recent visit to Germany has so greatly impressed my friend Prof. Hubrecht of Utrecht, to whom I told it, that I venture to think you will find it of sufficient interest to be laid before your readers.

My sister, Frau Prof. Grosse of Brunswick, possesses an old bullfinch which pipes, among other tunes, "God Save the King" beautifully, even embellishing it now and then with some charming little gracenotes. For some time he was the only bird in the house, until, about a year ago, my sister received the present of a canary bird, a lovely but untrained songster, singing, as they say in Germany, "as his beak was grown."

The cages containing the two birds stood in two adjoining rooms. At first one of the birds would be silent when the other was singing. Gradually however the young canary bird commenced to imitate the tune of the bullfinch, trying more and more of it at a time, until after nearly a year's study he had completely mastered it, and could pipe it quite independently by himself. As I said before, this, in a canary bird, though a rare accomplishment, is nothing very extraordinary or unheard of.

Now, however, I come to my point. What I am going to relate seems to me so wonderful that I should consider it absolutely incredible had I not with my own ears heard it, not once, but dozens of times within the few days of my visit.

When the bullfinch, as sometimes happened, would, after the first half of the tune, stop a little longer than the rhythm of the melody warranted, *the canary would take up the tune where the bullfinch had stopped*, and properly finish it. This, then, is what I heard:—



I should be glad to read in a further issue of your paper whether you share my astonishment, or if any of your readers can perhaps recall, or have ever heard of, a similar experience.

George Henschel.

Kensington, April.

Mendel's Principles of Heredity in Mice.

In Nature of March 19 Mr. Bateson refused to discuss the eye-colour of Mr. Darbishire's mice as a simple character, separable from coat-colour. He then treated Mr. Darbishire's results as dependent on gametes of two kinds; one, G, bearing the characters "white coat and pink eye," the other, G′, bearing "colour in the coat and pink eye." The hybrids resulting from the cross were said to be of constitution GG′, and their offspring were represented, in constitution and in relative frequency, by

$$GG + 2GG' + G'G'.$$

Hybrids are here represented as producing gametes of two kinds only, each kind like that of one pure race; eye-colour and coat-colour are transmitted together in one unresolved "allelomorph." The mice in any one of the three groups are said to be formed from similar pairs of gametes, and they should themselves be similar; but they are not. The colour in the coat of a mouse GG′ may be yellow, or some shade of wild-colour, or black; that of a mouse G′G′ may be yellow, fawn, or "lilac."

In Nature of April 23 Mr. Bateson abandons his first formula; he now says (1) that more than two kinds of gametes take part in the first crosses, since the gametes of one or both pure races are heterogeneous; (2) that coat-colour is split into simpler elements when the hybrids form gametes. The heterogeneity of gametes in two races, both of which breed true, while one has been declared by Mr. Bateson to be universally recessive, is a doctrine too amazing for brief treatment; I therefore consider only the second of the new assumptions.

The hypothesis of March 19, invoking only two kinds of gametes, supposes that one out of every four offspring of hybrids will be a recessive albino, and this is not contradicted by the facts: but the hypothesis regards black and yellow coat-colour as produced by identical pairs of gametes. The new hypothesis provides different gametic elements for the black and for the yellow mice, but it reduces the number of "recessive" albinos among the offspring of hybrids to a *maximum* of one in *nine*. The two "Mendelian predictions" which Mr. Bateson has so far uttered *ex post facto* are mutually contradictory; with which of them is the inheritance of coat-colour "in punctilious agreement"?

Oxford, April 24. W. F. R. Weldon.

The Discovery of Japan.

From a review in Nature of November 13, 1902 (vol. lxvii. p. 28), I gather Herr Hans Haas, like many other writers on Japan, considers Ser Marco Polo the first who brought any news of Japan to the west. In this connection, it will be interesting to note that in his "Six Voyages," Paris, 1676, Tavernier tries to identify a local name of the classic geographers, *Jabadi*, if I remember correctly, with the ancient vernacular designation of the empire, *Yamato*, or rather with its Chinese rendering, *Yamadai* or *Jabatai*.

Whether this identity be true or not, it is almost certain that Japan was well known to the mediæval Arabs much prior to Marco Polo. In a French translation of the "Voyages of the Two Arabs in the Ninth Century," an island near China is mentioned the inhabitants of which used to send a tribute to the latter, in the firm belief that it would make their own country peaceful. This island seems to point to Japan, the story being apparently a version of the legend, recorded in Wang Chung's "Lun Hang," first century A.D., that under Ching-Wang of the Chau dynasty (*c.* 1100 B.C.), China enjoyed such an extraordinary peace that it caused even the winds and waves in the neighbouring States to be perfectly calm, on which account the people of Lacs gave him thanks by their envoys, who reached the capital after several years' journey, and the Japanese made him presents of the Salty Herb (now supposed to mean the *Angelica Kiusiana*, Maximowicz). The "Second Annals of Japan" mentions several Arabs, including women, passing into or becoming settled in Japan during the eighth and ninth centuries. This is no wonder, for, in those ages, China under the grand dynasty of Tang was so prosperous and powerful that nearly all Asiatic peoples of significance vied in asking her favours, and they saw each other very frequently in that empire; besides, doubtless there were many Japanese who passed through China into the lands then called her territories or tributaries; thus, Twan Ching-Shih, in his "Miscellany," written ninth century A.D., speaks of his meeting with a Japanese priest, who came back from his travels in India, where he witnessed the figures of the famous Chinese pilgrim, Hiuen-Tsiang, revered in the Buddhist churches. Indeed, the "Second Annals" relates how, in the year 753 A.D., the Japanese ambassador was successful in a dispute with the Arabian about the first seat of honour on occasion of a state banquet on the New Year's Day. Add to these, in the "Hokuhen Zuihitsu," written eighteenth century, it is argued that in the Middle Ages there were mutual acquaintances between the Japanese and the Persians.

When we see in the sixteenth and seventeenth centuries (in part) the Spaniards and Portuguese flourishing in the Japanese ports under the native appellation *Namban*, or South Barbarians, it is very striking to find in a memoir evidently written in the fifteenth century, entitled "The Successions of Governors of a County in Wakasa" (in Hanawa's "Collection," ed. 1894, p. 375), the following passage:—

"June 22, 1408. A vessel of the Nambans arrived (in the province of Wakasa). Their emperor's name is Arekishinkei, and the envoy's Mongwan-hon-a. His Majesty's presents to the Japanese emperor were a living black elephant, a mountain-horse (*sic*), two pairs respectively of the peafowl and parrots, and various other articles. The ship was wrecked by a storm, and stranded on November 18, but, after being reconstructed, started for China on October 1, 1409."

This took place just 135 years before the advent of the Portuguese deserters Herr Haas describes as the first Europeans reaching Japan; and if so, what were these "Nambans" of the years 1407–8, the first instance, so far as I know, of the name in the Japanese records of this sort?

In the same review, the writer, talking about Xavier's labours, says:—

"What would be interesting and instructive to know would be what the Japanese, especially the Buddhists and Confucianist scholars, thought of his doctrines. No hint has come down to us—perhaps they took no thought of a strange religion that seemed of no importance."

As he expresses it at the same time, Xavier's stay was too short to qualify him to make his dogmatic teaching in its utmost expression; but one must not conclude thereby that in the same century Japan was totally destitute of the native scholars of repute taking interest in the subject of Christianity. Thus we read in a eulogy on Master Seigwa (1561–1619), the greatest of all Confucianists of that age, that he was thoroughly learned not only in all Japanese and Chinese literatures, but, moreover, "as well in the books of the Buddhists in India as in the doctrines of Jesus Christ of the South Barbarians" (Oota, "Ichiwa Ichigen," ed. 1885, tom. xix, fol. 19, *b*).

As the native documents and treatises of any concern to Christianity were well-nigh annihilated under the most rigorous inquisitions, which were mainly incurred by the so-called South Barbarians intermeddling with the political affairs of the country, and which that religion continued to undergo during the two centuries of the Tokugawa Shôgunacy, practically no hint has come down to us of what the native scholars thought about it before the persecution began. From what are left dispersed in their works, however, we may be fair in judging that most of the intelligent Japanese, then and directly after, descried in the tenets and rituals of Roman Catholicism nothing but an especial form of Buddhism. To the Europeans, Nobunaga's dictum on its toleration is well known—"While there exist so many sects already, why do we not let this sect stand?" Kumazawa Ryôkai (1619–91), the renowned Confucianist reformer in politics, calls the creed simply Southern Buddhism, *i.e.* Buddhism of the South Barbarians. Later, Arai Hakuseki (1657–1725), after repeatedly giving ear to the Roman missionary, J. B. Sidoti, is said to have remarked upon the subject, "His doctrine is as absurd as Buddhism, they differing from one another only in the points of their terminology" (Amenomori's "Adversaria," ed. 1892, vol. x. p. 86). Parallel to these, I remember I have read in a letter of Xavier's contained in Ramusio's "Viaggi e Naviationi" a passage implying his recognition of some Christian essence in the Buddhist dogmas then current in Japan.

As I recollect there was in a back number of NATURE a certain though very brief reference to a Life of J. B. Sidoti, it will be *apropos* of this letter to give a few facts relating to him, which, I think, are not so well known now among Christians as they ought to be. Arai Hakuseki, mentioned above, was a man of singular parts, extensively erudite, notorious in poetry even in China, very active in politics of the court at Yedo, and nowadays nobody denies him the honour of the first introducer of the western science into the Land of the Rising Sun. This innovation, however, was simply the result of his official interviews with that devoted but unfortunate missionary in 1709 A.D. Sidoti professes to have made himself adept in the Japanese language at Rome, but after all his acquirements appear to have been too limited to make him speak freely in it. So Hakuseki made every effort in his brain to secure from him accurate information on subjects of the regions, then perfectly unknown to the Japanese, through a Dutchman's interpretation, observing on the difficulties of the task at the outset, "Still is it reasonable to suppose that all this stranger's words are nothing but a shrike's shrieks?" The results of these conversations were the two works "Choice Reviews of a Foreigner's Tales" and "A Memoir on the Western Ocean," which formed the principal cause of the eighth Shôgun's edict to tolerate the reading of the European books pertaining to science and arts, the *sine quâ non* of their wholesale importation in these present days. That all the conduct of Sidoti greatly affected Japanese minds, in spite of their hatred of his creed, is borne out by a letter he wrote in a prison, whereby he petitioned the authority to chain him tightly in cold winter nights, in order to let the miserable watchmen about him enjoy their sleep at ease (see Oota, *op. cit.*). Immediately after Hakuseki's remark on his religion quoted above, this passage follows:—"But his personality was so uncommon that it makes me ever unable to forget him!" And it will be greatly gratifying and edifying to the modern Christians to reflect upon how powerful the unparalleled morality of this single, forlorn missionary was after his death, in effecting the reopening of the doors, which his nominal brethren, the very worthy "South Barbarians," had caused the Japanese to shut against themselves. In fact, Yuasa's "Miscellany from a Literary Society" tells us, "Hakuseki used to say all Sidoti's deportments convinced him in the belief that even the Five Virtues[1] of our Sage were no more than what that missionary daily carried himself with"; an unexampled encomium uttered on a Christian by the followers of the great Chinese philosopher!

KUMAGUSU MINAKATA.

Mount Nachi, Kii, Japan, March 10.

Sir O Lodge and the Conservation of Energy.

THE utterances of many men of science as to the doctrine of the conservation of energy betray a tendency to exaggerate the importance of the position of this principle in the general scheme of physical science. It appears sometimes to be forgotten that the principle of energy, if applied to even the simplest dynamical system which is possessed of more than one degree of freedom, is, taken by itself, wholly insufficient for the determination of the motion of such system. Although the principle has been of inestimable value as regulative of the relations between the different forms of molar, molecular, and corpuscular energy which the state of our knowledge compels us to distinguish, it is nevertheless true that in an ultimate dynamical formulation of physical phenomena, the principle of energy descends to the rank of being one integral only of the dynamical equations of a system, a knowledge of the other integrals being indispensable for the complete determination of the motions of the system.

