THURSDAY, AUGUST 14, 1890.

THE INCOME-TAX AND THE PROMOTION OF SCIENCE.

THE case of the Commissioners of Inland Revenue *v.* Forrest (the latter representing the Institution of Civil Engineers), which was finally decided on the 1st inst. by the House of Lords, is of great importance to all scientific corporations, associations, and institutions in this country, and, incidentally, the judgments cannot fail to interest, and possibly also to amuse, men of science, because it became necessary for their Lordships to consider what is science, or, rather, what the Legislature meant by the word science in a particular statute. Shorn of all technicality, the question was whether the Institution of Civil Engineers was liable to pay income-tax under the Revenue Act of 1885, section 11 of which was framed with the object of imposing a duty of 5 per cent. on the yearly value, income, or profits of bodies which escape probate, legacy, and succession duties, inasmuch as they never die and have no legal heirs or successors. The net was thrown with the object of catching trading corporations, companies, and associations, and compelling them to pay, in the shape of an annual impost, an equivalent for the various death duties levied on private individuals. The Act imposing this tax, however, exempted different classes of associations, and notably in sub-section 3 of section 11 it exempted all property the income or profit of which is applied for religious or charitable purposes, "or for the promotion of education, literature, science, or the fine arts." The whole question therefore resolved itself into this: Is the Institution of Civil Engineers an association "for the promotion of science"? The Commissioners thought it was not, in the sense used in the Act; Lord Coleridge and Mr. Justice (now Lord) Field sitting in one Court agreed with the Commissioners; Lord Justice Lopes in the Court of Appeal, and the Lord Chancellor in the House of Lords, were of the same opinion; but Lord Esher and Lord Justice Fry in the Court of Appeal, and Lord Watson and Lord Macnaghten in the House of Lords, held that the Institution was one for the promotion of science, and therefore exempt from the tax. The Institution therefore had a majority of the judges in the Court of Appeal and in the House of Lords, and it is now the law of England, until the Legislature chooses to alter it, that the Institution and all similar associations and bodies are exempt from this tax. Science, and, indeed, literature and the fine arts as well, owe a debt of gratitude to the Institution for its sturdy stand against the demand for payment. Although it is successful, its costs, over and above what it will receive from the Crown as the losing party, would, if invested, probably yield an income sufficient to satisfy the demand made upon it; by continuing the fight it has been the means of relieving the revenues of every association of the kind in the country from a burden of 5 per cent. per annum, an impost which in some cases would be intolerable, and would perhaps lead to the extinction of many struggling associations which are worthy of more support than they receive. In a sense, all science is relieved of a tax, and this it owes to the Institution of Civil Engineers.

We have said that the question turned on the meaning to be attached to the phrase "promotion of science," and ultimately to the word "science." The consideration of this question was complicated by the circumstance that in 1843 an Act was passed for dealing with the application of local rating (the Act of 1885, which was in question in this case, dealt wholly with Imperial taxation) to "exclusively" scientific and literary institutions supported wholly or in part by voluntary contributions. Under this Act it has been decided, for example, that the Zoological Society and the Russell Institution are liable to local rates, and it was against decisions such as these, and the instinct of judges to seek for a precedent, that the Institution of Civil Engineers had to fight in the present instance. Lord Macnaghten, however, boldly threw over the Act of 1843 and the decisions under it altogether, and refused to regard them as throwing any light on the Act of 1885. It referred, he said, merely to local rates, exemption from which is an invidious distinction, and throws a burden on everyone in the neighbourhood; while the present case being one of Imperial taxation, the range of exemption is far more extensive, and the conditions far more liberal.

The previous statute, and all the decisions under it, being thus disposed of, the judges were deprived of precedents, and had to answer for themselves what was science in the intention of the Legislature in 1885. Most intelligent people have a satisfactory working definition of the word; but it evidently perplexed the keen and experienced legal intellects of the judges in the House of Lords. The Lord Chancellor thought it could not, in this place, be equivalent to knowledge, because this would exempt almost every institution in the country, but that it did refer to science generally, and not to any particular branch of it. The Institution was, he argued, established for the benefit and interest of civil engineers, and not directly (though, no doubt, indirectly) for the advantage of the whole community. "I think a member of it makes a very good bargain for himself in becoming a member of it," and hence he did not regard it as exempt from taxation. Lord Watson took quite a different view, without going largely into questions of definition. It was indisputable, he said, that there was a science of civil engineering, that its development is of the utmost consequence to the national interests, that the labours of the Institution are of value to the profession at large, and constitute a substantial addition to the sum of human knowledge, and that it would be difficult to say what more effective measures could be adopted for the promotion of engineering science than those of the Institution. He found, therefore, that the latter applied its income, not to the professional ends of individuals, but for "the promotion of science," and that it was entitled to the exemption. Lord Macnaghten faced the question of the meaning of the word "science" in the Act:—

"I see no reason why it should be confined to pure or speculative science. The expression plainly includes applied science, and it was intended, I think, to denote a particular branch of science, as well as universal science or science generally."

This being his view, Lord Macnaghten, like Lord Watson, found no difficulty in arriving at the conclusion that the Institution of Civil Engineers did in fact promote science :—

"Substantially, as it seems to me, the whole of the Society's income is applied to the promotion of science. My Lords, I cannot conceive in what better way the promotion of mechanical science, and in particular of those branches of mechanical science which lie within the province of civil engineering, could be effected. I cannot doubt that by means of the discussions on the papers read at the ordinary meetings of the Society much new light has been thrown on scientific questions, and much knowledge, which would otherwise have perished, has been preserved. I see no trace of a selfish or illiberal spirit in the proceedings of the Society, nor do I find anything to lead me to suppose that its property and income are applied otherwise than *bonâ fide* for the promotion of science. The action of the Society may incidentally benefit the profession to which its members belong—I have no doubt that is so—but I agree with the Master of the Rolls in thinking that 'that which this Society does is something higher and larger than the mere education of students and others for the profession of civil engineers.'"

The admirable definition of the object of the Institution, embodied in the charter of 1828, was stated in the course of one of the judgments to have been drafted by Thomas Tredgold. The Institution, it says, is established for the purpose of

"the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in States both for external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation, and docks, for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns."

It is only right to say, in conclusion, that the utility of the work done by the Institution was admitted in the warmest manner by those judges who found themselves compelled to decide against its claim to exemption, now happily established.

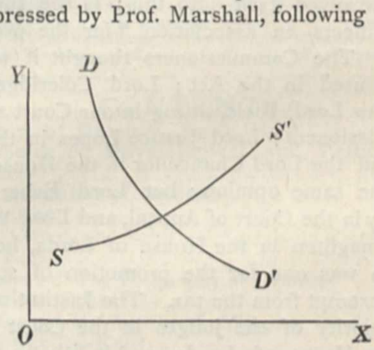
PRINCIPLES OF ECONOMICS.

Principles of Economics. Vol. I. By Prof. Alfred Marshall. (London: Macmillan and Co., 1890.)

ECONOMICS admit of being reduced to principles more than other sciences dealing with human actions, for the reason which Prof. Marshall has thus expressed: "Wide as are the interests of which the economist takes account when applying his doctrines to practice, the centre of his work is a body of systematic reasoning as to the quantities of measurable motives." These measurable motives are not necessarily self-interested: "The range of economic measurement may gradually extend to much philanthropic action." Even now the supply of labour and of capital is largely due to the motive of family affection. The uniformities of action resulting from such measurable motives may be regarded as the laws of motion in what Jevons called *the mechanics of industry*—a science which Prof. Marshall has cultivated with more success than any of his predecessors, owing to an unexampled combination of antithetical powers, the comprehensive grasp of mathematical reasoning, and the careful handling in detail of the observed facts.

As in physical mechanics innumerable conditions may be comprehended under the principle of virtual velocity, so also there is a unifying principle in the mechanics of industry. "Most economic problems have a kernel relating to the equilibrium of demand and supply." It is the peculiar merit of Prof. Marshall's arrangement to treat the law of supply and demand generally, before applying it to particular "markets," such as that relating to labour. It is here that he differs most from Mill, who seems to put asunder what the nature of things has joined together under one law—distribution and exchange. If Prof. Marshall's conception does not come as a surprise to his readers, it must be considered that he himself, in published and unpublished writings, has prepared the scientific world to accept his view. The services of others, particularly Prof. Walras, in improving upon the old wooden conception of distribution are not to be forgotten. Still it is true that, as far as we know, Prof. Marshall is the first adequately to treat what he has elsewhere called the pure theory of domestic (as opposed to international) value; uniting in a comprehensive view the doctrine of final utility, which Jevons and other recent writers have made prominent, with the equally eternal verities relating to "cost of production," which are connected with the name of Ricardo. The "theorems of Ricardo and Marshall" are rightly coupled by Signor Pantaleoni in his masterly "Principii di Economia Pura."

The relation between cost of production and demand is thus expressed by Prof. Marshall, following Cournot.



In the annexed diagram the abscissa indicates the amount of a product, and the ordinate the price thereof. DD' is the demand curve, representing the quantity of the product which is demanded at each price; SS' the supply curve, representing the quantity which is offered at each price. The intersection of these curves determines the equilibrium of the *market*—a generic term used in a wide sense, covering the temporary equilibrium of a fish-market and those slow processes of competition which it requires a generation to work out.

From this point of view is apparent the inaccuracy of those who describe value as altogether an affair of final utility, and speak of Ricardo as being "preposterous" in the classic sense of putting the cart before the horse. To use our own illustration, these economists might be compared to a physicist who should insist that in the determination of the position at which a balloon reaches equilibrium, the buoyant gas plays a more important part than the heavy car. To be sure balloons could not go up without gas; whereas they might, and sometimes do, without a car. Still, from a mathematical point of view, we submit, it is legitimate to attribute to the positive and negative forces a "fundamental symmetry"—as Prof. Marshall characterizes the equilibrating motives towards utility and from *disutility*. By parity of reasoning they also are to be condemned who, neglecting final utility, worship only cost of production. But it may well be doubed whether this form of what we may call the monophysite heresy in regard to the doctrine of value is attributable in a serious degree to Ricardo. It is tenable that

"the older economists seem to have been rightly guided by their intuition when they silently determined that the forces of supply were those the study of which was the more urgent and involved the greater difficulty."

The theory of cost of production would be easy if all economic action were as simple as in the case of one who goes on picking and eating blackberries until the labour of picking just compensates the pleasure of eating. The concrete case is greatly complicated by the element of *time*. Under cost of production we must include the less direct efforts and sacrifices, such as that of the parent who, vicariously competing in the labour market, supplies an educated employer or artisan to that occupation where there appears to be the best opening. Before the education is completed perhaps the opening has ceased to be the best. The normal tendency to equilibrium is thus ever interrupted by the introduction of some new condition:—

"There is a constant tendency of the surface of the sea towards a position of rest, but the moon and sun are always shifting their places and always therefore changing the conditions by which the equilibrium of the sea is governed; and meanwhile there are ceaseless currents of the raging winds; the surface is always tending towards a position of normal equilibrium, but never attains it."

In this troubled scene everything is in flux, and subject to the theory of fluxions:—

"The amount of the commodity and its price, the amounts of the several factors or agents of production used in making it and their prices—all these elements *mutually determine one another* [we italicize words which convey a lesson which has never before been taught thoroughly], and if an external cause should alter any one of them, the effect of the disturbance extends to all the others."

If there is any of the economic variables of which it may be said that it is determined without determining, it might be the old Ricardian "inherent properties" of land, about which Prof. Marshall has much that is new to say. As for the quasi-rents which more recent theory has evolved, they are all affected with the fallacy which Prof. Marshall's scientific method is particularly adapted to guard against—the treating as constant quantities which are variable. The "margin" from which the remuneration in any skilled occupation is measured is itself a variable, varying with the remuneration; because the supply of competitors is dependent upon the prospect held out by the great prizes in that occupation. The apologist of the existing economic *régime* who defends the profits of the successful employer as being a rent of ability, the Socialist who attacks the interest of capital as being a rent of opportunity, are alike building their insecure constructions upon the sands of a shifting coast-line.

We are prevented by the narrowness of our limits from exhibiting the important results obtained by the full treatment of the subject to which we have barely adverted—namely, the *simultaneous* determination both of the relative value of products, and the remuneration of producers, in a *régime* of free competition. We must hasten on to observe that the same methods of abstract reasoning are applicable, *mutatis mutandis*, to a *régime* of monopoly. This case is important, not only for itself, on account of the prevalence of trusts and monopolies, but also by reason of the analogy between governmental and monopolistic action. Prof. Marshall, by original methods, deduces the startling conclusion

"that it might even be for the advantage of the community that the Government should levy taxes on commodities which obey the law of diminishing return, and spend part of the proceeds on bounties to commodities which obey the law of increasing return."