This tendency to exaggeration is illustrated in a very striking manner in the interesting paper by Sir O. Lodge on "Interaction between the Mental and the Material Aspects of Things" (see NATURE, April 23, p. 595). Sir O. Lodge, in discussing the question whether the assumption of a direct action of life upon matter is consistent with physical laws, advances the theory that, although life cannot generate mechanical energy, it can exert guiding mechanical forces which do no work on matter. Sir O. Lodge appears to think that by restricting the action of the psychical on the physical in this way, he has suggested a compromise which ought to satisfy the supporters of naturalism whilst it at the same time leaves sufficient play for the action of the psychical.

The really fundamental issue between the advocates of thorough-going naturalism and their opponents is at bottom the following:—Can the human body, or the physical world including living organisms, be rightly regarded as theoretically completely representable as a dynamical system, in such a manner that the whole of the motions of the system are completely determinate in accordance with the laws of dynamics? Is the physical a complete system without taking account of any action on it arising from the psychical, or is it, on the other hand, necessary to suppose that an action of the psychical on the physical exists, without which the actual motions of the physical cannot be completely determined? If the latter question be answered affirmatively, then it makes no difference in principle whether such action of the psychical does work, or whether it can be represented by the introduction into the dynamical system of *ex hypothesi* unknown frictionless constraints; in either case the laws of physics, regarded as a sufficient system for the determination of all motions, fall to the ground.

Sir O. Lodge's contention "that the fundamental laws

1 Mildness, Faithfulness, Self-Respect, Respect to Others, and Complaisance. When asked about Confucius's character, Tsze-Kung, the most eloquent of all his disciples, enumerated these as its five components. In the eighteenth century there was a Confucianist master in Japan who opined it wise to substitute in the temples the five letters signifying them written on scrolls for the images of the philosopher. See the "Analects of Confucius" and the "Kwagetsu Shinshi."

of physics, complete and accurate as they are, in no way exclude guidance of events by the agency of life or mind or other unknown influence" cannot, it appears to me, be regarded as true in any sense relevant to the main issue between naturalism and its opponents; that his contention holds because the psychic can be supposed to be sufficiently dexterous to apply all its interfering forces on matter "perpendicular to the direction of motion" is, to my thinking, a complete fallacy based upon an undue estimate of the importance of the conservation of energy as compared with a more general formulation of dynamics.

In an earlier part of his paper Sir O. Lodge has endorsed a somewhat different form of statement: "That life is something outside the scheme of mechanics, although it can nevertheless touch or direct material motion, subject always to the laws of energy *and all other mechanical laws* (the italics are mine) supplementing them, but contradicting or traversing them no whit." In this statement Sir O. Lodge has deigned to recognise the existence of the other mechanical laws. Considering that the motions of all the parts of a mechanical system are completely and uniquely determinate by means of the law of energy and all the other mechanical laws, it seems difficult to understand how room is left for supplementing these laws, or how the psychic can interfere in a mechanical system at all without traversing mechanical laws.

I have no intention of expressing any opinion whatever on the main point of dispute between naturalism and its opponents, or of discussing the question whether our experience of the world can be adequately represented by a dualism of the physical and the psychical. My sole object has been to show that in suggesting that, provided the psychical does not generate energy, it does not, by the impressing of force, really interfere with the completeness of the system of physical laws, Sir O. Lodge has simply drawn a herring across the path of the controversy between naturalism and its opponents. E. W. HOBSON.

Christ's College, Cambridge, April 25.

Density and Change of Volume of Nova Persei.

DR. RITTER, when dealing with stellar atmospheres, touched upon the question of pulsation periods and changes of density of gaseous stars. His deductions are that the brightness of a variable (gaseous) star is inversely proportional to the square of its volume, and also that the period of pulsation varies inversely as the square of the star's density. Now Nova Persei's periods of pulsation have increased from about one day to five days and longer, from which changes, according to Dr. Ritter, we can estimate that the star's density has diminished from 1/10 to 1/300 of that of water. The square of the ratio of these two fractions is 1/900. The brightness of Nova Persei should have decreased to this fraction, which is equal to a decrease of about seven magnitudes.

Important information as to the constitution of this star might be gained if a rigorous comparison between pulsation period and brightness could be carried out.

Dr. Ritter's investigations will be found in Wiedmann's *Annalen*, 1879, vol. viii. p. 177, and 1881, vol. xiii. p. 367.

C. E. STROMEYER.

A Katydid's Resourcefulness.

DURING the past summer an intimate friend of the writer's observed a peculiar case analogous to the Irishman's "spitting on his hands for a fresh hold." An ordinary katydid, in trying to climb along the slats of a window blind that were very smooth owing to the glazed surface of the paint, kept slipping on the smooth surface. It would raise one front leg and then the other, bringing the foot or claw to its mouth, and there wet it with the "molasses" which exuded from the creature's crop. Is this one of the practical uses made by the locust family of this sticky fluid to enable it to walk upon very smooth surfaces? If so, the writer has never had it brought to his notice before.

Iowa City, Ia., October, 1902. ARTHUR G. SMITH.

ABORIGINAL REMAINS IN N.W. FLORIDA.[1]

THE first of these two papers deals with archæological investigations along the coastal region of N.W. Florida, being a continuation of the searches conducted during ten successive seasons along other portions of the coast and the waterways running down to it. The work on this occasion was principally centred in the districts around Perdido Bay, Pensacola Bay, Santa Rosa Sound, and Choctawhatchee Bay. As has hitherto been the case in the investigation of Floridan antiquities, a rich harvest resulted, mainly of objects of pottery. This in spite of the excavation craze which has led numbers of unskilled searchers to probe the soil for its buried treasures. "In no part of Florida," writes Mr. Moore, "is the pursuit of this *ignis fatuus* so intense, and persons, otherwise sane, seemingly, spend considerable portions of their time with spade and divining rod in fruitless search." Some twenty mounds were investigated, and the paper is devoted mainly to a detailed description of the finds. Numerous interments were discovered; the greater number of the skeletons were, however, incomplete. The custom of burying the remains of the dead under inverted earthenware bowls of large size was evidently very prevalent, and recalls the similar practice observed by the pre-dynastic Egyptians. An interesting custom is revealed in connection with the pottery vessels found with the greater number of interments. Very many of the pots buried with the dead exhibit a hole purposely broken through the base, this having been done, it is believed, in order to "kill" the vessel to free its spirit to accompany that of the departed. This custom was seemingly very largely practised, and must have been associated with a system of primitive animistic philosophy which is almost world-wide, and which finds expression under different, though kindred, forms of manifestation.

The finding of a definite class of mortuary pottery is also of great interest. These ceremonial pots were usually small, often somewhat fantastic in form, and of poor materials, and a very interesting feature consists in their basal perforations having been made *at the time of manufacture.* These vessels were, in fact, made for ceremonial "killing"—one may say, were made ready-killed—and they served as cheap substitutes for the more valuable useful forms. A parallel is thus afforded to the modern Chinese practice of burning at funerals cheap paper models of useful objects, money, &c., and to the specially-made valueless burial coins of Egypt and elsewhere.

The decoration upon the pots is for the most part bold in design, and incised or stamped, at times exhibiting zoomorphic or anthropomorphic themes in partial or complete relief. Some of the incised scroll-work is very skilfully executed, and gives a bold, intricate and effective pattern, notably in the case of a fine vase from a mound near Point Washington.

The second short paper deals with researches conducted along the Tombigbee River by the same explorers. A large number of mounds and camp sites were examined, and about 178 miles of the river banks were searched. The results were disappointing, and but poorly rewarded the labour expended. The mounds were largely domiciliary, and the finds from them were few in number. The author gives a complete list of mounds and camp sites along the region examined, and of the names of the owners of the properties upon which they stand, and this should prove very useful to future investigators.

[1] "Certain Aboriginal Remains of the North-West Florida Coast and the Tombigbee River." Two papers by Clarence B. Moore. *Journ.* of the Academy of Natural Sciences of Philadelphia, second series (vol. xi., part 4, 1901.)

POSITIVE SCIENCES AT THE INTERNATIONAL CONGRESS OF HISTORY.

THE name of Rome and the favourable season gave to the congress recently held in the Italian capital an international character, evident, not so much in the numerous concourse of visitors from all parts, as in the nature of the subjects treated. The congress was interesting, not only with regard to the original communications on historical subjects, but still more so respecting the series of discussions on the necessity of collecting and putting in order the material for study so as to render it easily accessible. Bibliographical questions are of greater importance to the historian than to the man of science. The latter, who has at his disposal material in a great measure of recent date and easily accessible, has been able, with greater facility than the historian, to get up good indexes and catalogues; but the difficulties which stand in the way of those desirous of collecting historical data, and of those who have to put them in order, varying, uncertain, obscure as such data are, scattered here and there in innumerable archives and libraries, are very great indeed.

All, or nearly all, the resolutions voted by the congress refer persistently to the necessity of the publication of catalogues, bibliographies, of entire bodies of documents of a given kind, of atlases, reproductions, &c., and, contrary to what is customary amongst Anglo-Saxon peoples who rely more on personal initiative, an appeal is, of course, made to Governments and academical bodies.

The importance assumed by the eighth section—"History of the Sciences"—is a gratifying fact to the cultivators of positive sciences. At the historical congress of Paris in 1900 this section was less attended; in Rome, on the contrary, the students of the history of the principal sciences were represented, assembled in friendly unanimity for a common object.

Amongst the mathematicians I may mention Tannery, who traced the origin of the terms "analysis" and "synthesis" in mathematics; Loria, who, besides other communications, spoke in favour of the publication of the works of Torricelli; Vailati, who spoke on the theory of the lever according to Archimedes; Torni-Bazza, who treated of Niccolò Tartaglia and of an inedited manuscript of Oxford, and others.

Pirotta gave an account of the science of botany and its bibliography in Rome, Mattirolo spoke on Aldovrandi, Celani and Baldacci presented antique herbaria.

Camerano narrated the history of the doctrines of Lamarck in Italy at the beginning of the nineteenth century.

Guareschi, with the aid of documents, showed the accusations of plagiarism against Lavoisier, formulated originally in England, to be unfounded.

Sudhoff treated of Paracelsus and his writings; Blanchard, of the *jetons* of the members of the medical faculty of Paris; Barduzzi, of the University of Siena and of Andrea Mattioli; Pensuti, of the hospitals of antiquity.

Günther discussed the *Jacobsstab* (Jacobs's-staff or cross-staff), an ancient astronomico-geodetic instrument erroneously attributed to Regiomontanus; Millosevitch showed the necessity of promoting the knowledge of Ginzel's canon of eclipses as a means of ascertaining the dates of the period of classical antiquity. There were communications on the history of the tides (Almazia), on the mariner's compass (Moretti), and on seismology (Baratto).

On a motion of Giacosa, a catalogue of the writings on scientific subjects extant in the archives and libraries of the kingdom was voted; the necessity of courses of lectures on the history of the sciences in the universities was discussed, the limits of these courses being then determined, and finally, a permanent international committee was appointed, to which was entrusted the care of the section of the history of the sciences at the future congress of Berlin.

Positive sciences were likewise dealt with in some other sections. Montelius demonstrated the extension of relations between Italy and Scandinavia, proved by the amber trade up to the Bronze age. The woollen industry, introduced principally from England, and its economic results were discussed (Schulte). An interesting communication by Bargagli-Petrucci related the measures taken in Siena in the thirteenth and fourteenth centuries to provide the town with drinking-water, and the deliberations on the subject.

Modern science with its positivistic ideas has likewise not been without influence on the history of methodics. Thus, Vailati treated of the applicability of the notions of cause and effect in the domain of historical sciences, whereas Hartmann argued that history must follow evolutionist methods, excluding consciousness as a causal factor. PIERO GIACOSA.

JULIUS VICTOR CARUS (1823–1903).

TWO generations of zoologists have been familiar with the name of J. V. Carus, who died in Leipzig on March 10 at the age of fourscore years. His name has come to be associated with zoological scholarship, with bibliographical and historical work, with the promulgation of Darwinism, and with the *Zoologischer Anzeiger*, which he edited for the last quarter of a century.

Julius Victor Carus was born at Leipzig on August 25, 1823; he came of a scientific family, represented by several famous names in the history of science. His father was an illustrious surgeon—for a time professor at Dorpat; his mother was the daughter of a renowned gynæcologist. From 1841 onwards, Carus studied medicine and natural science at the famous university of his birthplace, and in 1846 he became assistant physician at the Georgen-Hospital there.