This reasoning is, of course, very abstract; abstracting the indirect evils which governmental interference may produce. But it at least suffices to destroy the *a priori* presumptions in favour of "economic harmonies" and unqualified *laissez faire*. Prof. Marshall reaches these and other important conclusions by estimating the "consumers' rent"—that is, the advantage which consumers derive from a fall of price. In connection with this subject we should advert to his beautiful theory of the elasticity of demand. The more elastic or expansive demand is, the greater is the increase of consumers' rent due to a given fall of price.

We should like to dwell upon the practical importance of these conceptions. But it is impossible here to analyze a work almost every page of which presents a new idea. We must be content with indicating methods as distinguished from particular theories. The mathematical method appears to be established in its proper position by the precept and example of Prof. Marshall:—

"Our observations of nature, in the moral as in the physical world, relate not so much to aggregate quantities as to increments of quantities. . . . It is not easy to get a clear full view of continuity in this aspect without the aid either of mathematical symbols or diagrams." . . .

Prof. Marshall expresses some preference for diagrams:—

"Experience seems to show that they give a firmer grasp of many important principles than can be got without their aid, and that there are many problems of pure theory which no one who has once learnt to use diagrams will willingly handle in any other way."

Developing a metaphor suggested by our author, we might compare these mechanical aids to reason to the machinery employed in material production. Appliances useful to one producer will not be equally so to another. There is what Prof. Marshall calls the "law of substitution," according to which each producer selects the expedients most serviceable in his own case. Usefulness will depend much on familiarity. "It seems doubtful whether anyone spends his time well in reading lengthy translations of economic doctrines into mathematics that have not been made by himself."

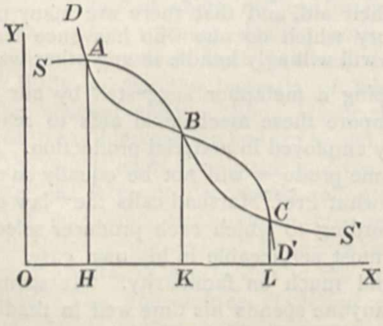
By way of illustrating this character of intellectual machinery, we shall advert to some passages which seem to us to contain things which some would rather have expressed otherwise. In the first note of his "Mathematical Appendix," Prof. Marshall, referring to the weakened motive power of distant or deferred pleasures, thus writes:—

"Let h be a pleasure of which the probability is p, and which will occur, if at all, at time t. Let r be the rate of interest per unit which must be added to present pleasures before comparing them to future, and let $R = 1 + r$; then the present value of the pleasure is phR^{-t}."

Should it not be more clearly expressed here, or elsewhere, that this formula holds only of marginal utility, and that it is not a general psychological truth irrespective of conditions imposed by a money market? For instance, I anticipate a series of pleasant hours extended over several weeks during which I shall be occupied in mastering this stupendous work. But I do not observe that the anticipated pleasure of the third week differs from that of the first according to an exponential law of variation.

Another verbal modification is suggested by the frequent use of the "law of substitution"; which, as above intimated, imports that producers will, as a rule, substitute the less for the more expensive methods of production. Might it not be well more often to substitute the simpler statement that the producer will seek to maximize his net advantages, considered as a function of different variables, *e.g.* labour, capital borrowed, &c.? From the principle that the partial differential of this function with respect to each of the variables is equated to zero follow, more easily perhaps than by verbal exposition, propositions of the form that "wages tend to equal the net produce of the worker's labour" (pp. 547-48). No doubt it is convenient to have a term which, as we understand, covers two distinguishable cases: where the maximum of advantage is pursued by varying the variable, or by discontinuously passing from one function to another. Indeed, this is a distinction on which Prof. Marshall, true to his motto, *Natura nil facit per saltum*, has, probably for good reasons, not insisted as much as might have been expected.

The condition above mentioned, that the first term of variation should be equated to zero, may of course indicate a minimum, as well as maximum, of utility. Prof. Marshall, following the analogy of physics, attributes to



a minimum the property of equilibrium. For example, in the case represented by the annexed figure, which corresponds to the author's Fig. 20 (p. 424)—SS' and DD' being, as above explained, the supply and demand curves —Prof. Marshall says, "H and L are points of stable equilibrium, and K is a point of unstable equilibrium." This interpretation may appear doubtful, when we consider that the supply curve, when *descending*, is the locus of *minimum advantage* for the producer. At any assigned price, *e.g.* SH or BK, this locus represents the very worst arrangement for the producer, the very bottom of the trough, where he cannot, even theoretically, be supposed content to stay. If this view be accepted, some doubt will be thrown on the "theory of multiple positions of equilibrium" (*ibid.*). A solution of these little difficulties, consistent with the author's conclusions, will probably be found by those who follow out the hints afforded by his pregnant notes.

A comparison with the eminent mathematical economists Messrs. Auspitz and Lieben suggests one more scruple. Those theorists regard the demand curve as the *envelope* of a series of discontinuous curves, each of the sort contemplated by Prof. Marshall, corresponding to different scales of living. This conception, if accepted as important, might have some bearing on the theory of "consumers' rent."

But in dwelling on such technical points we should run the risk of conveying an unfair impression of the worth and accuracy of Prof. Marshall's work. The theoretical subtleties about which a difference of opinion is possible "have a very narrow range of practical bearing." Prof. Marshall is the first to admit of his theory, "when pushed to its more remote and intricate logical consequences, especially those connected with multiple position of equilibrium, that it slips away from the conditions of real life, and soon ceases to be of much service in dealing with practical problems." Besides, this is a subject on which, as Disraeli said, the author is much more likely to be right than the critic. In this sort of mixed mathematics the authority of one who is, above all others, conversant with both ingredients of the mixture is almost supreme. He, of all mathematical economists, has best complied with his own maxim that the economist, while he employs "systematic reasoning as to the quantities of measurable motives, ... must never lose sight of the real issues of life; and these are all, with scarcely any important exceptions, affected more or less by motives that are not measurable."

Of the two parts of the economist's work we have here dwelt somewhat exclusively on that which best admits of being viewed synoptically, the more abstract side. We must be content with recording, without illustrating, the judgment that the moral and mathematical parts of Prof. Marshall's work are on a level of excellence. He not only applies the differential calculus to measure increments such as "a shilling's worth of happiness," but he also brings a higher faculty to judge of goods which cannot be measured by money, such as "the fulness and nobility of human life," "a pure heart, and a love towards God and man." He renders to the queen of the sciences the things which belong to her province, and to the spiritual side of our nature things which transcend man's power of calculation.

F. Y. E.

SADI CARNOT'S ESSAY.

Reflexions on the Motive Power of Heat, &c. From the original French of N.-L.-S. Carnot. Edited by R. H. Thurston, M.A., LL.D., Dr. Engg., Director of Sibley College, Cornell University ; " Officier de l'Instruction Publique de France" ; etc., etc., etc. (London: Macmillan and Co., 1890.)

NE soyons pas exigeants: la perfection est si rare! This is one of the rules laid down by Sadi Carnot for his own guidance :—and we will endeavour, as far as possible, to give his present Editor and Translator the benefit of it. They need it sadly.

There is no Press-mark on the book before us, but it bears internal evidence of having been printed in the United States. Surely there are few, if any, British printers who, at the end of a line, would divide words into such startling fragments as knowl-edge, quan-tity, uncer-tainties, transfor-mation, mecha-nism, hypothe-sis, mo-tive, &c., &c.!

The book is (described as) a "Translation of the famous work of Carnot." It is made from the Reprint of 1878, to which Carnot's surviving brother had added a slight but very interesting biographical sketch of the Author, as well as some extremely important excerpts from his unpublished MS. These additions are translated also. An exceedingly inconvenient arrangement, the separation of the longer foot-notes from the text of Carnot's Essay and their collection at the end of the book, is explained as "*simply a matter of convenience in book-making*." We presume, though it is not stated, that the quite unnecessary reprinting of Sir W. Thomson's paper, on Carnot's Theory, is also a simple matter of book-making!

The book is prefaced by a *Publisher's Note*, a *Note by the Editor*, and an Essay (also by the Editor) on *The Work of Sadi Carnot*. We forbear to comment on the first two of these. On the third we would make two remarks :—

(1) It is somewhat difficult for us who have lost so recently (and from our little island alone) men like Faraday, Joule, and Clerk-Maxwell, to feel the full justice of the statement that Sadi Carnot was perhaps "*the greatest genius, in the department of physical science at least, that this century has produced*." Exaggeration like this leads the reader to doubt the judicial competence of the man who employs it. We yield to none in our estimation of the value and originality of Carnot's work :—but such feelings must not blind us to the relative merits of others.

(2) Our opinion of the competence of the Editor is not enhanced by his informing us that at eighteen Hamilton "conceived" Quaternions (he means, presumably, the *Characteristic Function*, a totally different thing); nor by his even more striking novelties in scientific history.

As to the Translation itself, two questions arise. Was it necessary, and is it satisfactorily carried out? We have much doubt as to the propriety of translating *any* scientific work from French, German, Italian, or Latin, into English. If a man cannot read it in the original, his ignorance (all but criminal) should be punished. But if the propriety of translating at all is doubtful, the possibility of procuring a really adequate translation is much more doubtful. It may be confidently laid down, as an axiom, that no adequate translation of a really scientific work can be made except by a man whose knowledge of the subject is at least nearly on a par with that of the Author. Such men are always scarce, and can usually employ their time more profitably than in reproducing, in a different idiom, the thoughts of another.

But if a translation must be made, accuracy is essential. Change of idiom is inevitable, change of meaning (however slight) intolerable. Let us see how the present Translator stands in this respect. The task before him was a difficult one, for Carnot's reasoning is in several places somewhat delicate; and in one or two places a little obscure. Failure was therefore *à priori* more probable than success; and, while even complete success was not likely to be of much use to any one, failure was certain to make the result misleading :—*i.e.* a great deal worse than useless.

One of the first passages which we chanced to read, on opening the book (p. 21), runs thus :—

"Scarcely a year had passed when the proscription, *which included* the Director, *obliged him to give up his life, or at least his liberty, to* the conspirators of fructidor. . . . (Our mother) *fled to* St. Omer, *with* her family, while her husband *was exiled* to Switzerland, then to Germany."

Compare the words we have italicised with the corresponding ones in the original (given below) :—and then judge of the fitness of the perpetrator for the translation of a work of real difficulty and of particular nicety of reasoning.

"Une année à peine s'était écoulée quand la proscription *vint frapper* le Directeur, *obligé de dérober sa vie, tout au moins sa liberté, aux* conspirateurs de fructidor. . . . (Notre mère) *se réfugia* à Saint-Omer, *dans* sa famille, tandis que son mari *s'exilait* en Suisse, puis en Allemagne."

There is more than one first-class blunder for every single line in the passage translated!

On p. 26 we read :—

". . . . for his name . . . . was henceforth the cause of his advancement (*sic*) being long delayed."

Who, attempting to put this bad English back again into French, could possibly hope to reproduce the original? It runs thus :—

". . . . car son nom . . . . devait suffire pour que désormais il n'attendît son avancement que de la longeur du temps."

The word "Anvers," which occurs more than once, is not translated at all; while for "plusieurs places fortes" we find (p. 26) the extraordinary substitute (we cannot call it an *equivalent*) "many *trying* places"!

After these experiences we might have dispensed with any further examination of the book. But we felt bound to examine at least a part of the translation of the Essay. We selected as a first test a well-known passage, in which Carnot elegantly meets a supposed objection to his reasoning. The original is as follows :—

". . . la quantité de chaleur nécessaire pour reporter le liquide à sa température première sera aussi infiniment petite et négligeable relativement à celle qui est nécessaire pour donner naissance à la vapeur, quantité toujours finie."

The meaning is absolutely clear, the contrast being between an infinitesimal, and an essentially *finite*, quantity of heat. What sort of notion of Carnot's reasoning can he have who *translates* the passage as below (p. 59)?

"The quantity of heat necessary to raise the liquid to its former temperature will be also indefinitely small and unimportant relatively to that which is necessary to produce steam—a quantity always *limited*."

The sting is, of course, in the tail:—its proper place. But this one word suffices to destroy the entire argument.