But zoology had a stronger hold on him than medicine, and thus we find him pursuing comparative anatomy at Würzburg, at Freiburg i. Br., and at Oxford (autumn of 1849). At Oxford he acted as conservator of the Museum of Comparative Anatomy, and it was there that he perfected his wonderful command of the English language. In 1851 he returned to Leipzig as a docent, and there he remained, as professor extraordinarius of comparative anatomy, and as director of the zootomical collections, for more than half a century. There was, indeed, a notable break in 1873 and 1874, when he acted as *locum tenens* in the chair of zoology in Edinburgh for Prof. Wyville Thomson, then absent on the *Challenger* expedition. In Edinburgh memories still linger of his excellent lectures on comparative anatomy, which seem to have been somewhat in advance of the requirements and desires of the majority of his large constituency of medical students.

Carus was a man of extraordinary industry, with a high ideal of careful and scholarly workmanship, and instinctively interested in the history of his science. Thus he did more in the way of translation and bibliography, exposition and history than in the way of original research. It will be an evil day for natural science when this type of worker fails to be appreciated.

Among the works of Prof. J. Victor Carus we may note an early paper on alternation of generations

("Zur nähern Kenntniss des Generationswechsels"), Leipzig, 1849; his "System der tierischen Morphologie" (1853); his beautiful atlas, "Icones Zootomicæ" (1857); his text-book, "Handbuch der Zoologie," in collaboration with Gerstaecker (1863–1875); his essay "Ueber die Wertbestimmung der zoologischen Merkmale" (1854); his investigation on Leptocephalids (1861); his useful "Prodromus Faunæ Mediterraneæ" (2 vols., 1884–1893); his "Bibliotheca Zoologica," in collaboration with Engelmann (2 vols., Leipzig, 1862); his edition of the *Zoologischer Anzeiger*, since its beginning in 1878; his excellent translations of the more important of Darwin's works, of Lewes's "Physiology of Daily Life," &c.; but above all his erudite and invaluable history of zoology ("Geschichte der Zoologie"), 1872. Although this well-known history is not marked by the genius which illumines Sachs's "History of Botany," it is a great work, quite enough in itself to make the name of Carus famous.

In reference to Carus's translation of Darwin's works, it is interesting to recall what Mr. Francis Darwin says in the "Life and Letters," vol. iii. p. 48. "From this time (1866) forward Prof. Carus continued to translate my father's books into German. The conscientious care with which this work was done was of material service, and I well remember the admiration (mingled with a tinge of vexation at his own shortcomings) with which my father used to receive lists of oversights, &c., which Prof. Carus discovered in the course of translation. The connection was not a mere business one, but was cemented by warm feelings of regard on both sides." In 1866 we find Darwin writing to Carus:—"I wish I had known when writing my historical sketch that you had, in 1853, published your views on the genealogical connection of past and present forms."

While Carus did not himself make many contributions to the research-literature of zoology, he was certainly one of those who facilitated the progress of the science. It is hard to say how much we owe to the persistent patience implied in the onerous labour of editing the *Zoologischer Anzeiger*, which has helped to keep us up to date for so many years, and has prompted other *Berichte* on similar or different lines. There can be no doubt that Carus gave his mature strength to making this journal a success—an indispensable item in every zoological laboratory, and an organon of progress. We are glad to see that the editorship, which he so ably discharged, has passed into the expert hands of Prof. E. Korschelt.

Although he lived a very quiet and unobtrusive life—*arbeitsreich*, as his fellow-countrymen say—he had his share of honours. He was an honorary doctor of philosophy of the University of Jena, and an LL.D. of both Oxford and Edinburgh, and he received decorations from Prussia, Saxony, and Russia. Herr Professor, Dr. med., phil. et jur. Julius Victor Carus, Ritter pp., was the doyen of the medical faculty of the University of Leipzig, and his obsequies were duly honoured both by the University and by the city on March 13. In the venerable Paulinerkirche the University preacher, Prof. D. Rietschel, spoke of Carus's devotion to science, literally maintained "till the pen dropped from the wearied fingers," of his keen artistic interests, of the nobility of his character, and of the strength of his family affections. He leaves a widow, three daughters (one married to Dr. J. Lehmann), and a son, Victor, to lament his loss. The Dean of the Medical Faculty, Prof. Hoffmann, spoke of his scientific patience and of the loyalty of his services along lines which frequently weakened health and other personal inhibitions left open to him. The fact seems to be that Carus might have been *professor ordinarius* at Leipzig if he had not gracefully and magnanimously bowed to the strong claims of Rudolf Leuckart; "er war kein Streber und verstand es nicht seine Forschungen schnell genug zur Discussion zu stellen, sondern er legte sie in grossen Arbeiten langsam nieder." Thus it is readily intelligible why he devoted himself to a line of work which was not only organically congenial, but brought him some security of income.

It is, therefore, all the more desirable that we should record, as it were from a distance, how much we honour the name of Carus—as a bibliographer, as a historian of the science of zoology, and as one who, by persistent patience of recording, has made the steps of progress easier to thousands. J. A. T.

NOTES.

A ROYAL COMMISSION has been appointed to obtain and distribute full information as to the best mode by which the United Kingdom and British dominions may be represented at the St. Louis International Exhibition to be opened next year, to assist with advice and cooperation, and generally to promote the success of the exhibition. The commissioners are:—His Royal Highness the Prince of Wales, president; Viscount Peel, chairman; the Earl of Jersey, Earl Howe, Lord Castletown, Lord Inverclyde, Lord Alverstone, Lord Avebury, Mr. Horace Plunkett, the Hon. Charles Napier Lawrence, the Hon. Sir Charles W. Fremantle, Sir G. Hayter Chubb, Sir Edward J. Poynter, Sir C. Rivers Wilson, Sir E. Maunde Thompson, Sir William H. Preece, Sir W. T. Thiselton-Dyer, Sir Herbert Jekyll, Sir Lawrence Alma-Tadema, R.A., Sir C. Purdon Clarke, Sir George T. Livesey, Mr. Henry H. S. Cunynghame, Mr. Edwin A. Abbey, R.A., Mr. Charles Vernon Boys, F.R.S., Mr. Thomas Brock, R.A., Mr. George Donaldson, Prof. C. Le Neve Foster, F.R.S., Mr. John C. Hawkshaw, Mr. Thomas G. Jackson, R.A., Mr. W. Henry Maw, Mr. F. G. Ogilvie, Mr. William Q. Orchardson, R.A., Mr. Boverton Redwood, F.R.S., Mr. Alfred G. Salamon, Mr. Joseph W. Swan, F.R.S., Mr. J. J. Harris Teall, F.R.S., and Mr. F. W. Webb. Colonel C. M. Watson, C.B., is appointed secretary of the Commission.

AT a meeting of the above commissioners on Tuesday, the Prince of Wales gave a short practical address, in the course of which he remarked: "Both France and Germany appear fully to realise the advantages to be gained by making a good display of their productions, and in these countries large sums have been provided by their respective Governments to assist in meeting the expense of the exhibits. There is one point to which it would seem desirable to direct attention. In previous international exhibitions, while other countries have arranged to have combined national displays in certain groups, it has been the habit for British manufacturers to show individual exhibits, rather than to combine together so as to produce the best possible effect. It is hoped that in the case of the St. Louis Exhibition it may be possible to arrange so that exhibitors will combine in order to display British products to the best advantage. It should be remembered that the competition will not be between individual British manufacturers, but between them as a whole and their foreign rivals. As regards the amount which will be available to carry out the work of the Royal Commission, I understand that His Majesty's Government has included a sum of 30,000*l*. in the Estimates for 1903–04 as a commencement, and that a decision will not be arrived at as to the total amount to be granted until it has been ascertained to what extent British manufacturers show a willingness to take part in the exhibition."

WE learn from the *Times* that the first annual meeting of the South African Association for the Advancement of Science, which already has 762 ordinary and 30 associate members, was opened on Monday at Cape Town, the Governor, Sir Walter Hely-Hutchinson, being among those present. Sir David Gill, K.C.B., F.R.S., delivered the presidential address. He urged the special claims of science upon the colonies and colonial Governments, and referred to the duties of the Association and to the prospects of scientific progress in South Africa. He also referred to the proposed visit to South Africa of the British Association in 1905, and the great good which would result from such a visit of scientific men.

WE regret to see the announcement of the death of Prof. J. Willard Gibbs, of Yale University, where he had filled the chair of mathematical physics since 1871. Prof. Gibbs was in his sixty-fifth year, and was elected a Foreign Member of the Royal Society in 1897.

THE death is announced of Mr. A. F. Osler, F.R.S., distinguished by his meteorological studies and the self-registering anemometer which bears his name. Mr. Osler was ninety-five years of age, and was elected a fellow of the Royal Society in 1855.

THE governing body of the Jenner Institute of Preventive Medicine will shortly appoint a director of the Institute, and applications are invited for the post.

THE subject of the Silliman lectures to be given at Yale University by Prof. J. J. Thomson, F.R.S., will be "The Present Development of Our Ideas of Electricity." The lectures, eight in number, begin on May 14.

AN International Kite Competition has been arranged for June 25 to be held on the Sussex Downs. Amongst the jury are Mr. C. V. Boys, F.R.S., Dr. W. N. Shaw, F.R.S., Sir Hiram Maxim, and Dr. H. R. Mill.

IT is reported by the *Times* correspondent at Sofia that preparations are being made at Odessa for the establishment of telegraphic communication with Varna by the Marconi system. The Russian authorities will thus be able to avoid the use of the telegraphic lines traversing Rumania.

THERE will be extra meetings of the Institution of Electrical Engineers on April 30 and May 7. It is expected that Mr. Aitken's paper on "Divided Multiple Switchboards: an Efficient Telephone System for the World's Capitals," will be read and discussed at the former meeting.

A REUTER telegram from Cape Town states that Dr. Rubin is about to leave there for Chinde, with a party of observers and native carriers, for the purpose of measuring an arc of meridian into North-eastern Rhodesia, from the Zambesi to Lake Tanganyika. The expedition will be away three years.

ON Monday next, May 4, the Berlin Gesellschaft für Erdkunde will celebrate the seventy-fifth year of its existence by a special meeting and a banquet. At the meeting a report will be read on the scientific activity of the Society during the past five years, Dr. Sven Hedin will give an address on his explorations in Tibet, and Prof. K. Sapper one on his studies of volcanic eruptions in the West Indies and Central America.

IT is stated in *Science* that the Swedish Government has voted 4000*l*. for the publication of the scientific results of Dr. Sven Hedin's journey through Central Asia. The work will comprise an atlas of two large volumes, while a third volume will contain Dr. Hedin's report on the geography of the country. Further volumes will be devoted to the meteorological, the astronomical, and the geological observations, and to the botanical and zoological collections. The work will be published in English.

IN reply to a question asked in the House of Commons on Tuesday, Mr. Gerald Balfour said that up to the present time, in spite of careful negotiation, the Board of Trade has been unable to effect arrangements for a system of wireless telegraphy from shore to ship and ship to shore. The same difficulties have not arisen in the case of communication between ships at sea. Mr. Arnold-Forster informed the House on the same day that the present average expenditure upon wireless telegraphy in the Navy is about 20,000*l*. per annum.

THE council of the Institution of Civil Engineers has made the following awards for papers read and discussed before the Institution during the past session:—A Telford gold medal to Mr. Maurice Fitzmaurice, C.M.G., a Watt gold medal to Mr. B. Hopkinson, and a George Stephenson gold medal to Mr. P. J. Cowan. Telford premiums to Messrs. C. Hopkinson, E. Talbot, F. W. S. Stokes, P. J. Cowan, J. T. Milton, and W. J. Larke. The presentation of these awards, together with those for papers which have not been subject to discussion and will be announced later, will take place at the inaugural meeting of next session.

A RECENT cablegram from Captain Colbeck brings the information, says the *Times*, that, when he discovered the position of the winter quarters of the National Antarctic expedition, the ice prevented him from bringing the *Morning* nearer than eight miles to the *Discovery*. The transhipment of coals and provisions had, therefore, to be done by means of sledges dragged over that distance. The *Discovery* is only provisioned until next January, so that the despatch of the *Morning* for her relief a second time is an absolute necessity in order to avoid a catastrophe. For the additional expense a sum of 12,000*l*. is urgently needed, 6000*l*. this year and the rest next year.