In the translation of the foot-note (preparatory to the discussion of the air-engine) where Carnot gives experimental facts as to the temperature-effects of condensation and rarefaction of gases, we have, among other blunders, a really amusing one. Carnot says:—

". . . l'air qui vient toucher immédiatement la *boule* du thermomètre reprend peut-être par son choc contre cette *boule*, ou plutôt par l'effet du détour qu'il est forcé de prendre à sa rencontre, une densité &c."

The translator would almost seem to have thought that a game at Bowls is here alluded to; for he gives the passage in the form:—

"The air which has just touched the *bowl* of the thermometer possibly takes again by its collision with this *bowl*, or rather by the effect of the *détour* which it is forced to make by its *rencounter*, a density &c."

Since so much of this passage has been left untranslated, it is to be regretted that the whole sentence (and, for that matter, the whole Essay) has not been left in its own strikingly original and well-chosen language.

Many years ago we met with a book something like this one. The writer was translating from Laplace, and rendered the passage

"Si l'on prend, pour unité de temps, la seconde décimale ou la cent-millième partie du jour moyen . . ."

in the following exquisite fashion:—

"If we take the *second decimal*, or the $\frac{1}{100000}$ of the mean day as the unity of time . . ."

This is perhaps finer than anything in Mr. Thurston's translation, but he occasionally rises nearly to its level.

We conclude, as we commenced, with a maxim of Carnot's:—

De l'indulgence, de l'indulgence!

P. G. T.

TRIASSIC FISHES AND PLANTS.

Fossil Fishes and Fossil Plants of the Triassic Rocks of New Jersey and the Connecticut Valley. By J. S. Newberry. (Washington: Government Printing Office, 1888.)

THE fourteenth of the splendid series of monographs issued, and so liberally distributed, by the U.S Geological Survey, is by Prof. Newberry, and deals with the fossil fishes and plants of the east coast Triassic areas known as the Palisades and the Connecticut Valley. Their red shales, sandstones, and conglomerates occur for the most part in narrow basins parallel to the coast or coast ranges, intersected by sheets and dykes of diabase, and average about 5000 feet in thickness. In a very few spots the almost barren shales are charged with carbonaceous matter, and in these plant and fish remains have been met with. The two areas are separated by the wide Hudson Valley tract of older rocks, and are distinguished by all the Palisade beds dipping at an angle of 3° to 15° west, while the Connecticut beds dip as uniformly to the east. Various theories accounting for their deposition are discussed, but the simplest would be to regard them as local deposits of a flat, shallow, sandy, thoroughly sheltered coast-line, subjected to heavy tides. With gradual and intermittent subsidence, and consequent continued encroachment on the land, most extensive beds of varying fineness might be formed. A dip, such as that observed, would ensue, as the beds passed successively under low-water mark, and fell under pressure of the sea into the ordinary slopes of a shelving shore. Sun cracks, ripple marks, and footprints would be formed in each bed in the belt exposed between the high-water marks of neap and spring tides. That the deposits originally swarmed with prey is evident from the footprints of nearly 100 varieties of animals, only a part of which were perhaps amphibious, which made them their promenade. Almost every trace, however, of such organisms as mollusca, annelids, crustacea, and plants, have disappeared.

The second part of the memoir, relating to the fossil fishes, occupies about two-thirds of the volume, and commences with some preliminary remarks on the gradual discovery of the fauna under consideration. Some of these fishes were among the first fossils to attract the attention of American geologists, and two species were figured and described by Agassiz in his "Poissons Fossiles." To Messrs. W. C. and J. H. Redfield, however, palæontology is mainly indebted for the knowledge of the fauna previous to the researches of Dr. Newberry; and their original collection, now in the Yale College Museum, has furnished much of the material for the present memoir. Dr. Newberry himself undertook excavations at Boonton, N.J., in 1866, thus obtaining a large series of specimens for the Columbia College, New York; and numerous discoveries have been more recently made in other localities, by various investigators, to whom the author expresses indebtedness.

The detailed descriptions of the genera and species, illustrated by no less than twenty plates, form the first satisfactory account of the American Triassic fish-fauna; and this will prove of great value for comparison with the corresponding assemblages of fishes met with elsewhere. To the Lepidosteoid family of Lepidotidæ are assigned *Ischypterus*, with eighteen species, *Catopterus*, with six species, *Acentrophorus*, *Dictyopyge*, and *Ptycholepis*, each with one species; while the Crossopterygian family of Cœlacanthidæ is represented by a peculiar genus and species—*Diplurus longicaudatus*. Some interesting general remarks upon each genus precede the more detailed discussion of the various species; and, in the case at least of *Ischypterus*, we are inclined to agree with the author when he suggests that future researches may tend to reduce the number of specific types he at present feels justified in recognizing. In such cases as the present, it is most difficult to distinguish the results of crushing and disintegration from actual specific characters; and even in a formation so little disturbed as the black Triassic shale in which these fishes are entombed, the apparent form of the head and trunk cannot always be relied upon in specific diagnoses.

Ischypterus is undoubtedly identical with *Semionotus*, as Dr. Newberry suspects, and is thus represented both in America, Europe, and South Africa. Ichthyologists will doubtless also agree with the systematic position in which the author places the genus. To us, however, it appears that this determination was more conclusively proved by the researches of Dr. Traquair in 1877, when he offered to the Geological Society some detailed remarks on the osteology of the fish; and on that occasion the intimate connection between *Ischypterus* and *Semionotus* was equally pointed out. Each of the species is illustrated by at least one figure, and good reason is given for assigning to one of the larger forms the supposed fragment of a *Tetragonolepis*, brought from Virginia by Lyell.

Catopterus and *Dictyopyge* are retained as distinct genera, in accordance with the usual custom; and then follow two interesting types which the author himself has added to the list. A very distinct species of *Ptycholepis* is described from Durham, Conn., and an equally peculiar species of *Acentrophorus* is made known from the Chicopee Falls, Mass. Of these genera, the first has hitherto been known chiefly from the English and German Lias, though also rarely obtained from the Austrian Keuper; while the second has previously been found only in the Permian magnesian limestone and marl slate of Durham, England.

A preliminary definition of the Cœlacanth fish *Diplurus longicaudatus* was given by Dr. Newberry several years ago; and the detailed description and figure now published are a welcome addition to our knowledge of the group to which the fish belongs. The finest specimen is nearly complete, and is only disappointing in the matter of cranial osteology. The largest specimen discovered measured about three feet in length, thus exceeding in size any Cœlacanth hitherto met with below the Jurassic.

The third portion of the memoir deals with the fossil plants, only seventeen species of which have been brought together. These confirm the views of Saporta as to the infra-lias, or, at most, Keuper, age of the formation, arrived at from a study of the far more important series described by Fontaine in the sixth monograph of the Survey, issued in 1883; a series procured from the coal-bearing outliers of the same age in Virginia and Carolina.

Of plants common to the Rhætic of Europe we have *Clathropteris platyphylla*, *Cheirolepis Münsteri*, *Otozamites latior*, *O. brevifolius*, two species of *Pachyphyllum* hardly separable from *P. peregrinum*, *Equisetum Rogersi*, claimed by Saporta to be identical with *E. arenaceum*, and the doubtful stems well known in many Triassic rocks, sometimes referred to Calamites, but here referred to *Equisetum Meriani*, Brong., and *Schizoneura*.

Among the novelties is *Dendrophycus triassicus*, a supposed algoid with a cabbage-like leaf destitute of transverse nerves. From the fact that there is in the British Museum an identical structure, from a gritty Tertiary limestone of Mull, which can hardly be organic, we should question the vegetable nature of this fossil, without, however, being able to suggest any other plausible origin. There is a new Cycadinocarpus, founded on a compressed cycas-looking nut, possibly the fruit of one of the Otozamites; and the obscure plant, referred to by Fontaine under the misleading name of *Bambusium Carolinense*, now called *Zoperia simplex*. Whether, as suggested by the author, this may prove to be an aquatic Monocotyledon—"a kind of gigantic Schollera"—there are no sufficient materials for discussing. It is somewhat surprising to find *Baiera Münsteriana* located among the Cryptogams, as there are so many forms connecting it with Ginkgo, all possessing the remarkable twin fibro-vascular bundles in the petiole which result in the symmetrically cleft leaf, that its position is scarcely doubtful. We prefer that the Cycads should precede the Conifers, but in so small an assemblage of species, their want of arrangement is of no great importance.

A. S. W. AND J. S. G.

SEA ANEMONES OF THE NORTH ATLANTIC.

Den Norske Nordhavs-Expedition, 1876–1878. *XIX. Zoologi: Actinida.* Ved D. C. Danielssen. Med 25 Plader og 1 Kart. (Christiania: Grondahl and Son's Bogtrykkerl, 1890.)

ANOTHER part of the General Report of the Norwegian North Atlantic Expedition has just been published, containing a memoir on the Actinida of the North Atlantic, by D. C. Danielssen. It will be remembered that this fine series of memoirs is published under the sanction of the Norwegian Government, and with some assistance from their Treasury. They have been distributed to very many of the Academies and learned Societies of the world, and reflect immense credit on the zeal and intelligence of the Norwegian naturalists.

All the specimens described by Dr. D. C. Danielssen in this memoir were collected from deep water, and most of them from the "cold area." These anemones, for the greater part, proved capable of accommodating themselves to changes of habit and temperature, and it was therefore possible to keep them alive for a considerable period, during which their external characteristics were observed and their portraits taken. That, despite the heavy rolling sea so generally met with in the North Atlantic, the artist has done his part well, is proved by a glance at the first five plates which accompany this memoir, which have been printed in colours by Werner and Winter, of Frankfort-on-the-Main.

This memoir represents the first serious attempt, since the publication of Richard Hertwig's Report on the *Challenger* Actinaria, to describe the sea anemones of an extended area, taking their anatomical features as the basis of their classification; and it seems to us to justify the remark that a very much larger series of facts must be noted before an even fairly plausible scheme of classification of this group can be formulated. No doubt the systems of Gosse and Andrès, based for the most part on mere external characteristics, have had their day; but no new scheme to take their place has yet been properly developed; a wider and closer anatomical investigation of even well-known species must be undertaken ere this can be looked for.

Perhaps this will in some measure account for the fact that of the Actiniæ collected during the expedition, thirty-nine out of forty-one are described as new species, for which eighteen new genera are diagnosed, and five new families are formed. The large majority of these new forms belong, as might be expected, to the Hexactiniæ of Hertwig, but some belong to the Edwardsiæ, Zoantheæ, and Ceriantheæ; while a new tribe has been provisionally made to receive two forms (Fenja and Ægir), not at first sight clearly appertaining to the Actinaria. These forms have elongated, cylindrical, vermiform bodies, with an apparently complete body cavity; the oral disk is surrounded with tentacles, and opens into an œsophagus, which is continued into a closed intestine, which opens at the aboral end of the body. There are twelve septal chambers, complete in themselves, with twelve pore openings around the anal opening.

In *Fenja mirabilis* the body is 70 mm. in length and 15 mm. in breadth at the anterior extremity, whilst the posterior part is rather narrower; the surface of the body is smooth and shining.

In *Ægir frigidus* the animal is surrounded with a mucous investment, and the body is but 30 mm. in length; from 8 to 10 mm. in breadth at the anterior extremity, to 4 to 5 mm. in breadth at the somewhat rounded posterior extremity. While in Fenja the ovaries do not materially differ from the type in the Actinida, those in Ægir greatly approach the form generally met with in the Alcyonida.

It would seem useless to speculate as to the position these strange forms must occupy until something more is known of their structure and something of their development. Dr. Danielssen writes that, if the cœlom is to be regarded as the distinctive feature, then it is evident they cannot be placed among the Cœlenterata; but he adds that perhaps too much stress has been laid on the so-called gastro-vascular apparatus as a systematic feature in this group, and that what is called the œsophagus in Actinida is possibly a rudimentary intestinal formation.

We have alluded to these two forms in some detail as being of very special interest, but an almost equal interest attaches to others which are also to be found described, but which our space forbids us to do more than thus generally refer to. In addition to the coloured plates representing the new species, there are nineteen with the various anatomical details, making this memoir one of the best illustrated of the series. It follows so closely on the memoir on the Alcyonida by the same distinguished author, that we cannot but express our admiration for the energy he displays in working out the natural history of the Norwegian coast, which is now better known than that of our own shores.

OUR BOOK SHELF.

Smithsonian Report, 1887. (Washington: Government Printing Office.)