THE *Tageblatt* publishes a wireless telegram transmitted by its correspondent from a train running between Rangsdorf and Zossen. The message states that experiments with wireless telegraphy were made from a train in motion on the Berlin-Zossen section of the military railway by a wireless telegraph company using the Braun-Siemens system. During the journey active communication was maintained between Marienfeld and Rangsdorf stations and the train, and trustworthiness in transmission was found in every case.

MR. C. C. PATERSON has been appointed to take charge of the electrotechnical work, including photometry, at the National Physical Laboratory. Under an arrangement with the Indian Government the laboratory is about to take over the work of preparing the tide tables for Indian ports. In this it will have, for the present, the assistance of Mr. Roberts, of the "Nautical Almanac" Office, in whose hands the work has been for many years. The committee has appointed Mr. F. J. Selby, formerly scholar of Trinity College, Cambridge, as assistant in charge of the work.

THE fourteenth International Congress of Medicine is being held at Madrid. In reality a series of congresses has been arranged. The first, that of the medical Press, commenced on April 20 in the Madrid University, and concluded on April 22. On April 23 the International Congress of Medicine proper was opened, the first meeting being held in the Theatre Royal, the King, the Queen Mother, and the Ministers being present. This main conference concludes to-day. On May 1 a third congress of Spanish-speaking European and American medical men commences and lasts for two days. On May 3 the fourth and last medical congress meets, and is to be purely a Spanish congress.

We regret to record the death of Mr. G. P. Bulman, Newcastle-upon-Tyne, at the early age of twenty-six. He contributed several papers on the marine Mollusca of Northumberland to the reports issued from the Marine Laboratory, Cullercoats. He also made some experimental attempts to solve certain of the problems relating to heredity. The results he obtained with regard to "hybrid oochromy" were described in Nature, June 27, 1901 (p. 207). At the time of his death he was carrying on in the gardens of the Durham College of Science an experiment to test the much-discredited phenomenon, telegony—about which he wrote in *Natural Science*, vol. xiv.

Mr. F. J. M. Page, writing from the Chemical Laboratory, London Hospital, states that radium bromide seems to have more penetrating power than the nitrate. Using the bromide he observed a distinct luminosity on a zinc sulphide screen after the rays had passed through ten post-cards and the card of the screen (in all 5 millimetres). A diamond was found to be superior to zinc sulphide in detecting these rays; thus, on covering the bromide with a florin, no effect on the zinc sulphide could be seen, whereas a diamond glowed perceptibly when placed on a heap of *five* florins (8·5 mm.) over the radium salt. A barium platinocyanide screen proved to afford a slightly more delicate test than the diamond.

At the meeting of the Institution of Mechanical Engineers on Friday, April 24, the president, Mr. J. H. Wicksteed, gave an address in which he traced briefly the development of the uses of iron, and Prof. W. E. Dalby read a paper on the education of engineers in America, Germany and Switzerland. Mr. Wicksteed remarked that in the earliest written records to which an accurate date can be fixed, namely, in the fourth millennium B.C., pyramid texts are found which prove beyond question that iron was well known in Egypt at that time, and that it was forged into weapons, tools and instruments. After an obscure existence of at least 3000 years, iron became historically famous. The time of Homer, 880 B.C., was notable for the attention that was given to iron. The iron of antiquity was made direct from the ore, and was spongy malleable iron, which could be made more or less steely; and it was only as reducing furnaces were enlarged and the blast increased that it came about within the last 400 years that cast-iron was produced on a commercial scale. Up to that time, bronze held the field for objects which could not be shaped by hand-hammering. The best authorities give the date 1490–1500 for the discovery of cast-iron, and it is remarkable that this discovery exactly corresponds with the revival of letters in England. From this time iron became as tractable as bronze, and the iron foundry was added to the forge.

A large audience attended the meeting of the Royal Geographical Society on Monday to hear papers by Captain Sverdrup and Mr. P. Schei on four years' Arctic exploration and scientific observation in the *Fram*. From the furthest point north to which the expedition advanced—namely, Land's-lok, in about 81° 40′ north lat., and long. 94° W.—they were unable to see land either towards the north or towards the west, and some new islands which were discovered would appear to form the natural termination of the Polar archipelago north of the American continent. Although Captain Sverdrup was not prepared to assert that no land really existed north or west of the point he had indicated, he thought it extremely unlikely that land would be discovered in those directions, for as far as ever they were able to see there was nothing but sea covered with ice of the usual coarse Arctic character. Captain Sverdrup said that in many parts of the newly-discovered lands there appeared to be an abundance of animal life, especially musk-oxen and smaller game, such as hares and ptarmigan, as well as foxes and wolves. Bears also were numerous in parts. Almost everywhere remains were discovered of Eskimo habitations. The scientific results of the expedition are very valuable. Meteorological observations were taken every second hour, both in summer and in winter; records were also made of the temperature of the sea and of the ice, as well as of the tidal water. Magnetic observations were made at each of the several winter quarters. The expedition brought home rich and valuable materials for the study of the zoology, botany, and geology of parts of the Arctic which had never before been visited. The *Fram* reached Norway on September 12, 1902, after an absence of four and a quarter years.

Symons's Meteorological Magazine for April contains articles of exceptional interest relating to the rainfall of the last winter, the shortage of water, and the storm of February 26, by Prof. C. J. Joly, Astronomer Royal for Ireland. We select for especial notice the table of rainfall extremes at Camden Square for forty years, 1858–97. The average rainfall is 25.46 inches. The driest period is the spring, the rainfall each month from February to May being below two inches; in all other months the average fall exceeds two inches, the maximum, 2·71 inches, occurring in October. The greatest monthly fall was 6·72 inches in August, 1878, and the lowest 0·01 inch in February, 1891. The greatest daily fall was 3·28 inches on June 23, 1878. Rain falls, on an average, on 161·8 days in the year, the extremes being from 106 to 204 days.

The appendix to the reports of the British South Africa Company on the administration of Rhodesia, for 1900 to 1902, contains a meteorological report by Mr. George Duthie. During the year ended March 31, 1902, or part of it, there were in operation seven barometric stations (three in Mashonaland and four in Matabeleland), three climatological or thermometric stations (one in Mashonaland and two in Matabeleland), and nine purely rainfall stations—making nineteen rainfall stations in all (twelve in Mashonaland and seven in Matabeleland). One barometric station and five rainfall stations have been added during the year. Mr. Duthie's report contains abstracts of the observations made at the stations, and also summaries of observations made in British Central Africa under the direction of Mr. McClounie.

The fourth, and concluding, number of vol. iii. of the *West Indian Bulletin* contains two articles by Mr. Maxwell-Lefroy, late entomologist to the Agricultural Department. The first forms the concluding portion, divided into thirteen subjects, of a lengthy account of the scale insects of the West Indies. His second paper is on "Crude Oil and Soap, a New General Insecticide." Kerosene is rather expensive in the West Indies, and so also is American crude petroleum, so Mr. Maxwell-Lefroy was induced to experiment with a crude oil mined in Barbados, and from this and soap he has obtained an emulsion which is a most valuable insecticide, from the very much increased insecticidal properties of the heavy oil used. Mr. Francis Watts has some notes on West Indian fodders, and there is a report of an address by Dr. Morris on agricultural efforts at Dominica.

We have to acknowledge the receipt of a brochure on the causes of weather and earthquakes, from Captain A. J. Cooper, who is known to hold some rather unorthodox views on the subject of tides and other phenomena. The greater part of the pamphlet is occupied with comparisons between the dates of storms and the configuration of the planets. The principle on which this comparison is made seems to be wrong. A storm having been recorded, an inquiry is made into the positions of the planets, moon, &c. It would be more convincing if, from the arrangement of the planets, the weather was foretold. The reply of the author is, however, that we do not know sufficient of the state of the weather over the whole world to be able to say whether the prediction is justified or not. The author does not seem to have read Prof. Schuster's address to the Astronomical Section at Belfast, in which he will find discussed the true principles which indicate a real connection between phenomena in which some relationship can be traced.

A METHOD of studying the action of insects' wings by instantaneous photography is described by Herr Robert von Lendenfeld in the *Biologisches Centralblatt.* The photographs were taken by concentrated sunlight, as many as 2500 exposures per second being obtained by revolving a cog-wheel in the plane in which the image of the sun was focused. The photographic images of the insect were separated by means of a revolving mirror. One great difficulty was to make the fly fly, and it must not be forgotten that the insect was confined in a very restricted space, or even in some cases held in the fingers, thus hardly reproducing the conditions of free flight.

IN a note in the *Bulletin* of the Imperial Naturalists' Society of Moscow, M. W. Mamontow describes a diamond contributed to the mineralogical museum at Moscow from the Ural Mountains. It was one of four diamonds found in a new secondary bed near the village of Koltachi; it weighed 1·107 carat, and its specific gravity was 3·516. Most of the Ural Mountain diamonds weigh less than a carat. The author describes sixteen deposits in the southern and central Urals from which more than 222 crystals have been obtained in seventy-three years.

WHETHER the microbes which are constantly present in the intestinal canal of man and animals are essentially necessary to promote digestion, are harmless and unnecessary, or are even injurious, is a question on which various observers have arrived at different results. In a paper communicated to the *Bulletin* of the Imperial Naturalists' Society of Moscow, Mdlle. P. V. Tsiklinsky discusses this question. From an examination of the literature of the subject, and from a study of the microbe flora in question, the authoress is led to believe that, while certain microbes do undoubtedly promote digestion, and, in accordance with M. Metchnikoff's observations, in some cases exercise an antagonistic influence against germs of disease, it is probably possible, by artificial means, such as by variation of diet, to dispense with the bacteria in question, and thus to avoid the danger that they often cause in the living animal. Further, the view is put forward that the thermophilous microbes of the intestinal canal are mere varieties of ordinary non-thermophilous microbes, and not distinct species.

WE have received from Messrs. W. Watson and Son, of High Holborn, their latest catalogue of microscopes and accessories. Among the new items may be mentioned the series of substage condensers, which, through the courtesy of Messrs. Watson, we have had an opportunity of testing. These are all of a high order, especially the "holoscopic" oil immersion condenser, which appears to be as good as, if not superior to, any similar condenser we have had through our hands. The "macro illuminator" is a most useful accessory for low-power photomicrography, the illumination of large objects being by its aid very easily accomplished. There is also described a new two-speed fine adjustment, the design and construction of which is of considerable merit as well as a fine adjustment, designed for photomicrography and high-power work by Mr. E. B. Stringer, which should be of the greatest value to workers in these branches. The well-known "Van Heurck" microscope, than which there is probably no finer instrument to be obtained, is again described fully, as well as a new metallurgical microscope, for which there should, in view of the great advances recently in this branch of work, be a considerable demand.

WE have received what appears to be the first part of a new Italian entomological journal, *Redia*, published at Portici. This part comprises a single memoir, by Signor F. Silvestri, on the termites and the insects which live with them of South America. For the purpose of his researches the author visited Argentina in 1898, and Chili and Uruguay in the following year, obtaining a vast store of material, which has since been carefully worked out. The present memoir contains accounts of a number of new generic and specific types discovered by the author. Six plates are devoted to details of structure.

A UNIQUE specimen has been added to the gallery of fossil reptiles in the Natural History Museum. This is a considerable portion of the skeleton of a gigantic sauropod dinosaur obtained from the Oxford Clay near Peterborough by Mr. E. N. Leeds, of Eyebury. When first the bones of this species were discovered some years ago, they were described by the late Mr. J. W. Hulke as *Ornithopsis leedsi*, but the generic title has since been changed to Cetiosaurus. The remains include the tail, sacrum, and parts of one hind and one fore limb. The Peterborough dinosaur, which is evidently allied to the American Diplodocus (of which restored sketches are placed alongside), is the first example of the larger forms of these reptiles found in Britain of which enough of the skeleton has been found to admit of its being mounted. The mounting reflects the greatest credit on the mason and artificers of the museum.