THIS important publication is increasing year by year in value, in consequence of the pains taken to increase the quantity and quality of the records of progress in the various sciences. In the present volume it brings the records of the Institution down to June 30, 1887. We find the proceedings of the Board of Regents and of the Executive Committee, the Report of the Secretary on the general work of the establishment, the National Museum, and the Bureau of Ethnology. But there is very much more than this, although these matters are by no means of merely local interest. The progress of astronomy, North American geology and palæontology, vulcanology and seismology, geography and exploration, physics, chemistry, mineralogy, zoology, and anthropology, take up no less than 500 pages, and are admirably done. We should add that the record of each branch of science is accompanied by a full bibliography, which largely increases its usefulness. The miscellaneous papers this year deal chiefly with the Western mounds and Indian archæology.

Travels and Discoveries in North and Central Africa. By Henry Barth. (London: Ward, Lock, and Co., 1890.)

FORTY years ago Barth was invited to join a mission which the British Government was about to despatch to Central Africa. He accepted the invitation, and was absent from Europe nearly six years, in the course of which he travelled from Tripoli to Bórnu, and from Bórnu to Timbúktu. The account of his explorations, published in 1857 in German and English, was immediately recognized as one of the most important and fascinating of modern books of travel; and even now, after so long an interval, it has lost but little of its interest. In the present volume, which belongs to the Minerva Library, the first half of the great traveller's elaborate work is reproduced with many of the original illustrations. The books of travel by Darwin and Wallace, which have been reissued in the same series, differ considerably from that of Barth, who was not a naturalist; but, as Mr. Bettany, the editor, says, "to make up for this he is extremely rich in topographical, historical, and anthropological details." Mr. Bettany contributes to the volume a short introduction, in which he brings together some of the leading facts relating to Barth's career.

Weather Forecasting for the British Islands. By Captain Henry Toynbee, F.R.A.S., &c. (London: Edward Stanford, 1890.)

THIS is a most interesting and useful little book, and should be in the possession of all those who take any interest whatever in weather forecasting. It is written with the intention of showing what a single observer can do as regards this subject, supposing him to have a barometer, means for observing roughly the direction and force of the wind, and power to recognize cirrus clouds and the direction from which they are coming. To make the book more complete, the author has added some daily weather charts to illustrate the application of the principles and variations which occur in practice, and to show what can be learnt from them.

The Encyclopædia of Photography. By Walter E. Woodbury. (London: Iliffe and Son, 1890.)

THIS is the second part of the work we noticed before, to be completed in about twelve parts issued monthly. The ground covered is from B to Coffee Process, between which entries will be found information useful to all classes of photographers. Bromide paper, camera-bellows making, carbon process, may be mentioned as among the subjects most fully treated of. When completed, the work will contain over 1000 references, and be illustrated by about 200 explanatory sketches and diagrams by the author.

Japan and the Pacific. By Manjiro Inagaki, B.A. (Cantab.). (London: T. Fisher Unwin, 1890.)

THIS book, so far as it has any elements of interest, appeals rather to politicians than to students of science.

The subject with which the author deals is the relation of Japan to the Eastern Question, and therefore to England and Russia. It is a striking fact that such matters should be discussed in an English work by a native of Japan. Mr. Manjiro Inagaki cannot, however, be congratulated on the way in which he sets forth his ideas. His facts are thrown together so loosely that it is sometimes difficult to make out the propositions which he wishes to prove or to illustrate.

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.*]

Indiscriminate Separation, under the Same Environment, a Cause of Divergence.

I HAVE accumulated a large body of facts indicating that separated fragments of a species, though exposed to the same environment, will in time become divergent. I find that, wherever a species possessing very low powers of migration is for many generations divided into a series of fragments by barriers that do not obstruct the distribution of surrounding species, more or less divergence arises in the separated portions of the species, though, in the same areas, there is no divergence in the environing species whose distribution is not obstructed. I still further find that, whenever the distances intervening between the different fragments are an approximate measure of the time and degree of separate breeding (as is frequently the case, as long as the divergence does not involve any physiological and psychological segregation), these distances are also an approximate measure of the degree of divergence.

The validity of this conclusion is called in question because it is inconsistent with the theory that all divergence is due to diversity of natural selection, and that all diversity of natural selection is due to exposure to different environments. The divergences in the cases above referred to, it is said, are probably due to differences in the environment that are not easily recognized. This was the explanation suggested by Darwin when the facts were reported to him in 1872. The division of a species into isolated portions did not seem to him to furnish any factor that could produce divergence unless it was aided by exposure to different external conditions. The same view is expressed in his "Origin of Species," sixth edition, p. 319.

My reply is twofold. (1) The theory that all the divergences in Sandwich Island land mollusks are due to differences in the environment requires us to believe that there are occult influences increasing in difference with each additional mile of separation, and that these influences control the natural selection of the mollusks, but have no influence on any of the other species occupying the same areas. A theory that involves so heavy an assumption cannot be received when a simpler theory is open to us. (2) I believe I can entirely remove this objection, urged against my conclusion on these purely theoretical grounds, by showing that there are certain causes of divergence, not depending on exposure to different environments, that are necessarily introduced by the division of a species into isolated groups; and that, under the influence of these causes, diversity of habits may arise producing diversity of natural selection, even while the fragments are exposed to the same environment.

I have elsewhere called attention to the fact that the independent breeding of separated groups, so far as we can judge, always tends to produce divergence; and I have shown that, when a species is indiscriminately broken into independent fragments, the tendency to divergence will, on the average, vary in direct proportion to the instability of the species, and in inverse proportion to the size of the fragments, for on these factors depends the probable degree of departure of the average characters of the fragment from the average character of the species previous to its being broken into fragments, and, therefore, the degree of segregation.

I wish now to show that the maintenance of certain classes of characters always belonging to an unbroken species is due to a form of selection that can continue only so long, and so far, as free crossing continues. Reflex selection is a formative principle, depending on the relations in which the members of an inter-generating group of organisms stand to each other, while they continue to inter-generate; but when two portions of an original species have become so divergent as to compete with each other in the same area without crossing, they form incipient species, and each belongs to the environment of the other. While they are members of the same inter-generating group, their mutual influence results in reflex selection, which maintains the correspondence with each other by which power to cross is preserved; while they are members of groups that do not cross, their mutual influence results in mutual selection that inevitably tends toward the preservation of variations that, through greater divergence, best escape from competition. I have elsewhere defined reflex selection as being the exclusive propagation of those better fitted to the relations in which the members of the same species stand to each other, resulting from the failure to propagate of those less fitted. Among those that are equally fitted to the environment of the species, and therefore equally preserved by natural selection, there is often great difference in the degrees of fitness for sustaining such relations to the rest of the species as will secure an opportunity to propagate. To this class of influences belong the different forms of sexual selection through which the sexual instincts and other sexual characters of the different sexes are kept in full co-ordination. In like manner we must believe that the pollen of any species is kept up to its full degree of potency by the constant selection which results from the failure to propagate of the individuals whose pollen is less potent or whose germs are more difficult to fertilize than the average. We cannot call this sexual selection; but we have to class it as the form of reflex selection through which the physiological co-ordination of the male and female elements with each other is so maintained as to secure full fertility. Again, there is a constant selection of animals that are suitably endowed with the recognition marks and calls by which the different members of the species know each other, and that have the corresponding instincts that lead them to associate with their own kind who are thus endowed. I have elsewhere called this principle of social co-ordination "social selection," and have classed it as a form of reflex selection.

There are several other forms of reflex selection. One of these secures harmony in the habits and modes of life of the different members of a freely inter-generating group of organisms; for individuals, whose habits are not sufficiently co-ordinated with those of the mass of the species to allow of their interbreeding with them, will fail of propagating. This we may call co-ordinative industrial selection. We are now prepared to understand one reason why independent breeding resulting from indiscriminate separation is in time transformed into segregation. Independent breeding is in its very nature the suspension, not only of one form, but of all forms of reflex selection between the separated portions of the species. The importance of the cessation of natural selection in producing the different stages of the degeneration of organs that are disappearing has been fully discussed by Prof. Romanes (see NATURE, vol. xli. p. 437, and previous communications there referred to), who points out that, as the power of the special form of heredity by which any organ is produced has been built up by the many generations of natural selection that have acted in favour of the organ, so the gradual weakening of that power follows the cessation of the natural selection. Prof. Weismann seems to appeal to the same principle when he attributes the disappearance of "rudimentary organs" to the action of "panmixia." Now, in the cessation of reflex selection which follows independent breeding, a similar principle is introduced, and the inevitable result must be the weakening of the power of heredity by which the portions of the species were held in correspondence with each other before their separation. I have elsewhere shown that separate breeding necessarily disturbs unstable adjustments; and we here see that the most stable of the adjustments by which each part of a species is kept in correspondence with every other part gradually becomes unstable under the continued influence of separation. Whenever a species is divided into two portions that do not interbreed, the four forms of reflex selection above described will cease to act between the two portions, and they will continue in sexual, social, physiological, and industrial harmony with each other, only in so far as the force of the old heredity holds them to the old standards. But the power of heredity in these respects will in time fail, if reflex selection is entirely removed. If the separate breeding is long continued, incompatibility in all these respects tends gradually to arise; but it is manifest that incompatibility of industrial habits implies diversity in the forms of natural selection that shape each portion. I therefore maintain that separation which necessarily includes the cessation of reflex selection between the portions separated is a cause of segregation and divergence, and that it introduces diversity of natural selection, which is a still further cause of divergence.

Unless the separated portions of a species possess exactly the same average character (which we must believe is seldom, if ever, the case), separation must, from the first, be more or less segregative; and even in cases where the portions completely correspond in character (if there are any such cases), the cessation of reflex selection which is involved in the separate breeding, must result in segregration as soon as the power of heredity begins to weaken; and this is in due time followed by other forms of intensive segregation. I therefore conclude that indiscriminate separation may be regarded as a preliminary form of segregation (*i.e.* discriminate separation), and that in the nomenclature we ordinarily use both principles may be called "segregation" without confusion.

26, Concession, Osaka, Japan. JOHN T. GULICK.

The Affinities of *Heliopora cœrulea.*

IN Prof. Moseley's admirable account of the structure and affinities of *Heliopora*, published in the Transactions of the Royal Society, 1876, and afterwards in the *Challenger* Reports, there occurs the following passage: ". . . directly the coral (*i.e. Heliopora*) was left at rest a swarm of a species of *Leucodora*, closely resembling *Leucodora nasuta*, which infests the coral and perforates it all over, expanded themselves at once."

This will probably explain the cause of the curious mistake that Mr. Saville Kent has made, in his letter published in last week's NATURE (p. 340), in supposing that *Heliopora* is a tubicolous annelid. *Heliopora* is *not* a tubicolous annelid, nor does it belong to the "Hydrozoic division of the Cœlenterata," but it is, without a shadow of doubt, as Moseley described it to be, an Alcyonarian.

When I was preparing my paper on the "Siphonoglyphe in the stomodæum of Alcyonarians" in 1883, Prof. Moseley kindly placed at my disposal his preparations of *Heliopora*, and I was able then fully to confirm his conclusions as to the Alcyonarian nature of this interesting coral.

During my visits to the coral reefs on the coasts of North Celebes and the adjacent islands, I came across many large and beautiful specimens of *Heliopora*, some of which I carefully preserved for further investigation at home. I never found the polyps fully expanded with the eight pinnate tentacles standing out from the disk like the petals of a flower, but in the few instances when I saw the polyps protruded ⅛ inch or thereabouts from the surface of the coral the tentacles were partially withdrawn, so that their characteristic features were hidden.

Since my return from Celebes I have made a large number of sections of the material I brought back with me with a view to the publication of a short paper on some further details of its anatomy, and I have recently been able to supplement this by a series of preparations I have made from the excellent material given to me by Prof. Haddon, who found *Heliopora* in abundance in Torres Straits.

I will not venture, in the present state of my investigation, to state my opinion as to the position that *Heliopora* should occupy in the group to which it undoubtedly belongs; I merely wish to call the attention of the readers of NATURE to the fact that its Alcyonarian characters are beyond dispute.

Downing College, August 9. SYDNEY J. HICKSON.

Meteors.

LAST night, between 11.12 and 11.52, I and another observer saw altogether eighty-three meteors, eighty of which were Perseids. Some of them were very brilliant, especially those near the neighbourhood of Aquila.

The remaining three meteors had different paths, one having a direction exactly opposite to that of the Perseids.

The other observer was watching the radiant point and the region around it, while I observed the south-west quadrant.

More observations would have been made, but were interrupted by clouds. W. J. LOCKYER.

Observatory House, Westgate-on-Sea, August 12.

A LIQUID COMPOUND OF NICKEL AND CARBON MONOXIDE.