AMONG the series of memoirs on the fishes of Japan by Messrs. Jordan and Fowler, to which allusion has so frequently been made in these columns, none is of more general interest than the one on the sharks and rays (Elasmobranchs), forming No. 1324 of the *Proceedings* of the U.S. Nat. Mus. Of the numerous forms recorded, by far the most noteworthy is the shark described as *Mitsukurina owstoni*. The genus and species are based on a single specimen captured in 1898 off Misaki in deep water, which, until November of last year, remained the only known example. Dr. Smith Woodward has suggested that this shark is not generically distinct from the Eocene Scapanorhynchus, but this is not admitted by the authors of the memoir before us, although the characters on which they maintain its distinctness appear insignificant. Messrs. Jordan and Fowler adopt more family groups than is usual, and use several names which are unfamiliar, although in employing Cetorhinus, in place of Selache, for the basking-shark they are undoubtedly right.

As Prof. L. Bailey has made a special study of plant-breeding and plant form, he is well qualified to discuss the modern theories of variation and principles of hybridisation. These subjects he treated in an address delivered before the American Society for Plant Morphology and Physiology, and his paper has been printed in *Science*. Prof. Bailey points out that the most important part of Mendel's contribution is the law of heredity which he put forward, which is based upon similarity or purity of the two fusing elements.

THE Botanical Club of Canada has endeavoured to stimulate the collection of phenological records throughout the various provinces of the Dominion, and in Columbia and

Nova Scotia many of the schools undertake these observations as a form of nature-study. The schedules which have been distributed include the observation of farming operations and a few meteorological phenomena, in addition to the ordinary data connected with the opening of flowers. The annual report contains a series of observations made in Nova Scotia, from which average dates or phenochrons are calculated.

ATTENTION is directed by Mr. O. E. Dunlap to a remarkable diversion in the waters of Niagara which happened on March 22 (*Scientific American*, April 4). On the previous afternoon ice came down the upper river from Lake Erie in such quantities that immense masses lodged on the rocks above Goat Island and diverted the water from the American to the Canadian channel. Thus the river-bed above the American fall between the mainland and Goat Island was left practically dry, and numbers of people were able to walk from Green Island over reefs of rock to the head of Goat Island. Here and there gravelly deposits and loose blocks of limestone were to be seen, amid great patches of ice, and barely enough water fell over the limestone ledge to curtain the rocky cliffs below. It is recorded that a similar incident occurred on March 29, 1848.

THE fossil fruits to which Bowerbank gave the name Nipadites have in this country been obtained from the London Clay of Sheppey and the Bracklesham Beds of Sussex. The various forms from the Eocene strata of Belgium have been grouped under one specific name, *Nipadites Burtini*, given by Brongniart in 1828 (as *Cocos Burtini*), and of which the *N. giganteus* of Bowerbank and the *N. Bowerbankii* of Ettingshausen are regarded as synonyms. These conclusions are stated in an essay by Mr. A. C. Seward and Mr. E. A. N. Arber (*Mém. Musée Roy. d'Hist. Nat. de Belgique*, tome ii., 1903). The authors remark on the structural resemblance between the fossil fruits and those of the recent palm, Nipa, which flourishes in the East Indies from the Lower Ganges and Ceylon, across the Malay Peninsula and Archipelago, even to Australia.

ON Tuesday evenings during May the following lectures will be given at the Royal Victoria Hall:—Dr. Mill, on "Weather and Weather Prophets"; Dr. Bertram Abrahams, on "Egypt"; Mr. Cunningham, on "Fishes"; and Canon J. W. Horsley, on "Insects."

PROF. N. W. LORD'S "Notes on Metallurgical Analysis" have reached a second edition. In its new form the book is not only suitable for students in technical schools, but also as a book of reference for use in metallurgical laboratories. Methods for the determination of all elements likely to be encountered in ordinary analyses have been included in the new edition, and the subjects of gas analysis and the testing of fuel have been more fully described than in the original issue of the volume. The book is issued from the Metallurgical Laboratory of the Ohio State University.

THE twenty-eighth issue—that for 1903—of the *Aide-Mémoire de Photographie*, edited by M. C. Fabre and published under the auspices of the Toulouse Photographic Society by M. Gauthier-Villars, of Paris, is full of valuable information for photographers. In addition to the lists of the principal photographic societies in Europe and America, the photographic magazines, and books on photography published during 1902, it contains a detailed review, in seven chapters, of photographic developments during last year.

THE additions to the Zoological Society's Gardens during the past week include a Chacma Baboon (*Papio porcarius*), four Black-backed Jackals (*Canis mesomelas*), two Caracals (*Felis caracal*), a Feline Genet (*Genetta felina*), a Dusty Ichneumon (*Herpestes pulverulentus*), four Suricates (*Suricata tetradactyla*), three Levaillant's Cynictis (*Cynictis penicillata*), two Bristly Ground Squirrels (*Xerus capensis*), a Crested Porcupine (*Hystrix cristata*), five Cape Hyraces (*Hyrax capensis*), seven Spotted Eagle Owls (*Bubo maculosa*), a Bearded Falcon (*Falco biarmicus*), five Jackal Buzzards (*Buteo jacal*), a Chanting Hawk (*Melierax musicus*), five South African Kestrels (*Tinnunculus rupicolus*), a Large African Kestrel (*Tinnunculus rupicoloides*), four Leopard Tortoises (*Testudo pardalis*), a Tuberculated Tortoise (*Homopus femoralis*) from South Africa, three Rufous Weaver-birds (*Hyphantornis textor*), a Grenadier Weaver-bird (*Euplectes oryx*), three Triangular-spotted Pigeons (*Columba guinea*), seven Egyptian Geese (*Chenalopex aegyptiacus*) from West Africa, presented by Colonel A. T. Sloggett, C.M.G.; a Sykes's Monkey (*Cercopithecus albigularis*) from West Africa, a Smooth-headed Capuchin (*Cebus monachus*) from South-east Brazil, a Ring-tailed Coati (*Nasua rufa*) from South America, seven Long-nosed Vipers (*Vipera ammodytes*), two Painted Frogs (*Discoglossus pictus*), two Edible Frogs (*Rana esculenta*), a Southern Mud Frog (*Pelobates cultripes*), European; two Pennant's Parrakeets (*Platycercus pennanti*), twelve Golden Tree Frogs (*Hyla aurea*) from Australia, two Seven-banded Snakes (*Tropidonotus septemvittatus*), a Hog-nosed Snake (*Heterodon platyrhinos*) from North America, deposited.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY:—

May 1–6. Epoch of Aquarid meteoric shower (Radiant 337° − 2°).
10. 2h. Mercury at greatest elongation (21° 31′ E.).
,, Ceres $\frac{3}{4}$° S. of μ Leonis (mag. 4·1).
11. Juno $\frac{1}{2}$° N. of ϵ Ophiuchi (mag. 3·3).
12. 8h. 7m. to 9h. 5m. Moon occults χ Ophiuchi (mag 5·0.
15. Venus. Illuminated portion of disc = 0·738, of Mars = 0 926.
,, 13h. 5m. to 16h. 27m. Transit of Jupiter's Satellite III. (Ganymede).
19. Neptune in conjunction with η Geminorum, Neptune 10′ S.
20. 14h. Venus in conjunction with ϵ Geminorum, Venus 10′ N.
21. Juno (mag. 8.7) in opposition to the Sun.

NOVA GEMINORUM BEFORE ITS DISCOVERY.—On receiving the Kiel announcement of Prof. Turner's discovery of Nova Geminorum, Prof. Pickering instituted a search for this object on the early photographs of this region taken for the Henry Draper memorial series.

A negative obtained on March 1d. 15h. 3m. (G.M.T.), whilst showing stars of 11 9 magnitude, shows no trace of the Nova, neither could the latter be found on any of the sixty-seven plates of this region taken between March 3, 1890, and February 28, 1903, although most of them show stars of the twelfth magnitude or fainter. A plate obtained on March 2d. 13h. 19m. shows stars of magnitude 9 0, but shows no object in the Nova's position.

On a photograph taken March 6d. 14h. 28m. there is the image of an object occupying the position of the Nova, the photographic magnitude of which is 5 08 ± 0.26, and negatives taken on several succeeding nights show that the magnitude gradually decreased until on March 25 it was only 8 08.

The photograph obtained on the last-named date was taken with an objective prism, and shows the spectrum of the Nova as a conspicuous object amongst the spectra of the surrounding stars. This spectrum shows six bright lines, their designations, assumed wave-lengths, and relative intensities being as follows:—

Hζ, 3889, (1); Hε, 3970, (3); Hδ, 4102, (8); Hγ, 4341, (10); —, 4643, (11); and Hβ, 4862, (9).

No dark lines are shown on the photograph, but this may possibly be due to the small dispersion employed. The same lines, together with the nebula line at λ 5003, are shown on spectrograms obtained on March 29 and 31, and April 1, the nebula line appearing as brighter than Hζ and of intensity 2–3. Later photographs contain lines at the estimated positions λ 4176, λ 4240 and λ 4462.

Prof. Pickering remarks on the utility of such a series of systematic observations as are carried on under the Draper memorial fund, and states that even in the absence of Prof. Turner's discovery and prompt announcement, Nova Geminorum would have been discovered, for its spectrum was a very conspicuous object on the Harvard photograph of March 25 (H.C.O. *Circular*, No. 70).

Recently Discovered Terrestrial Gases in the Chromosphere.—Owing to their proved relationship to helium, Prof. S. A. Mitchell, of Columbia University, suspected that the recently discovered gases neon, argon, krypton, and xenon might be found to exist in the chromosphere, and in order to test his supposition he compared the wave-lengths of the lines in their respective spectra with the wave-lengths of the chromospheric spectrum obtained by himself during the Sumatra eclipse.

Owing to the low densities of the new gases, it is to be expected that, as is the case with helium, they will not appear in the normal solar spectrum, even though they may appear in the spectrum of the chromosphere; and again, owing to the low atomic weights of neon and argon, Prof. Mitchell expected that these two gases might appear in the spectrum, whilst krypton and xenon, the atomic weights of which are greater, would probably not so appear.

As a result of his comparison Prof. Mitchell comes to the conclusion that lines due to neon and argon are present in the chromospheric spectrum, but the evidence as to the presence of krypton and xenon is, at present, inconclusive. Lines which are due to the more volatile gases of the earth's atmosphere (*i.e* those which are uncondensed at the temperature of liquid hydrogen), as published by Liveing and Dewar, appear at λλ 4047, 4398, 4422, 4431, 4540 and 4844, and the strongest argon lines, viz. those at λλ 4180.3, 4200·8, 4259·5, 4266·8 and 4430·3, are also represented in the spectrum of the chromosphere.

Prof. Mitchell suggests that these gases may have come to the earth's atmosphere from the sun, as suggested in the theory put forward by Arrhenius, which supposes that ionised particles are constantly being repulsed by the pressure of light, and thus journey from one sun to another (*Astrophysical Journal*, No. 3, vol. xvii.).

Catalogue of Measures of New Double Stars.—In *Bulletin* No. 29 of the Lick Observatory, Prof. R. G. Aitken publishes a further addition of 117 new double stars and their measures to his new catalogue of these objects; the earlier sections of this catalogue have already appeared in previous numbers of the Lick *Bulletins* and in the *Astronomische Nachrichten*.

The present section deals with Nos. 313 to 429 (Aitken) inclusive, and gives the position for 1900, the number in previous catalogues, the magnitude and the dates and figures of the various measures for each star. More than one-half of the pairs in this section are separated by angular distances not exceeding 1″, and more than three-fourths are only separated by 2″ or less.

The doubles have been discovered with the 12-inch telescope, but nearly all the measures have been made with the 36-inch.

"The Cambrian Natural Observer."—The latest issue of this interesting little volume, which is the official organ of the Astronomical Society of Wales, contains many interesting records of observations, both astronomical and meteorological, made by members of the Society during 1902. In future the "Observer" will only appear annually instead of quarterly as hitherto.

SEISMOLOGICAL NOTES.

The last publication of the Earthquake Investigation Committee of Japan contains five papers illustrated by twenty-six plates, all of which are the work of Dr. F. Ōmori. The first of these refers to a horizontal pendulum tromometer, which is essentially a conical pendulum seismograph carrying a load of 50 kg. and writing indices with a multiplication of 120. In addition to recording earthquakes, it indicates the almost continual existence of "micro tremors," the periods of which are about 0·3 second and the range 0·013 mm. When "pulsatory oscillations," which are a larger form of disturbance than the tremors, are in evidence, it would appear from the illustrations which are given of these movements that they might seriously interfere with the character of an earthquake record.