IN the August number of the Journal of the Chemical Society a full account is given of the remarkable new compound described by Mr. Mond, in conjunction with Drs. Langer and Quincke, at the last meeting of the Chemical Society. The following is an outline of the main facts described in their communication.

Carbon monoxide is found to be affected in a very curious manner when passed over finely divided metallic nickel heated to a temperature of 350°–450° C. The metal becomes converted into a black amorphous powder containing nickel and carbon, the carbon monoxide becoming at the same time changed into the dioxide owing to the loss of carbon. A comparatively small amount of nickel is capable of decomposing a very large quantity of carbon monoxide, and at the commencement of the operation the gas may be passed over at a very rapid rate without any escaping decomposition. As the operation continues, the change becomes less and less complete, but even after numerous repetitions of the experiment carbonic anhydride continues to be formed. The solid product of the reaction appears to vary in composition somewhat widely according to the temperature and the time during which the operation is carried on. The highest proportion of carbon found was 85 per cent. Some time ago MM. Gautier and Hallopeau obtained a similar product, containing 80 per cent. of carbon, by the action of carbon bisulphide upon metallic nickel. The nickel is only partially removed by acids, for even after repeated extraction the whole of the nickel is not found in solution.

When this black substance was allowed to cool in the current of carbon monoxide another change was found to occur, with production of some volatile substance, whose vapour rendered a non-luminous Bunsen gas flame placed in its path highly luminous. Further, on heating a portion of the tube near the exit a mirror of metallic nickel was obtained mixed with a little carbon. Evidently a gaseous substance containing nickel was contained in the issuing gas, a circumstance of considerable importance in view of the non-volatility of the ordinary known compounds of nickel. Experiments were then made with the idea of obtaining larger quantities of the new substance and isolating it from the other gaseous products. It was eventually found that when finely divided nickel, obtained by reducing nickel oxide in a current of hydrogen at a temperature of about 400°, is allowed to cool in a slow stream of carbonic oxide, the latter gas is very readily absorbed as soon as the temperature has fallen to about 100°. If the current of carbon monoxide is continued, or if that gas is replaced by an inert gas, such as carbon dioxide, nitrogen, or even hydrogen or air, the issuing gas carries away with it large quantities of the new nickel-containing vapour. After about an hour the quantity of this vapour evolved becomes less, and finally its evolution ceases. The property of the nickel to produce it is restored by heating it to 400° again and allowing once more to cool; indeed, up to a certain limit it forms the compound more abundantly after repeated use. If the issuing gas is collected and heated to 150°, its volume is found to largely increase, nickel more or less contaminated with carbon being deposited. At a temperature of 180° the nickel deposited was found to be quite free from carbon.

The new volatile compound was eventually isolated by leading the mixed issuing gases through condensers placed in a freezing mixture of ice and salt, in which the vapours condensed to a *colourless* mobile liquid of very high refractive power.

The final arrangement adopted for the preparation of the liquid is as follows. A quantity of nickel oxide is placed in a combustion tube, and reduced at about 400° by the passage of a current of hydrogen gas. The tube and contents are then cooled down to about 30°, and pure dry carbon monoxide instead of hydrogen passed through the tube without further heating it. The issuing gas is caused to pass through a Y tube surrounded by ice and salt. The lower end of the Y tube projects through the vessel containing the freezing mixture into a small flask in which the liquid collects. The gas leaving the Y tube still retains about 5 per cent. of the new body, and is therefore collected, dried, and again passed over the nickel until no more liquid condenses. The tube containing the nickel is then re-heated to 400° in a slow current of hydrogen, again cooled, and the operation recommenced. In this manner it is easy to obtain ten to fifteen grams of the liquid in each operation.

The liquid boils at 43° under a pressure of 751 mm. Its specific gravity is 1·3185 at 17°. At −25° it solidifies to a mass of needle-shaped crystals. The liquid is soluble in alcohol, and even more readily in benzene and chloroform. It is perfectly indifferent to dilute acids and alkalies, and is not attacked by concentrated hydrochloric acid. Strong nitric acid oxidizes it readily. As regards its composition, the nickel was estimated by weighing the nickel deposited on passing repeatedly through a heated tube, and the carbon by passing the vapour mixed with air over copper oxide, and absorbing and weighing the carbon dioxide produced. The following numbers were obtained :—

	I.	II.	Calculated for $Ni(CO)_4$.
Nickel ...	33·35 ...	33·37 ...	34·34
CO ...	66·60 ...	65·99 ...	65·66

Its composition, therefore, appears to be represented by the formula $Ni(CO)_4$. Its vapour density, the first density determination of a nickel compound, was determined by Victor Meyer's method at 50°. The value obtained was 6·01. $Ni(CO)_4$ corresponds to the density 5·9. At 60° the vapour was found to explode with considerable violence.

Vapour of nickel-carbon oxide, as its discoverers term it, reduces an ammoniacal solution of cuprous chloride, first decolorizing it and subsequently precipitating from it metallic copper. It also precipitates metallic silver from ammoniacal solutions of silver chloride. Chlorine decomposes it with production of nickelous chloride, $NiCl_2$, and carbon oxychloride, $COCl_2$. Bromine reacts in a precisely similar manner. The electric spark decomposes it slowly into nickel and carbon monoxide.

Experiments have also been made to ascertain the possibility or otherwise of preparing a similar compound of cobalt and carbon monoxide. It was found, however, that cobalt does not form such a compound; indeed, it is quite possible to separate nickel from cobalt by reacting with carbon monoxide in the above manner, the nickel only being removed. The metallic mirrors obtained by the decomposition of nickel-carbon oxide by heat were found to consist of unusually pure nickel, containing no traces of cobalt. They consisted of a grey metallic powder of specific gravity 8·2834 at 15°·4.

It became interesting, therefore, to ascertain the atomic weight of this pure nickel, especially in view of the recent work of Drs. Krüss and Schmidt. Accordingly, a series of three determinations were made, with the following results:—If O = 16, Ni = 58·58, 58·64, and 58·52. These numbers are sufficiently close to the value 58·74, long ago obtained by Dr. Russell, to justify the conclusion that nickel, as we have known it, is indeed a simple substance, whose atomic weight lies very near to the figure hitherto accepted—a conclusion which is further supported by the determination of the vapour density of this remarkable new compound, nickel-carbon oxide.

A. E. TUTTON.

BRITISH MUSEUM NATURAL HISTORY PUBLICATIONS.[1]

THE present Part (IV.) concludes Mr. Lydekker's "Catalogue of the Fossil Reptilia and Amphibia in the British Museum (Natural History)," the four volumes making together a work of 1247 pages. In Part I. the author records the Ornithosauria, the Crocodilia, the Dinosauria, the Squamata, the Rhynchocephalia, and the Proterosauria; Part II. contains the Ichthyopterygia and Sauropterygia; Part III. embraces the Chelonia; and Part IV. the anomalous group of the Placodontia, the Anomodontia, and the class Amphibia,

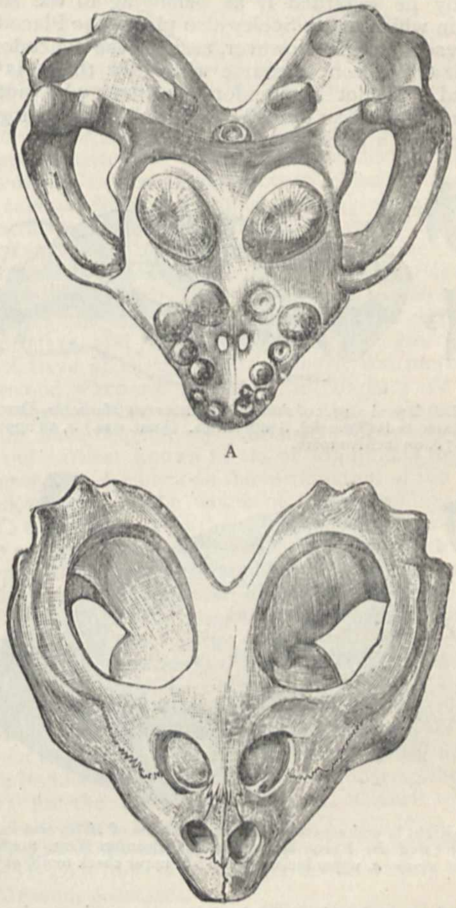


FIG. 1.—*Cyamodus* (*Placodus*) *laticeps*, Owen. A, palatal aspect; B, frontal aspect of cranium; from the Muschelkalk of Baireuth, Germany.

including the Ecaudata, the Caudata, and the Labyrinthodontia, with supplementary notes and additions to the preceding orders. The earlier parts having been already noticed in NATURE, we shall confine our attention to Part IV.

Amongst the rare remains of Reptilia met with in the Muschelkalk of Baireuth, Bavaria, none are of more interest than those belonging to the anomalous group of the Placodontia, the ordinal position of which is still uncertain. The skull and teeth of one of these reptiles

[1] "Catalogue of the Fossil Reptilia and Amphibia in the British Museum (Natural History), Cromwell Road, S.W." Part IV., containing the Orders Anomodontia, Ecaudata, Caudata, and Labyrinthodontia; and Supplement. By Richard Lydekker, B.A., F.G.S., &c. Pp. 295 and xxiv. With Index to the entire Work. Illustrated by 66 Woodcuts. (London: Printed by Order of the Trustees: and sold by Longmans and Co.; B. Quaritch; Asher and Co.; Kegan Paul, Trench, Trübner, and Co., &c., 1890).

was originally referred by Count Münster, and afterwards by Agassiz, to the class of fishes, under the genus *Placodus;* but more perfect specimens enabled Prof. Owen, in 1858, to show that this animal was really a reptile which probably fed upon shell-bearing mollusks and used its flat, broad, palate-like teeth, so thickly-coated with enamel, for pounding and crushing their shells (see Phil. Trans., 1858, p. 169).

Two genera, *Placodus* and *Cyamodus*, are referred to this group, at present known only by the skull and teeth, no vertebræ or bones of the pectoral or pelvic girdles, or limbs, having been as yet discovered. Owen originally referred this singular form to the Sauropterygia, but subsequently he regarded it as belonging to the Anomodontia, in which order Seeley also places the Placodontia. The present author, however, assigns the Placodonts to no ordinal position, a course which, we think, is to be regretted. If not Anomodont reptiles, why not give them the value of an order? Surely they have as good a claim to such a position as *Proterosaurus?*

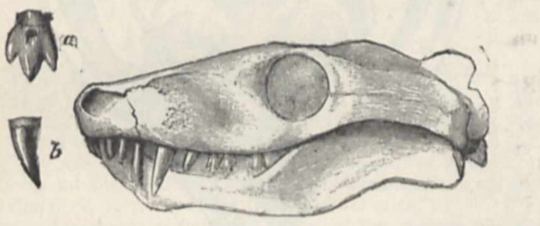


FIG. 2.—Left lateral aspect of skull of *Galesaurus planiceps*, Owen; from the Karoo beds (Triassic), South Africa. (⅓ nat. size.) *a*, an upper cheek-tooth; *b*, an incisive tooth.

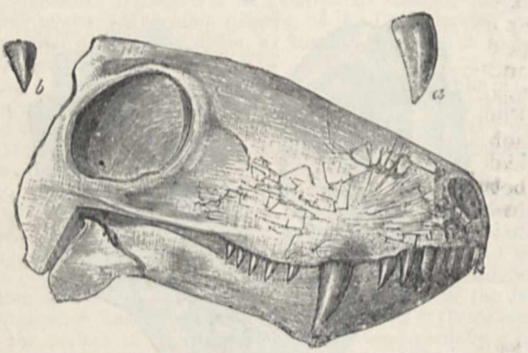


FIG. 3.—Right lateral aspect of imperfect cranium of *Ælurosaurus felinus* Owen; from the Karoo beds (Triassic), Beaufort West, South Africa. (⅔ nat. size.) *a*, upper incisive tooth; *b*, upper cheek-tooth, enlarged.

The Anomodontia, which follow next in order, are a truly Triassic group, and have been met with in Russia, India, North America, and in South Africa. It is especially from this last-named region that the British Museum collection has been most largely recruited, the majority of the specimens having been procured by Messrs. A. G. and T. Bain, Dr. Atherstone, and Sir George Grey. Quite recently, Prof. H. G. Seeley, F.R.S. (assisted by the Government Grant Committee of the Royal Society), visited the Cape, where he was most successful in obtaining a large series of reptilian remains, not yet fully worked out, but of which sufficient is already known to justify us in believing it will prove one of the most valuable additions made for years past to our National Museum.

The interest attaching to these South African Triassic rocks (if Triassic they be) lies in the fact that they have yielded evidence of one of the earliest mammals known—*Tritylodon*—represented by a most remarkable although imperfect cranium, with dentition similar to Cope's genus *Polymastodon*, from the Eocene of North America.

In the group of Anomodont reptiles are included several forms having a well-differentiated series of cheek-teeth, canines, and incisors, a character of dentition considered at one time to be peculiar to the Mammalia. Good examples of such dentition may be seen in the skulls of *Galesaurus*, *Ælurosaurus*, *Lycosaurus*, &c.

Another no less singular family, placed in this order, is that of the Dicynodontidæ, in which the surface of the

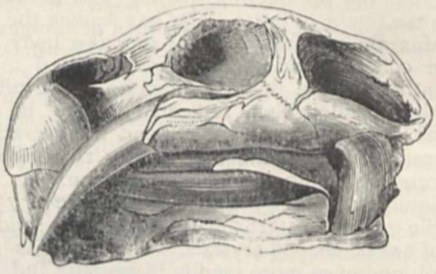


FIG. 4.—Lateral view of the skull of *Dicynodon lacerticeps*, Owen; from the Karoo series, South Africa.

palate and mandible are without teeth, the skull being provided with a pair of tusk-like maxillary teeth, growing from persistent pulps; the alveolar margins of the jaws being trenchant, and probably encased in a horny beak-like sheath, as in *Hyperodapedon*.

Another remarkable form of Anomodont, from these Reptiliferous beds of South Africa, has been referred to the genus *Pariasaurus* by Owen. In the form of its

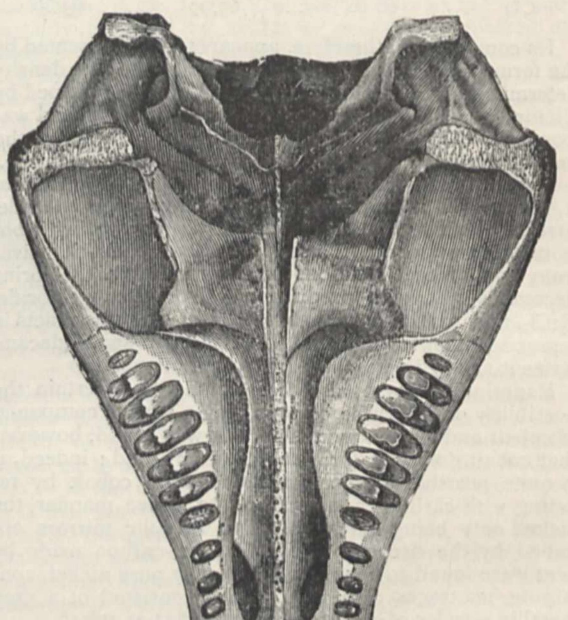


FIG. 5.—Palatal aspect of cranium of *Empedias molaris*, Cope; from the Permian of Texas, North America. (¼ nat. size.)

head it is very like a huge Salamander, 8 to 10 feet in length, having a numerous and uniform series of moderately tall marginal teeth in its jaws, with swollen and narrow crowns, ornamented with a few deeply-marked flutings descending from the cutting edge, and with numerous small conical teeth on the palate. The skull is deeply channelled on its surface, as in the Crocodilia and the Labyrinthodontia.

From the flattened wearing away of the crowns of the teeth, Prof. Owen has suggested it was a vegetable-feeding reptile. The vertebræ of *Pariasaurus* are notochordal, frequently having intercentra present, and there are not more than two vertebræ united to form the sacrum.

The Permian rocks of Texas have yielded to Prof. Cope a most remarkable genus of Anomodont reptiles, named by its describer *Empedias molaris*. The dentition forms an uninterrupted series without a distinct tusk, the incisors differing but little from the cheek-teeth in form, each tooth having a more or less distinct transverse edge. The teeth are about fifty-six in number.

The genus *Naosaurus*, also from the Trias of Texas, makes us acquainted with a very curious reptile, in which the neural spines of the vertebræ are of most enormous height, and each spine has often as many as six paired horizontal processes at intervals produced from its sides.

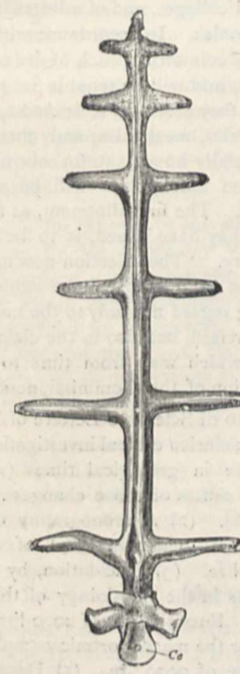


FIG. 6.—Anterior view of a dorsal vertebra of *Naosaurus claviger*, Cope; from the Permian of Texas. (⅛ nat. size.). *Ce*, centrum.

This reptile when living must have had an enormous dorsal crest, like some monstrous newt, rising from its back, but it is difficult to conceive any advantage which its owner could possibly derive from such an unwieldy appendage.

Turning to the Amphibia, one cannot fail to be struck by the similarity in the form of the cranium, and its external ornamentation, in the Labyrinthodontia and the Crocodilia. The body is also long, usually lacertiform, and the feet pentadactyle; a bony thoracic buckler and bony scutes are frequently present on the ventral aspect of the body. Doubtless these old Triassic reptiles were ancestrally related to the later Crocodilia, as well as to other and higher forms of Vertebrata.

Teeth in the Labyrinthodonts are usually present on the palatines and vomers, and more rarely on the pterygoids; and there is very generally an ossified sclerotic ring to the orbit. The vertebræ exhibit considerable variation in condition, being amphicœlous, and fully ossified in some instances, or with a notochordal canal, or with large intercentra and the centra represented by paired lateral pieces (pleurocentra) in others.

The parietal foramen is always present in the cranium, and in the Mastodonsauridæ the occipital condyles are well ossified.

The Trias of Würtemberg has yielded the finest known examples of these Labyrinthodont reptiles, quite recently described and figured by Dr. Fraas; but the most complete skeletal remains of Amphibia have been obtained from the Gaskohle (Lower Permian) of Bohemia by Dr. Anton Fritsch, of Prague; others from Germany by Prof. Credner, of Leipzig; and by Prof. Gaudry from the Lower Permian of Autun. The best examples in the collection are those of *Archægosaurus* from the Lower Permian of Saarbrücken, and of *Loxomma* from the Coal-measures of Coalbrookdale and Scotland.

To the Ecaudata (frogs and toads) little interest attaches in a palæontological sense, as no tailless forms of Amphibia are known earlier than the Miocene period; but good examples of these have been obtained from the Brown-Coal of Rott, near Bonn, and from the Fresh-water Tertiary Limestone of Oeningen, which also yields the remains of *Cryptobranchus scheuchzeri*, closely related to the giant salamander now living in the fresh-waters of Japan.

Contrasting for a moment the MAMMALIA with the REPTILIA, while many genera of the former, such as *Dinotherium*, *Mastodon*, *Machairodus*, *Phenacodus*, *Palæotherium*, *Anthracotherium*, *Taxodon*, *Sivatherium*, *Dinoceras*, and others, have died out, *eight entire orders* of REPTILIA and AMPHIBIA, embracing more than 200 genera, have all disappeared. This is the more readily understood when we consider the comparative periods of geological time during which the Mammalia and Reptilia have respectively flourished; for whilst it is true that the earliest known forms of Mammalia made their appearance as far back as the termination of the Triassic period, yet during the whole of the succeeding Jurassic and Cretaceous periods their numbers were few and their forms quite insignificant; and it is not until we arrive at Eocene times that the Mammalia commence to occupy anything like a prominent position in the animal kingdom. On the other hand, the Amphibia began to be abundant as early as the Coal period; and the Reptilia (ushered in by *Proterosaurus*) in the Permian attained a maximum development both in size and numbers in the Lias and Oolites, whilst the Mammalia were yet only in the incipient stage of their development.

Great credit is due to Mr. Lydekker for the manner in which he has performed the task of preparing these Catalogues for the National Collection, a work which will doubtless prove of extreme value to students of comparative anatomy and to workers at a distance who desire to know what objects in any particular family or genus the Museum possesses.

We could wish that greater distinctness had been given in printing these Catalogues to the important fact of particular specimens being the ones which are known as "types," and which are the actual ones that have been figured and described; where this is mentioned it does not catch the eye at once, as it should do. We would advocate the placing of such information in a separate line; and, if possible, they should be marked prominently by the use of *special type*. Perhaps the word "type" or "figd." could be inserted in black letter and begin a separate line.

Again, the formation and locality are hardly prominent enough, and under each genus we would like to see the "range in time" and also the "geographical distribution" given as a separate paragraph.

We hope this series of Catalogues, so helpful to all real workers, may be continued and completed for every group in the Geological Department. The Trustees could not perform a more useful service to science than by urging forward the issue of these works in every Department of the Museum.

THE AUSTRALASIAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE third annual meeting of this Association will be held, as we stated last week, at Christchurch, New Zealand. On January 15, the President-Elect, Sir James Hector, F.R.S., will hold a reception in the grounds of Christ's College, and the first general meeting will take place in the evening, when Baron F. von Mueller, F.R.S., will resign the chair, and an address will be delivered by his successor.

The Council of the Australasian Association invite the members of the British Association to attend this meeting, and a circular relating to the matter, signed by Profs. A. Liversidge, F.R.S., W. Baldwin Spencer, and F. W. Hutton, the general secretaries, will be distributed at the Leeds meeting. The cheapest way of reaching New Zealand is by the direct steamers which leave Plymouth every fortnight for Wellington. These steamers call at Teneriffe, Cape Town, and Hobart on their way out, and at Rio de Janeiro and Teneriffe on their way back. In the circular to which we have referred, it is stated that return tickets will be issued to members of the British Association proceeding to New Zealand to attend the Christchurch meeting for £84, which is 20 per cent. below the ordinary return fares. These tickets will be issued by the New Zealand Shipping Company and by the Shaw, Savill, and Albion Company, and holders may return by either line. In addition to this advantage, members of the British Association will be allowed to travel over the New Zealand Government railways (1770 miles) at half fares during January and February.

Visits to places of interest in the immediate neighbourhood of Christchurch will be made during the meeting. After the meeting is over, excursions will be made to the West Coast Sounds; to the top of Ruapehu; and, if possible, to the Upper Rakaia. The trip to the top of Ruapehu will start from Napier, and will be accompanied by Mr. H. Hill. The trip to the Sounds will start from Port Chalmers, and will be accompanied by Prof. Hutton.

Members of the British Association have thus a splendid chance of visiting New Zealand, and of seeing for themselves what is being done in science by our kinsfolk in Australasia; and no doubt a good many will avail themselves of the opportunity. Those who decide to accept the invitation are requested to notify their intention, as well as the name of the steamer by which they propose to go, to Prof. F. W. Hutton, the general secretary in Christchurch, in order that arrangements may be made for their reception. The following steamers will leave Plymouth in time for the meeting:—

Company.	Steamer.	Leave Plymouth.	Arrive at New Zealand.
N.Z. Shipping Co.	S.S. *Kaikoura*.	Nov. 15, 1890	Dec. 28, 1890
Shaw, Savill, and Albion Co.	S.S. *Doric*.	Nov. 29, 1890	Jan. 11, 1891

Members going by the *Kaikoura* could visit the Hot Springs district of the North Island before attending the meeting.

NOTES.

NOTHING of scientific value can be extracted from the ghastly descriptions of the recent electric execution. These graphic horrors are too evidently manufactured for sensational or political purposes to be trusted, even had the writers been spectators of the scene. But we may at least gather from them that an entire absence of physiological knowledge, and a very scant acquaintance with elementary physical principles, were exhibited alike by the contrivers of the operation and by the actual operators. With our present physiological knowledge, electric *currents*, whether steady, interrupted, or alternating, are not qualified primarily to produce death, but torture—which, of course, may lead ultimately to death. They have been recommended, in the interests of humanity, as efficient and (if the expression be permitted) healthy substitutes for the "cat." But Nature's own operations, in a thunderstorm, suggest the true substitute for the axe or the cord, viz. the discharge of a condenser of sufficient capacity, charged with so-called "statical" electricity.

THE French Association for the Advancement of Science has been holding its annual meeting at Limoges. The meeting began on August 7, and will come to an end to-day. M. A. Cornu, the President, chose as the subject for his address "the part played by physics in the recent progress of the sciences."