In a communication on the overturning and sliding of columns, the relationship between the horizontal component of earthquake motion and the displacement of bodies which are not attached to the ground, but simply rest upon the same, is discussed and illustrated with considerable detail. The effects of vertical motion are referred to, and cases are pointed out where gate-posts and buildings have been caused to jump. A paper bearing upon the seismic stability of tall chimneys gives the results of experiments upon the vibration of such structures. The remaining papers respectively refer to the vibration of the piers of railway bridges as caused by traffic, and the vibration of walls at the time of earthquakes.

These excellent publications are undoubtedly of great value, especially to those who have to construct to resist earthquake movements; but if the author could have given more complete references to investigations made by himself and also by others in connection with similar inquiries, their value would have been enhanced.

Other seismological notes are found in the reports of the Physico-Mathematical Society of Tokyo. In one of these, No. 16, Dr. Ōmori gives a summary of analyses he has made of seismograms of distant earthquakes. This is followed by notes relating to the transit velocity of the first preliminary tremor of earthquakes of near origin. We are told that the duration of these early movements has a constant relationship to the distance they have travelled. Therefore, if this distance is known, and the time of arrival of the large waves has been noted, it is an easy matter to determine the time at which the preliminary tremors must have arrived. With this factor and with a knowledge of the time at which they originated, their velocity may be calculated. A mean for this is given at 5 or 6 km. per second, whilst a mean value determined from observations is 8 km. per second. In arriving at these results, it must not be overlooked that in certain cases, at least, there has been an unavoidable want of precision in locating origins; the time of occurrence at an origin has been taken as the mean of times observed at stations regarded as being near to the same, and it has been assumed that the waves followed spherical paths. These and other factors have no doubt contributed to the wide limits assigned to the results of these investigations.

In the tenth number of the new series of publications issued by the Earthquake Commission of the Vienna Academy of Sciences, Dr. E. v. Mojsisovics gives a chronological series of notes relating to 157 earthquakes which in 1901 were recorded in various parts of the Austrian Empire. The first of these catalogues, which consists of observations made for the most part without the aid of instrumental appliances, was issued in 1898.

In addition to these lists of local disturbances, which may be compared to the slight shocks which from time to time are felt in this country, the Academy also publishes registers of disturbances which have originated at great distances and shaken the world throughout its mass. Illustrations of these latter are found in the eleventh and twelfth numbers of the publications, the former referring to Trieste and the latter to Kremsmünster.

At the first of these stations, three Rebeur-Ehlert pendulums have been kept at periods of about eight seconds, whilst at the second, similar instruments have periods of from three to four seconds. In 1901, at Trieste, 187 earthquakes were recorded, whilst at Kremsmünster only eighty-one were noted. Although the natural period of the pendulums has been comparatively short, both stations have suffered from "mikroseismische Unruhe" (air tremors?).

At the present moment the most interesting station where world shaking earthquakes are recorded is at Přibram, where on the surface and at a depth of 1100 m. Wiechert's pendulums are installed. From the few records hitherto obtained, it appears that the motion on the surface and that underground have a striking similarity.

DR. GOELDI ON BRAZILIAN DEER.

DR. E. GOELDI has decidedly advanced our knowledge of the deer of South America by a memoir on the antlers of three Brazilian species recently published in the *Memorias* of the museum at Para of which he has charge (*Mem. Mus. Goeldi*, part iii., 1902). All South American deer, it need scarcely be said, differ markedly from the more typical deer of the Old World, the males of the larger species, together with their relatives, the white-tailed and the mule deer of North America, being specially distinguished by the form of their antlers, which branch in a fork-like manner some distance above their base, instead of giving off a brow-tine close to the latter. Hitherto naturalists, in Europe at any rate, have had no definite information with regard to the gradual increase in the complexity of the antlers of the South American species as they are annually renewed. This deficiency in our knowledge has been supplied in the case of the marsh-deer, the pampas-deer, and the one commonly called *Cariacus gymnotis*, in the memoir before us. With great pains, Dr. Goeldi has collected a large series of the antlers of each of the three species belonging to animals of different ages, and in the plates accompanying his memoir has figured a selection which serves to display the gradual evolution from the young to the adult form. In the course of the memoir, it is incidentally mentioned that the aforesaid *C. gymnotis*, which is a near relative of the North American whitetail, has only recently made its appearance in Brazil, its proper home being Colombia and Guiana.

THE PEARL FISHERIES OF CEYLON.[1]

THE celebrated pearl "oysters" of Ceylon are found mainly in certain parts of the wide shallow plateau which occupies the upper end of the Gulf of Manaar, off the north-west coast of the island and south of Adam's Bridge.

The animal (*Margaritifera vulgaris*, Schum. = *Avicula fucata*, Gould) is not a true oyster, but belongs to the family Aviculidæ, and is therefore more nearly related to the mussels (Mytilus) than to the oysters (Ostræa) of our seas.

The fisheries are of very great antiquity. They are referred to by various classical authors, and Pliny speaks of the pearls from Taprobane (Ceylon) as "by far the best in the world." Cleopatra is said to have obtained pearls from Aripu, a small village on the Gulf of Manaar, which is still the centre of the pearl industry. Coming to more recent times, but still some centuries back, we have records of fisheries under the Singhalese kings of Kandy, and subsequently under the successive European rulers—the Portuguese being in possession from about 1505 to about 1655, the Dutch from that time to about 1795, and the English from the end of the eighteenth century onwards. A notable feature of these fisheries under all administrations has been their uncertainty.

The Dutch records show that there were no fisheries between 1732 and 1746, and again between 1768 and 1796. During our own time the supply failed in 1820 to 1828, in 1837 to 1854, in 1864 and several succeeding years, and finally after five successful fisheries in 1887, 1888, 1889, 1890 and 1891 there has been no return for the last decade. Many reasons, some fanciful, others with more or less basis of truth, have been given from time to time for these recurring failures of the fishery; and several investigations, such as that of Dr. Kelaart (who unfortunately died before his work was completed) in 1857 to 1859, and that of Mr. Holdsworth in 1865 to 1869, have been undertaken without much practical result so far.

[1] Abstract of a discourse delivered at the Royal Institution on March 27 by Prof. W. A. Herdman, F.R.S.

In September, 1901, I was asked to examine the records and report on the matter, and in the following spring was invited by the Government to go to Ceylon with a scientific assistant, and undertake what investigation into the condition of the banks might be considered necessary. Arriving at Colombo in January, 1902, as soon as a steamer could be obtained we proceeded to the pearl banks. In April it was necessary to return to my university duties in Liverpool, but I was fortunate in having taken out with me as my assistant Mr. James Hornell, who was to remain in Ceylon for at least a year longer, in order to carry out the observations and experiments we had arranged, and complete our work. This programme has been carried out, and Mr. Hornell has kept me supplied with weekly reports and with specimens requiring detailed examination.

The s.s. *Lady Havelock* was placed by the Ceylon Government at my disposal for the work of examining into the biological conditions surrounding the pearl oyster banks; and this enabled us on two successive cruises of three or four weeks each to examine all the principal banks, and run lines of dredging and trawling and other observations across, around and between them, in order to ascertain the conditions that determine an oyster bed. Towards the end of the time I took part in the annual inspection of the pearl banks, by means of divers, along with the retiring inspector, Captain J. Donnan, C.M.G., and his successor, Captain Legge. During that period we lived and worked on the native barque *Rangasameeporawee*, and had daily opportunity of studying the methods of the native divers and the results they obtained. [These were discussed in the lecture and illustrated by lantern slides.]

It is evident that there are two distinct questions that may be raised—the first as to the abundance of the adult "oysters," and the second as to the number of pearls in the oysters—and it was the first of these rather than the frequency of the pearls that seemed to call for investigation, since the complaint has not been as to the number of pearls per adult oyster, but as to the complete disappearance of the shell-fish.

Most of the pearl oyster banks or "Paars" (meaning rock or any form of hard bottom, in distinction to "Manul," which indicates loose or soft sand) are in depths of from 5 to 10 fathoms, and occupy the wide shallow area of nearly 50 miles in length, and extending opposite Aripu to 20 miles in breadth, which lies to the south of Adam's Bridge. On the western edge of this area there is a steep declivity, the sea deepening within a few miles from under 10 to more than 100 fathoms; while out in the centre of the southern part of the Gulf of Manaar, to the west of the Chilaw Pearl Banks, depths of between one and two thousand fathoms are reached. On our two cruises in the *Lady Havelock* we made a careful examination of the ground in several places outside the banks to the westward, on the chance of finding beds of adult oysters from which possibly the spat deposited on the inshore banks might be derived. No such beds, outside the known "Paars," were found; nor are they likely to exist. The bottom deposits in the ocean abysses to the west of Ceylon are entirely different in nature and origin from the coarse terrigenous sand, often cemented into masses, and the various calcareous neritic deposits, such as corals and nullipores, found in the shallow water on the banks. The steepest part of the slope, from 10 or 20 fathoms down to about 100 fathoms or more, all along the western coast seems in most places to have a hard bottom covered with Alcyonaria, sponges, deep-sea corals and other large encrusting and dendritic organisms. Neither on this slope nor in the deep water beyond the cliff did we find any ground suitable for the pearl oyster to live upon.

Close to the top of the steep slope, about 20 miles from land, and in depths of from 8 to 10 fathoms is situated the largest of the "Paars," the celebrated Periya Paar, which has frequently figured in the inspectors' reports, has often given rise to hopes of great fisheries, and has as often caused deep disappointment to successive Government officials. The Periya Paar runs for about 11 nautical miles north and south, and varies from one to two miles in breadth, and this—for a paar—large extent of ground becomes periodically covered with young oysters, which, however, almost invariably disappear before the next inspection. This paar has been called by the natives the "mother-paar," under the impression that the young oysters that come and go in fabulous numbers migrate or are carried inwards and supply the inshore paars with their populations. During a careful investigation of the Periya Paar and its surroundings, we satisfied ourselves that there is no basis of fact for this belief; and it became clear to us that the successive broods of young oysters on the Periya Paar, amounting probably within the last quarter century alone to many millions of millions of oysters, which if they had been saved would have constituted enormous fisheries, have all been overwhelmed by natural causes, due mainly to the configuration of the ground and its exposure to the south-west monsoon.

A study of the history of the Periya Paar for the last twenty-four years [given more fully in the lecture] shows that since 1880 the bank has been naturally restocked with young oysters at least eleven times without yielding a fishery.

The 10-fathom line skirts the western edge of the paar, and the 100-fathom line is not far outside it. An examination of the great slope outside is sufficient to show that the south-west monsoon running up towards the Bay of Bengal for six months in the year must batter with full force on the exposed seaward edge of the bank and cause great disturbance of the bottom. We made a careful survey of the Periya Paar in March, 1902, and found it covered with young oysters a few months old. In my preliminary report I estimated these young oysters at not less than a hundred thousand millions, and stated my belief that these were doomed to destruction, and ought to be removed at the earliest opportunity to a safer locality further inshore. Mr. Hornell was authorised to carry out this recommendation, and went to the Periya Paar early in November with boats and appliances suitable for the work, but found he had arrived too late. The south-west monsoon had intervened, the bed had apparently been swept clean, and the enormous population of young oysters, which we had seen in March, and which might have been used to stock many of the smaller inshore paars, was now in all probability either buried in sand or carried down the steep declivity into the deep water outside. This experience, taken along with what we know of the past history of the bank as revealed by the inspectors' reports, shows that whenever young oysters are found on the Periya Paar, they ought, without delay, to be dredged up in bulk and transplanted to suitable ground in the Cheval district—the region where the most trustworthy paars are placed.

From this example of the Periya Paar it is clear that in considering the vicissitudes of the pearl oyster banks we have to deal with great natural causes which cannot be removed, but which may to some extent be avoided, and that consequently it is necessary to introduce large measures of cultivation and regulation in order to increase the adult population on the grounds, give greater constancy to the supply, and remove the disappointing fluctuations in the fishery.