A CONSIDERABLE impetus to scientific study ought to be given by the science scholarships which the Royal Commission for the Exhibition of 1851 is about to establish. They amount in the aggregate to £5000 a year, and are to be used for the benefit of English provincial colleges, and of colleges in Wales, Scotland, Ireland, and the colonies. In accordance with the recommendations of a scientific committee, each of the scholarships will be £150 a year in value, and will be tenable for two years—in rare cases for three; and they are to be restricted to those branches of science (such as physics, mechanics, and chemistry), the extension of which is specially important for our national industries. A series of seventeen scholarships will be allotted to various institutions annually. The first allotment, as the Commissioners explain in a paper they have issued, is to be considered experimental and temporary. "The selection now made of institutions to which nominations are offered will be subject to modification in the future, having regard not only to the manner in which the nominations are exercised, but also to the claims of other universities and colleges which may from time to time be brought under the consideration of the Commissioners."

THE Reale Istituto di Scienze e Lettere of Milan offers prizes as follows:—(1) A historico-critical investigation of works on the variations of climate in geological times (with estimation of hypotheses as to the causes of those changes). Prize, 1200 lire (the lira equals 9½*d*.). (2) A monography of the Protista of spring water in Milan. Cagnola Prize of 2500 lire, and a gold medal of 500 lire. (3) Elucidation, by personal observations, of some points in the physiology of the nervous system, especially the brain. Fossati Prize of 2000 lire. (4) Elucidation of the physiology, or the macro- or microscopic anatomy, of the brain. Fossati Prize of 2000 lire. (5) Draper's theory of the progressive development of the light-rays of a body whose temperature is gradually raised having been attacked by Prof. Weber, a thorough investigation of the phenomena is desired, so as to establish their laws, to exclusion of the ordinary influence of the observer on the meaning of the phenomena. Secco-Commeno Prize of 864 lire. Papers to be written in Italian, French, or Latin, and sent in, with motto, to the Secretary, Palazzo di Brera, Milan. The dates are—for No. 1, April 30, 1891; for Nos. 2 and 3, May 1, 1891; for No. 4, April 30, 1892; and for No. 5, May 1, 1893.

THE Berlin Academy of Sciences has recently granted £60 (each) to Prof. Dames, of the Mineralogical Museum, for a geological investigation of Dalecarlia and the island of Gotland; to Prof. Urban, of the Botanical Garden, for a visit to Paris, to study the specimens of West Indian flora there; and to Dr. Rinne, for study of the Central German basalts. Further, £75 has been granted to Prof. Nussbaum for publication of his studies on Californian Cirrhipedia, and £27 for printing of Dr. Schumann's researches on the union of races. £75 is granted to the Anatomical Society, to further the publication of Prof. His's uniform anatomical terminology.

DR. ST. GEORGE MIVART, F.R.S., has been appointed Professor of the Philosophy of Natural History at the University of Louvain. The professorship is one of those included in the Faculty of Philosophy and Letters.

THIS week the Royal Archæological Institute has been holding its annual Congress at Gloucester. The first meeting took place on Monday, when the chair was taken by Sir John Dorington, in succession to Lord Percy. In his presidential address, Sir John described the neighbourhood of Gleva as it was under Roman civilization in contrast with its later condition in the time of the Saxon invasion.

ON Tuesday the Royal Horticultural Society held a meeting and show in the Drill Hall, and certificates were distributed by the Committee. A paper by Mr. Badger, on fruit-drying by evaporation, as practised in America, was read by Mr. Wilkes, the Secretary. Little fruit, it is said, will be preserved in England this year by the processes described, a worse season generally for plums and apples having seldom been known.

ON Monday the Fellows of the Royal Botanic Society held their fifty-first anniversary meeting. The Council, in their report, congratulated the Fellows upon the firm position held by the Society in the year of its jubilee, and thanked them for their action in response to which 109 new names were added to the list. The result was a permanent growth of prosperity, as shown by the total subscriptions for the year—£3568—which had not been reached since 1885.

THE *Kew Bulletin* for August opens with some interesting notes on Natal aloes, by Mr. J. Medley Wood, the curator of the Natal Botanic Gardens. There are also sections on Gambia mahogany, Ceylon cacao, chestnut flour, wine production in France, and ramie as food for silkworms. The number closes with a list of the staffs of the Royal Gardens, Kew, and of botanical departments and establishments at home, and in India and the colonies, in correspondence with Kew.

IN the new number of the *Internationales Archiv für Ethnographie* (Band iii., Heft 3), there is an article (in German) by Dr. Richard Andree, of Heidelberg, on the Stone Age of Africa. Dr. J. D. E. Schmeltz contributes a finely-illustrated and valuable study (also in German) of decorated weapons used in the East Indies. There is also a short English paper on Zuñi fetiches, by Dr. H. Ten Kate, of the Hague.

THE Japanese collections of Heinrich von Siebold were lately presented to the Hofmuseum of Vienna. They consist of about 5200 specimens, many of which are of great value. In recognition of the donor's generosity, the Austrian Emperor has raised him to the rank of Freiherr.

IN the museum of the Industrial Society of Mühlhausen, there s an interesting ethnographical collection, including a number of fine American antiquities. The objects are being rearranged by Herr E. Grosse.

A WORK on Hindoo folk-lore has just been issued from the London Printing Press at Lucknow, the author being Rai Bahadur Mal Manucha, chairman of the Fyzabad Municipal Board, and well known in Oudh as a legal practitioner. In the preface he says that while he was enjoying the vacation at Hardwar on the Ganges, it occurred to him that if a few notes on religious beliefs, social customs, superstition and folk-lore, proverbs and sayings, puns, riddles, aphorisms, and other miscellaneous matters in common vogue among the Hindoo community generally, and among the country people especially, were brought together, they would "aid a great deal in throwing light upon the hitherto partially explored regions of the mode of life led by the common people." In a lengthy article on the little book the *Times of India* says the author has gathered together a little of everything that his preface promises. We learn, for instance, that if a person is drowned, struck by lightning, bitten by a snake, or poisoned, or loses his life by any kind of accident, or by suicide, then he goes usually to hell. If he die naturally on a bed or a roof, he becomes a "Bhut," or evil spirit, and with this belief care is taken on the approach of death to move the person carefully on to the floor. The earth is believed to be resting on the horn of a cow and the raised trunks of eight elephants, called "Diggai," or "elephants supporting the regions," and each of the cardinal and sub-cardinal points of the compass has its appropriate guardian. An eclipse is produced by the occasional swallowing up of the sun or moon by the severed head of Ráhu, son of a demon family, who was decapitated by Vishnu for disguising himself as a god and drinking nectar.

IN the thirteenth of his "Res Ligusticæ," recently published, Count Salvadori announces the occurrence of *Cypselus affinis* in Liguria on May 14 last. The Count gives full synonymy of the species, and an interesting account of the species on this its first visit to Europe.

IT has been known for some time that Dr. Loria was engaged in prosecuting zoological researches in the Papuan sub-region, and now two instalments of his collection have been described by Count Salvadori. The localities visited by the Loria expedition have been Pulo Penang, Timor Cupang, Pulo Semau, Port Darwin, and Port Moresby in South-Eastern New Guinea. Three new species have been discovered in the latter locality, and have been named by the author, *Ægotheles loriæ*, *Arses orientalis*, and *Pitta loriæ*, the last-named being the only species collected on the island of Su-a-u, a small islet near South Cape.

PROF. GIGLIOLI has ju·t issued the second part of his "Primo Resoconto dei risultati della inchiesta ornitologica in Italia," the first portion of which we noticed last year. This second instalment is in the form of a goodly octavo volume of nearly seven hundred pages, and is entitled "Avifauna Locale." It consists of reports from the various provinces of Italy, furnished by different observers, with remarks as to the nidification, distribution, and migration of the various species. As to the value of these local lists there can be no question, and Prof. Giglioli may be trusted to choose men with a thorough knowledge of local ornithology to record the observations. As far as we can judge, Prof. Giglioli has been fortuuate in his coadjutors.

THE problem as to the origin of the nephrite of which the tombstone of Tamerlane, at Samarcand, is made—a question which has interested a good many mineralogists—seems to have been definitely solved by M. Grombchevsky's visit to the nephrite-mines on the Raskem-daria, on the eastern slope of the Pamir. M. Grombchevsky found there a big dyke of nephrite, of extreme hardness, embedded in the rocky banks of the Raskem-daria, which consist in that place of white jadite. The Chinese used to extract the nephrite by lighting great fires on the rock, and afterwards throwing water on it when it was heated. They stopped these operations in the course of the present century, when the heir to the throne, after having slept in a bed made of Raskem nephrite, fell ill. A large piece of the stone, so much liked by the Chinese, which was on its way to Peking, was put in chains (like Yakoob-Beg's guns, which are still kept in chains at Yanghi-ghissar) and thrown on the road-side at Kutcha, where it remains. After a careful analysis of the samples brought by M. Grombchevsky, Prof. Mushketoff (in the *Izvestia* of the Russian Geographical Society, xxv., 6) comes to the conclusion that the Raskem nephrite and that of Tamerlane's tombstone are identical.

As to the white jadite in which the dark nephrite is embedded on the Raskem-daria, and which was extracted by the Chinese on the Tunga River, it is like the jade obtained in Burmah on the tributaries of the Irawadi, and described in a recent issue of the *Scottish Geographical Magazine*.

SOME curious results have appeared in an examination, by Herren Geisler and Ulitzsch, of school children in the (Saxon) Freiberg district, with reference to growth (*Humboldt*). Twenty-one thousand children (of both sexes) were measured. The boys, up to the eleventh year, were found to be about 0·6 to 0·9 cm. taller than the girls; but they were then overtaken by the girls; and this superiority of the girls continued till the sixteenth year, when the boys again grew more than the girls. This is against Quetelet's opinion, that boys are throughout bigger than girls.

THE Liverpool Geological Society has issued Part II. of the sixth volume of its Proceedings. Among the contents is an address by the President, Mr. H. C. Beasley, on the life of the English Trias. Mr. T. Mellard Reade contributes geological notes on an excursion to Anglesey; a note on a boulder met with in driving a sewer heading in Addison Street, Liverpool; and a note on some mammalian bones found in the blue clay below the peat-and-forest bed at the Alt mouth.

AT the meeting of the Linnean Society of New South Wales on June 25, Mr. Fletcher exhibited one living and several spirit specimens of *Notaden Bennettii*, Gthr., from three different localities—namely, Dandaloo, on the Bogan River (collected by Mr. A. Fletcher), Warren, on the Macquarie (collected by Mr. Thacher), and Narrabri (collected by Mr. Henry Deane). He remarked that though this toad has hitherto been rare in collections, it is at times not uncommon in its native haunts. In two of the localities above named he had been informed that during April and May of this year considerable numbers had appeared, though possibly the recently prevalent floods may have been concerned in bringing them prominently under notice. From what he had seen of living specimens in captivity, the animals were expert burrowers; and from what he had heard as to their avoidance of water, their comparatively sudden appearance, followed shortly afterwards by a noticeable diminution in numbers, he was inclined to think that the species perhaps resembled the American spadefoot toad (*Scaphiopus*) in keeping generally out of sight except during a short breeding period. Mr. Ogilby remarked that Mr. Helms, who is away on a collecting expedition for the Australian Museum, had recently sent down specimens of the same species from Bourke.

SOME habits of crocodiles have been lately described by M. Voeltzkow. Travelling in Wituland, he obtained in January last 79 new-laid eggs of the animal, from a nest which was five or six paces from the bank of the Wagogona, a tributary of the Ooi. The spot had been cleared of plants in a circle of about six paces diameter; apparently by the crocodile having wheeled round several times. Here and there a few branches had been laid, but there was no nest-building proper. The so-called nest lay almost quite open to the sun (only a couple of poor bushes at one part). The eggs lay in four pits, dug in the hard, dry ground, about two feet obliquely down. Including eggs broken in digging out, the total seems to have been 85 to 90. According to the natives, the crocodile, having selected and prepared a spot, makes a pit in it that day, and lays about 20 to 25 eggs in it, which it covers with earth. Next day it makes a second pit, and so on. From the commencement it remains in the nest, and it sleeps there till the hatching of the young, which appear in about two months, when the heavy rain period sets in. The egg-laying occurs only once in the year, about the end of January or beginning of February. The animal, which M. Voeltzkow disturbed, and saw drop into the water, seemed to be the *Crocodilus vulgaris* so common in East Africa.