There are in addition, however, various minor causes of failure of the fisheries, some of which we were able to investigate. The pearl oyster has many enemies, such as star-fishes, boring sponges which destroy the shell, boring Molluscs which suck out the animal, internal Protozoan and Vermean parasites and carnivorous fishes, all of which cause some destruction, and which may conspire on occasions to ruin a bed and change the prospects of a fishery. But in connection with such zoological enemies, it is necessary to bear in mind that from the fisheries point of view their influence is not wholly evil, as some of them are closely associated with pearl production in the oyster. One enemy (a Plectognathid fish) which doubtless devours many of the oysters, at the same time receives and passes on the parasite which leads to the production of pearls in others. The loss of some individuals is in that case a toll that we very willingly pay, and no one would advocate the extermination of that particular enemy.

In fact the oyster can probably cope well enough with its animate environment if not too recklessly decimated at the fisheries, and if man will only compensate to some extent for the damage he does by giving some attention to the breeding stock and "spat," and by transplanting when required the growing young from unsuitable ground to known and trustworthy "paars."

Those were the main considerations that impressed me during our work on the banks, and were, therefore, the leading points dealt with in the conclusions given in my preliminary report (July, 1902), which ended as follows:—

"To the biologist two dangers are, however, evident, and, paradoxical as it may seem, these are *overcrowding* and *overfishing*. But the superabundance and the risk of depletion are at the opposite ends of the life cycle, and therefore both are possible at once on the same ground—and either is sufficient to cause locally and temporarily a failure of the pearl oyster fishery. What is required to obviate these two dangers ahead, and ensure more constancy in the fisheries, is careful supervision of the banks by someone who has had sufficient biological training to understand the life-problems of the animal, and who will therefore know when to carry out simple measures of farming, such as thinning and transplanting, and when to advise as to the regulation of the fisheries."

In connection with cultivation and transplantation, there are various points in structure, reproduction, life-history, growth and habits of the oyster which we had to deal with, and some of which we were able to determine on the banks, while others have been the subject of Mr. Hornell's work since, in the little marine laboratory we established at Galle. [Discussed and illustrated by lantern slides in the lecture.]

Turning now from the health of the oyster population on the "paars" to the subject of pearl formation, which is evidently an unhealthy and abnormal process, we find that in the Ceylon oyster there are several distinct causes that lead to the production of pearls. Some pearls or pearly excrescences on the interior of the shell are due to the irritation caused by boring sponges and burrowing worms. Minute grains of sand and other foreign bodies gaining access to the body inside the shell, which are popularly supposed to form the nuclei of pearls, only do so, in our experience, in exceptional circumstances. Out of the many pearls I have decalcified, only one contained in its centre what was undoubtedly a grain of sand; and from Mr. Hornell's notes, taken since I left Ceylon, I quote the following passage, showing that he has had a similar experience:—

"February 16, 1903—*Ear-pearls*. Of two decalcified, one from the anterior ear (No. 148), proved to have a minute quartz grain (micro. preparation 25) as nucleus."

It seems probable that it is only when the shell is injured, as, for example, by the breaking off or crushing of the projecting "ears," thereby enabling some fine sand to gain access to the interior, that such inorganic particles supply the irritation which gives rise to pearl formation.

The majority of the pearls found free in the tissues of the body of the Ceylon oyster contain, in our experience, the more or less easily recognisable remains of Platyelmian parasites; so that the stimulation which causes eventually the formation of an "orient" pearl is, as has been suggested by various writers in the past, due to infection by a minute lowly worm, which becomes encased and dies, thus justifying, in a sense, Dubois's statement that—"La plus belle perle n'est donc, en définitive, que le brillant sarcophage d'un ver" (*Comptes rendus*, October 14, 1901.)

[The lecturer then dealt with the work of Dr. Kelaart (1859), to whom belongs the honour of having first connected the formation of pearls in the Ceylon oyster with the presence of Vermean parasites, Filippi, Kukenmeister, Moebius, Humbert, Garner, Thurston, Giard, Seurat, Jameson, and finally Dubois—bringing the record up to January, 1903.]

We have found, as Kelaart did half a century ago, that in the Ceylon pearl oyster there are several different kinds of worms commonly occurring as parasites, and we shall, I think, be able to show in our final report that Cestodes, Trematodes, and Nematodes are all concerned in pearl formation. Unlike the case of the European mussels, however, we find, so far, that in Ceylon the most important cause is a larval Cestode of the Tetrarhynchus form. Mr. Hornell has traced a considerable part of the life-history of this parasite, from an early free-swimming stage to a late larval condition in the file fish (*Balistes mitis*) which frequents the pearl banks and preys upon the oysters. We have not yet succeeded in finding the adult, but it will probably prove to infest the sharks or other large Elasmobranchs which devour Balistes. It is only due to my excellent assistant, Mr. James Hornell, to state that our observations on pearl formation are mainly due to him. During the comparatively limited time (under three months) that I had on the banks, I was mainly occupied with what seemed the more important question of the life-conditions of the oyster, in view of the frequent depletion of particular grounds. It is important to note that these interesting pearl-formation parasites are not only widely distributed over the Manaar banks, but also on other parts of the coast of Ceylon. Mr. Hornell has found Balistes with its Cestode parasite both at Trincomalie and at Galle, and the sharks also occur all round the island, so that there can be no question as to the probable infection of oysters grown at these or any other suitable localities.

There is still, however, much to find out in regard to all these points, and other details affecting the life of the oyster and the prosperity of the pearl fisheries. Mr. Hornell and I are still in the middle of our investigations, and this must be regarded as only a preliminary statement of results which may have to be corrected, and I hope will be considerably extended in our final report.

It is interesting to note that the *Ceylon Government Gazette* of December 22 last announced a pearl fishery, to commence on February 22, during which the following banks would be fished :—

The South-East Cheval Paar, estimated to have 49 million oysters.

The East Cheval Paar, with 11 millions.

The North-East Cheval Paar, with 13 millions.

The Periya Paar Kerrai, with 8 millions—making in all more than 80 million oysters.

That fishery is now in progress, Mr. Hornell is attending it, and we hope that it may result not merely in a large revenue from pearls, but also in considerable additions to our scientific knowledge of the oysters.

As an incident of our work in Ceylon, it was found necessary to fit up the scientific man's workshop—a small laboratory on the edge of the sea, with experimental tanks, a circulation of sea-water and facilities for microscopic and other work. For several reasons [discussed in the lecture] we chose Galle at the southern end of Ceylon, and we have every reason to be satisfied with the choice. With its large bay, its rich fauna and the sheltered collecting ground of the lagoon within the coral reef, it is probably one of the best possible spots for the naturalist's work in eastern tropical seas.

In the interests of science it is to be hoped, then, that the marine laboratory at Galle will soon be established on a permanent basis with a suitable equipment. It ought, moreover, to be of sufficient size to accommodate two or three additional zoologists, such as members of the staff of the museum and of the medical college at Colombo, or scientific visitors from Europe. The work of such men would help in the investigation of the marine fauna and in the elucidation of practical problems, and the laboratory would soon become a credit and an attraction to the colony. Such an institution at Galle would be known throughout the scientific world, and would be visited by many students of science, and it might reasonably he hoped that in time it would perform for the marine biology and the fishing industries of Ceylon very much the same important functions as those fulfilled by the celebrated gardens and laboratory at Peradeniya for the botany and associated economic problems of the land. W. A. H.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

Mr. F. C. McClellan has been appointed to the new chair of forestry and estate management at the Royal Agricultural College, Cirencester.

The new science buildings of the Colston's Girls' School, Bristol, will be opened on Friday, May 15, by the Right Hon. Henry Hobhouse, M.P.

We have received a copy of the University of Colorado *Bulletin* for December, 1902. It contains a detailed account of the quarto-centennial celebration held at the end of last year in connection with the University of Colorado, when addresses were delivered by Profs. A. Reed, F. S. Lee, D. C. Jackson, and others.

The Council of the Manchester Literary and Philosophical Society has appointed Mr. A. P. Hunt, sublibrarian of Balliol College, Oxford, to be assistant secretary and librarian to the Society, in succession to Mr. Charles Leigh, who has been appointed deputy librarian of the Owens College, Manchester.

The second volume of the Report of the U.S. Commissioner of Education for the year 1900–1901 runs, like the former part, to more than twelve hundred pages. A large portion of the volume is concerned solely with statistics, and these refer to every grade of education. Uninteresting though these masses of figures are likely to prove to ordinary teachers, they will be found of great value by the student of educational problems. The descriptive article which will most directly appeal to men of science is one on instruction in mining engineering. It appears that the first school of mines in the United States was established in New York City in 1863, in connection with the institution which later developed into the existing Columbia University. At the close of 1901 there were thirty-seven institutions offering courses in mining engineering, two of the courses—those in connection with the University of North Carolina and the University of Texas—having been instituted in 1901. The article also contains short accounts of the systems of instruction in mining in each of the thirty-seven institutions holding courses. A chapter is given to consular reports sent home to the United States by its consuls in different parts of the world, and these reports contain many hints likely to be of practical value to the lecturers and others in American colleges. One chapter appears out of place in an educational report, since it is concerned with the introduction of domestic reindeer into Alaska.

The first part of vol. xiv. of the *Transactions* of the South African Philosophical Society contains an instructive paper by the Rev. Dr. Flint on the legal and economic bases of some colonial teaching universities, which concludes with the local application of the results of the inquiry. The paper summarises the salient facts in the history of the important colonial universities, but it is only possible here to refer to one or two points of interest. The Government of New South Wales voted at its establishment 50,000*l.* for the buildings of Sydney University. An endowment of not more than 20,000*l.*, with an annual sum of 500*l.* for the stipend of the principal, was provided for each college incorporated within Sydney University upon the condition that 10,000*l.* at least shall have been subscribed by its founders, the whole to be voted to the erection of buildings on land granted for the purpose. New Zealand University has also been generously treated by its Government, from which source it receives an annual grant of 3000*l.* But in addition to this the four affiliated colleges have received land grants to the extent of 40,000 acres, and Otago, for instance, receives in rent from lands granted in this way about 6500*l.* per year. Similarly, the University of Adelaide received from South Australia a grant of 50,000 acres. The University of Melbourne appears to receive in Government grants some 13,500*l.* It is well that these examples, which do not by any means exhaust the instances given in the paper, should be brought prominently before the people of South Africa, in view of the growing feeling that a worthy teaching university for the whole of South Africa is much needed.

The annual discussion before the Washington meeting last January of the American Society of Naturalists dealt with the question : How can endowments be used most effectively for scientific research? The speeches on this occasion are printed in *Science* for April 10. Prof. T. C. Chamberlin advocated the special endowment of chairs of research. There ought no longer, he said, to be a struggle on the part of the capable investigator to free himself from obligations to teach that he may devote himself to creative work. From 20,000*l.* to 40,000*l.* would effectively endow a chair of research, though Prof. Chamberlin argued later that the endowment should be made to the department rather than a specific chair, thus distributing the function of research among the members of the staff according to their capabilities and tastes. Prof. W. M. Wheeler showed how large a part of the value of fellowships was lost to research by expecting fellows to perform extraneous duties and to do their research always at a given institution. Prof. Münsterberg insisted that the only two factors which really count for research are to be found in the minds of the men engaged upon it; they are, first, intellectual quality, and secondly, the will to achieve. In these two respects he maintained American research to be defective. He urged the men of wealth who had millions ready for endowment first to make the career of research attractive, so that more men of first-class type may be tempted, and to create great premiums by putting above the present university system a still higher institution, an over-university where the finest masters of research, chosen by their peers, are brought together for far-reaching work which transcends the possibilities of the educational institutions. Whatever can be done to give the career national glory thus to attract the finest men will be productive for the work of research. To secure that able men shall do their best work he advised the following course:—Make the academic career in the real universities, the promotion to higher positions, dependent in first line upon research work, as it is in Germany, and the work will be done, in spite of all obstacles. There is at present no greater educational need than to educate the trustees and benefactors of universities.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, March 26.—"Some Physical Properties of Nickel Carbonyl." By James **Dewar**, M.A., Sc.D., LL.D., F.R.S., and Humphrey Owen **Jones**, M.A., B.Sc.

The authors' communication gives an account of the investigation of a number of the physical properties of nickel carbonyl which have hitherto been investigated only to a slight extent.

It was found that the compound in the gaseous state was much more stable than it had hitherto been supposed to be, and that no explosion took place when the vapour was suddenly heated, provided that oxygen was not present in the surrounding gas. When the vapour was decomposed by heat the products of dissociation were nickel and carbon monoxide; at temperatures below 180° C. only traces of carbon dioxide could be detected, so that the decomposition postulated by Berthelot to explain the explosion of the vapour does not take place to any appreciable extent.

A large number of vapour density determinations were made by Victor Meyer's method at a number of temperatures between 63° C. and 216° C. in an atmosphere of various inert gases (hydrogen, nitrogen and ethylene), and also in carbon monoxide.

The effect of temperature, of rate of admixture of the vapour with the surrounding gas by diffusion, and of the presence of one of the products of dissociation on the extent of the dissociation is very clearly seen from the numerical values and the curves.

A number of determinations of the vapour-density at various temperatures under reduced pressure were made, and also show the marked effect of temperature on the dissociation. The dissociation becomes practically complete only at the boiling point of aniline.

The critical temperature was found to be about 200° C., and the critical pressure was estimated to be about thirty atmospheres.

A number of vapour-pressure determinations were made by the statical method over a range of temperature between −9° C. and +30° C. From the values obtained, the Rankine formula gives the following relation between the absolute temperature T and the pressure p in millimetres of mercury:—

$$\log p = 7{\cdot}355 - 1415/T.$$

The results are compared with those obtained by Mittasch by the dynamic method.

Various constants are calculated from the results obtained, and these are found in several cases to be very similar to the corresponding constants for ether. The latent heat of vaporisation is 38·1 calories per gram, and the Trouton constant is 20·6. The molecule of nickel carbonyl appears to be 4.2 times larger than that of carbon monoxide.

Some experiments which were made show that the reaction between carbon monoxide and nickel is reversible, and proceeds rapidly at the ordinary temperature, and with a measurable velocity at very low temperatures.

Royal Microscopical Society, April 15.—Dr. Hy. Woodward, F.R.S., in the chair.—Mr. F. W. **Millett's** report on the recent Foraminifera of the Malay Archipelago collected by Mr. A. Durrand, part xiv., was taken as read.—The secretary read a paper by Mr. E. B. **Stringer** on a new method of using the electric arc in photomicrography. The method consists in employing the radiation of the electric arc itself altogether separated from the incandescent carbons. This, modified by certain light filters, yields a powerful violet monochromatic light on the extreme limit of visibility. The separation is effected by the substage diaphragm, the opening in which is adjusted so as to allow only the radiation of the arc to pass. A trough containing a solution of ammoniated sulphate of copper suppresses all but the violet band, and the ultra-violet rays are intercepted by another trough containing a solution of sulphate of quinine. Lantern slides of *Pleurosigma angulatum*, dry, and *Coscinodiscus asteromphalus* in styrax, taken with a Zeiss 3 mm. oil immersion apochromatic objective of 1·4 N.A. and 8 compensating eye-piece giving a magnification of 2200 diameters, were shown upon the screen. The author discussed the possibility of obtaining lenses corrected for the ultra-violet rays which would enable photography to do for the microscope what it had already done for the telescope. Three slides of *Navicula bombus* were shown on the screen to demonstrate the advantage of using the troughs containing solutions of ammoniated sulphate of copper and sulphate of quinine.—Dr. R. **Hamlyn-Harris** sent a description of an apparatus for facilitating the manipulation of celloidin sections. The apparatus consisted of a circular vessel 3½″ diameter and ⅝″ deep outside. The body is made of a non-corroding metal, and the bottom of brass. It is divided into twenty compartments; in each compartment are perforations to allow fluid to escape when the transfer is made from one fluid to another. The apparatus suggested itself to the writer's mind in consequence of the difficulties experienced by him in preparing, staining, and mounting a series of celloidin sections in successive order.—Mr. C. F. **Rousselet** exhibited about two dozen mounted slides of Rotifers of the genus Brachionus. The specimens, besides those collected in England, came from America, Asia Minor, Bohemia, China, Germany, and Hungary, and comprised sixteen species, including one not yet described, and a number of varieties. The author mentioned that the *B. reubens* exhibited was the true species of Ehrenberg, and different from the one figured under that name in Hudson and Gosse's monograph.

PARIS.

Academy of Sciences, April 20.—M. Albert Gaudry in the chair.—Statistics of the minor planets. The distribution of the elements taking the aphelia as the argument, by M. O. **Callandreau.** The aphelia distances arrange themselves symmetrically about their mean value in a manner resembling the arrangement of accidental errors.—On spirillosis in the Bovidæ, by M. A. **Laveran.** An account, with drawings, of the detailed examination of the blood of Transvaal cattle infected with spirilla. These parasites have always been found in the blood of cattle associated with other organisms. At the present time only two diseases are definitely known to be produced by spirilla, the relapsing fever caused by *Sp. Obermeieri*, peculiar to man, and the spirillosis produced by *Sp. anserinum.* The parasite described in the present paper forms a new species, to which the name *Sp. Theileri* is given.—On the integration of differential equations of the second order with constant coefficients, by M. E. **Vallier.**—The specific heats and heats of vaporisation and of fusion of aniline and some other organic compounds, by M. **de Forcrand.** The specific heat of aniline in the solid and liquid state and of the latent heat of fusion has been determined by the method of mixtures. Measurements are also given for nitrobenzene, benzene, and acetic acid.—Photographic observation of the eclipse of the moon on April 11, 1903, at the Observatory of Toulouse, by M. **Montangerand.** The atmospheric conditions on the night of the eclipse were very favourable, eleven negatives being obtained.—Observation of the lunar eclipse of April 11–12, 1903, by M. R. **Mailhat.** Eighteen negatives were taken and submitted to the Academy.—On M. Guichard's new transformation of surfaces of total constant curvature, by M. **Tzitzéica.**—On a new generalisation of the theorem of M. Picard on entire functions, by M. Georges **Remoundos.**—Researches on electric convection, by MM. V. **Crémieu** and H. **Pender.** In spite of the contradictory nature of some of the experimental results obtained, the authors believe that they are justified in drawing the conclusion that charged metallic surfaces, either continuous or divided into sectors, and turning in air in their own plane, produce magnetic effects in the sense predicted by electric convection, and agreeing within 10 per cent. with the order of magnitude calculated for convection. The interposition of fixed armatures between the moving surfaces and the measuring apparatus appears to have no influence on the magnetic effects obtained.—On magnetic hysteresis at high frequencies, by MM. C. E. **Guye** and B. **Herzfield.** The question has frequently been raised as to whether the energy lost by hysteresis in a magnetic cycle is independent of the speed with which the cycle is completed, and very contradictory results have hitherto been published. The chief cause of uncertainty is the presence of Foucault currents, and in the experiments described in the present paper an attempt has been made to eliminate this difficulty by the use of very fine iron wires, and a thermal method for measuring the energy dissipated in the wire has been adopted. Up to 1200 periods per second the energy consumed by hysteresis is independent of the velocity of the cycle.—On the magnetic properties of the terrestrial atmosphere, by M. Charles **Nordmann.** The magnetic properties of the atmosphere can only have a very small effect on the earth's magnetic field, and can only produce a negligible fraction of the diurnal period of a magnetised needle.—On electric sparks, by M. B. **Eginitis.**—The electrical separation of metallic powders and inert material, and of the metallic part of a mineral from its gangue, by M. D. **Negreano.**—On a self-registering galvanometer and a rotating contact, and their use in tracing the curves of alternating currents, by M. J. **Charpentier.** The mechanism controlling the introduction and motion of the sheet of paper upon which the curve is to be drawn is the chief characteristic of the recording galvanometer for which novelty is claimed.—The nature of the sulphur compound in the water from the Bayen spring at Bagnères-de-Luchon, by M. F. **Garrigou.** The Bayen water, before contact with air, contains a sulphydrate of sulphur.—Soluble cellulose, by M. Léo **Vignon.** Oxycellulose, prepared from cellulose by means of hydrochloric acid and potassium chlorate, is acted upon by aqueous solutions of potash in the cold, with regeneration of cellulose and forming a soluble cellulose, which can be precipitated from the solution by hydrochloric acid, or chlorides of the alkalis and alkaline earths.—Physiological and histological observations on the Gephyrians (endothelial derivatives and pigmentary granules), by M. Marcel A. **Hérubel.**—On the existence of an axile filament in the adult conjunctival fibrilla, by M. P. A. **Zachariadès.**—Indophil reaction of the leucocytes in the aseptic suppurations caused by the subcutaneous injection of essence of turpentine, by MM. J. **Sabrazès** and L. **Muratot**.

DIARY OF SOCIETIES.

THURSDAY, April 30.

Royal Society, at 4.30.—Croonian Lecture: The Cosmical Function of the Green Plant: Prof. K. A. Timirjazev.

Royal Institution, at 5.—Hydrogen: Gaseous, Liquid and Solid: Prof. Dewar, F.R.S.

Institution of Electrical Engineers, at 8.—Divided Multiple Switchboards: An Efficient Telephone System for the World's Capitals: W. Aitken.

FRIDAY, May 1.

Royal Institution, at 9.—Recent Advances in Stereochemistry: Prof. W. J. Pope.

Geologists' Association, at 8.—The Zones of the White Chalk of the English Coast. IV.—Yorkshire: Dr. A. W. Rowe.

MONDAY, May 4.

Society of Chemical Industry, at 8.—Problems in the Fat Industry: Dr. Julius Lewkowitsch.

Society of Arts, at 8.—Mechanical Road Carriages: W. Worby Beaumont.

Victoria Institute, at 4.30.—Report on the Congress of Orientalists held at Hamburg, together with a Short Description of the Laws of Hammurabi, the Amraphel of Genesis, Ch. xiv., as Engraved on the Recently Discovered Monument: Dr. T. G. Pinches.

TUESDAY, May 5.

Royal Institution, at 5.—The Blood and some of its Problems: Prof. Allan Macfadyen.

Society for the Promotion of Hellenic Studies, at 4.30.

Society of Arts, at 4.30.—The Lagos Hinterland: its People and its Products: Major J. H. Ewart.

WEDNESDAY, May 6.

Entomological Society, at 8.—Descriptions of twelve New Genera and Species of Ichneumonidæ and three New Species of Ampulex from India: Peter Cameron.

Society of Public Analysts, at 8.

Society of Arts, at 8.—The Construction of Maps and Charts: G. J. Morrison.

THURSDAY, May 7.

Royal Society, at 4.30.—*Probable Papers*:—On *Lagenostoma Lomaxi*, the Seed of Lyginodendron: Dr. F. W. Oliver and Dr. D. H. Scott, F.R.S.—On the Physiological Action of the Poison of the Hydrophidæ: Dr. L. Rogers.—Preliminary Note on the Discovery of the Pigmy Elephant in Cyprus: Miss D. M. A. Bate.

Royal Institution, at 5.—Hydrogen: Gaseous, Liquid and Solid: Prof. Dewar, F.R.S.

Röntgen Society, at 8.30.—Exhibition Evening.

Chemical Society, at 8.—(1) β-Bromonitrocamphor and β-Bromocamphoryloxime. Influence of Impurities in Conditioning Dynamic Isomerism; (2) Spontaneous Decomposition of Nitrocamphor: T. M. Lowry.—The Active Constituents of *Butea frondosa*: E. G. Hill.

Linnean Society, at 8.—The Ingolfiellidæ, fam. nov., a New Type of Amphipoda: Dr. H. J. Hansen.—The Evolution of the Marsupials of Australia: A. Bensley.—Copepoda Calanoida from the Faröe Channel, and Other Parts of the North Atlantic: Rev. Canon Norman, F.R.S.

Institution of Electrical Engineers, at 8.—Applications of Electricity in Engineering and Shipbuilding Works: A. D. Williamson.—Electric Driving in Machine Shops: A. B. Chatwood.

FRIDAY, May 8.

Royal Institution, at 9.—Rural England: H. Rider Haggard.

Royal Astronomical Society, at 5.

Malacological Society, at 8.—On the Necessity of Examining and Comparing the Animals before Determining some Species of the Genus Oliva: F. G. Bridgman.—Notes on some British Eulimidæ: E. R. Sykes.—Note on the Occurrence of *Planorbis marginatus*, Drap., and *Limnaea pereger*, Müll., in the Pleistocene of Bognor, Sussex: Alexander Reynell.

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