IN the last official report from Gambia, the Colonial Surgeon has an interesting paragraph on native diseases. The natives of Africa, he says, who are world-renowned for their superstition, attribute all diseases to one of two causes: either they have been "witched," or some enemy has made "greegree" against them. Of the latter there are two forms: (*a*) the "greegree" that is administered to a person, and most usually consists of an infusion made of roots, leaves, or bark from trees supposed to have the desired properties; (*b*) the "greegree" that is prepared against a person. This is done with much ceremony, and the process is accompanied by incantations, recalling the scene of the "witches' cauldron" in "Macbeth." The treatment relied upon for cure, and much practised in the country, is to call in a man who is supposed to be a "doctor," who, after looking at the patient, sits down at his bedside and writes in Arabic characters on a wooden slate a long rigmarole, generally consisting of extracts from the Koran. The slate is then washed, and the dirty infusion is drunk by the patient. As a result of this state of ignorance and superstition, unqualified practice of every description is openly carried on, and drugs and poisons are daily sold by persons who are wholly ignorant of their properties, but who have acquired sufficient influence over ignorant patients to extort money.

THE *Deutsche Seewarte* has just published in a tabular form the results of the meteorological observations made on German and Dutch ships for the ten-degree square, lat. 20°–30° N., long. 30°–40° W., situated in the centre of the North Atlantic. This is, in fact, the eighth such square which has been similarly published in the last few years; the results for each month are grouped in one-degree squares, of which there are one hundred in each ten-degree square, and the observations for any part of such sub-square are so grouped as to be readily available for combination with the materials collected by other institutions. The winds are recorded under 16 points, with additional columns for variable winds, calms, and storms. Other columns include the means of the various data, the duration of rainfall, and remarks of special interest extracted from the logs used in the discussion. The volume contains xxvi. + 193 large quarto pages.

IN the third number of the *Sammlung von Vorträgen und Abhandlungen*, Prof. Foerster, the Director of the Berlin Observatory, has brought together seven lectures delivered by him in recent years to scientific societies and artisan audiences in Berlin and Hamburg, and various papers reprinted from *Himmel und Erde*, the Prussian *Normal Kalender*, and other sources. Four of the lectures have relation to standard time, the universal meridian, and the Washington Conference; others are included in the prediction of earthquakes and meteorological phenomena, luminous night clouds, the red skies which followed the Krakatão eruption, and Karl Braun's cosmogony. In a paper on the zodiacal light, it is held that, although the constitution of the light is still a matter of doubt, the evidence gained by means of the spectroscope and polariscope indicates that it consists not merely of sunlight reflected from bodies of a meteoritic nature, but also of innate light, due, probably, to electrical effects in a gaseous medium. A paper from the *Kalender* for 1891 contains an account of recent work done at Potsdam on the motion of stars in the line of sight, the instruments employed in the investigation being fully described. Prof. Foerster enjoys some renown in Germany as a popular exponent of scientific questions, and numerous reprints of his papers and discourses have appeared.

THE demand for techical education in New South Wales is rapidly increasing both in Sydney and in the principal centres of population throughout the country. At present there are between 3000 and 4000 students enrolled, as against a total of 2200 this time last year. A tender has been accepted for the erection of a new technical college in Sydney, to cost £19,537, and the building is to be completed by March next.

THE American journal *Bradstreet's* in a recent article describes a school of manual training at Baltimore, which claims to be the pioneer public manual training school, as well as the only absolutely free school of the sort in the world. The school was opened in 1884 with sixty pupils and four instructors; now it has 549 pupils and fifteen instructors. It has had manual training for its chief object. The ordinary work of advanced public school grades is here but a department called the literary department. This is an essential difference from the manual training in so many schools, where it is one feature of many, and not the chief. It is not meant to teach trades, but rather the use of the tools used in all common trades, and the rudiments of mechanical industry. The regular course of the school takes three years, but there is a preparatory course of two years for the benefit of those who could not continue the ordinary public school course. All the students have their daily work in the shops, drawing-rooms, physical laboratory, and literary department. Each class has its own recitation-room, and only leaves it for drawing, shop, and laboratory work. In shop work the classes are limited to twenty-four boys, while in drawing and other studies double that number are instructed at a time. In the first year fifteen weeks are devoted to carpentry, five to wood-turning, and twenty to forging. In the second year fifteen weeks are devoted to pattern-making, five to moulding, fifteen to vise-work, and five to soldering and brazing. In all the shops instruction is given as to the care and use of tools, laying off and designing work, and the composition of the material used. Each class makes some special design for graduation, and the class this year is engaged on a ten horse-power dynamo, thirteen lathes, and a Gordon printing press. The dynamo will be set up, and is expected to furnish electricity enough to light both buildings with incandescent lights. The boys also do all the plating required, and make all repairs on the machinery in use.

THE additions to the Zoological Society's Gardens during the past week include an Ashy-black Macaque (*Macacus ocreatus*) from the East Indies, presented by Mr. W. J. Bosworth; a Two-banded Monitor (*Varanus salvator*) from the East Indies, presented by Captain W. J. Rule; a Wapiti Deer (*Cervus canadensis* ♀) from North America, an Aard Wolf (*Proteles cristatus*) from South Africa, two Patagonian Conures (*Conurus patagonus*) from La Plata, purchased; two Ariel Toucans (*Ramphastos ariel*) from Brazil, received in exchange; a Barbary Wild Sheep (*Ovis tragelaphus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on August 14 = 19h. 33m. 5s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 4510	—	Pale blue.	19 37 45	+14 25
(2) G.C. 4514	—	Greenish-blue.	19 41 56	+50 15
(3) δ Sagittæ...	4	Yellowish-red.	19 42 29	+18 16
(4) β Aquilæ...	4	Yellow.	19 49 54	+ 6 8
(5) δ Aquilæ...	3·4	White.	19 19 54	+ 2 54
(6) 483 Birm.	7	Very red.	18 58 32	− 5 49
(7) S Scorpii	Var.	—	16 11 7	−22 37

Remarks.

(1) This is a small planetary nebula which gives the usual spectrum of three bright lines, in addition to a comparatively distinct continuous spectrum of considerable length. In further observations special attention should be directed to the character of the chief line, and maxima of brightness in the continuous spectrum should be looked for. It is not improbable also that many faint lines may be found with the improved instruments now in use. In the General Catalogue the nebula is thus described: "A planetary nebula; bright; very small; round."

(2) This is one of the so-called "nebulous stars" appearing in ordinary instruments as a star out of focus. The central nucleus gives a continuous spectrum, but the surrounding atmosphere gives a spectrum consisting of three bright lines. It would be a considerable advance in our knowledge if the spectrum of the nucleus could be determined. It may be that we are simply in presence of a star like those of the Pleiades, produced by the intersection of streams of meteorites, or it may be an ordinary case of condensation of a nebula. In the former case the spectrum would probably be that of a hot star, whilst in the latter case it would be one of an early group, possibly consisting of bright lines. Further observations are obviously required. The General Catalogue description is as follows: "A nebulous star; bright; pretty large; round; star of 11th magnitude in the middle."

(3) A bright star, with a well-marked spectrum of Group II. The bands 2, 3, 7, and 8 are strong, and 1, 4, 5 are well seen (Dunér). The usual observations for bright carbon flutings and absorption lines are required.

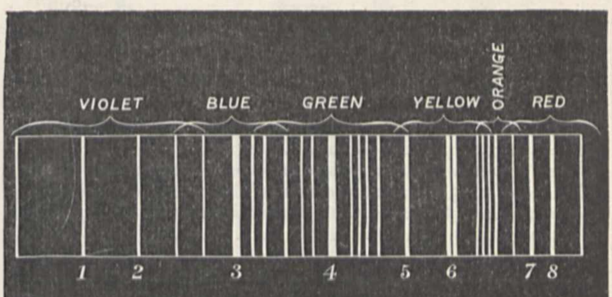
(4) and (5) Gothard states that these are stars of the solar type and of Group IV. respectively, the former being confirmed by Vogel. The usual more detailed observations are required in each case.

(6) This is a comparatively bright star of the rare type of Group VI., and offers a good opportunity for a detailed study of this kind of spectrum. In addition to the three usual carbon bands, it shows the secondary bands 4 and 5 (Dunér). The intensity of band 6 (λ 564), as compared with the other carbon bands, is not recorded by Dunér. The presence or absence of line absorptions should be particularly noted.

(7) The spectrum of this variable has not yet been recorded. According to Gore's catalogue, the period is about 177 days, and the magnitude ranges from 9·1–10·5 at maximum to < 12·5 at minimum. There will be a maximum about August 19.

A. FOWLER.

LIGHTNING SPECTRA.—Mr. W. E. Wood, in the current number of *The Sidereal Messenger*, gives the results of some observations of lightning spectra made on June 22, 1890. The results were obtained with a Browning direct-vision spectroscope of small dispersion, and having no scale, so that the lines mapped in the accompanying diagram are eye estimates.



With respect to the 25 bright lines shown it is remarked, "two moderately bright lines lie in the violet, one heavy bright line in the blue, and which I estimate to be the familiar F line, one brilliant line in the green (the coronal or auroral line?), one brilliant line on the yellowish-green, a double line in the yellow—very brilliant (the sodium line?), a fainter but fairly broad line on the edge of the red, and two very bright lines in the centre of the red, one of which I think is a hydrogen line. The fainter bright lines lie approximately as shown in the diagram. The intense flashes, those which usually do the damage during a storm, gave *exceptionally* faint, continuous spectra, and rarely more than the lines number 3, 4 and 5. Heat-lightning flashes gave the principal bright lines 1 to 8, and the spaces between were occupied by a multitude of finer bright lines. An absorption band in the violet occurred in all *bright* flashes of heat-lightning, and in some cases I saw two such bands in the red, lying on either side of the pair 7 and 8. . . . It might be well to state that the line, which I judge to be the auroral line, was in all cases the most noticeable, and especially so in discharges of heat electricity, which seemed to occur in the upper and more rarefied strata of the air."

Solar Activity.—Prof. Tacchini gives the following results of solar observations during the second quarter of this year (*Comptes rendus*, August 4):—

	No. of days of obser-vation.	Relative frequence of spots.	Relative frequence of days without spots.	Comparative area of spots.	Comparative area of faculæ.	No. of groups of spots per day.
April	19	2·08	0·75	1·40	10·40	0·44
May	20	2·55	0·54	2·58	25·83	0·71
June	26	1·35	0·76	0·86	8·10	0·25

A comparison of these figures with those of the first quarter of this year shows that the spots are slowly increasing in magnitude, and that the number of days without spots is diminishing.

The following results have been obtained for the prominence:—

	No. of days of observation.	Mean number.	Mean height. ″	Mean extent. ″
April	19	1·90	35·2	1·5
May	20	1·55	37·9	0·9
June	26	2·42	27·7	1·3

Denning's Comet (*c* 1890).—Dr. A. Berberich has computed the following orbit of the comet discovered by Mr. W. F. Denning at Bristol on the 23rd ult., from observations made at Nice on the 24th and 25th, and at Strasburg on the 27th (*Astronomische Nachrichten*, No. 2982):—

T = 1890 Sept. 24·7573 Berlin Mean Time.

$$\left.\begin{array}{l}\omega = 158^\circ\ 26'\ 64''\\ \Omega = 96\ 35\ 42\\ \iota = 99\ 37\ 67\end{array}\right\}\text{Mean Eq. 1890·0.}$$

$\log q = 0·12288$

$\Delta\lambda \cos\beta = +\ 0''·08;\quad \Delta\beta +\ 0''·06.$

Ephemeris for Berlin Midnight.

1890.	R.A. h. m. s.	Decl. ° ′
Aug. 14	15 22 56	+52 45·7
15	23 42	51 22·0
16	24 29	49 57·4
17	25 16	48 32·0
18	26 4	47 5·9
19	26 52	45 39·2
20	27 41	44 11·9
21	28 30	42 44·3

Brightness = 1·82 on August 17, and = 1·95 on August 21, that at discovery being taken as unity.

The comet will pass perihelion about September 25, at a distance of 1·33 the mean distance of the earth from the sun.

From the ephemeris given it will be seen that the comet is between β Boötis and θ Draconis on August 15.

GEOGRAPHICAL NOTES.

The Russian *Official Messenger* of August 1 gives the following news about the work done by M. Grombchevsky during last spring. On March 13 the expedition left Khotan for Niya. After having passed through the oasis of Keria, the travellers crossed the desert, where they met with a succession of *barkhans* (downs), reaching to the unusual height of 200 feet. From Niya they visited the Sougrak gold-mines, which are worked by nearly 3000 families living in caverns excavated in the loess and conglomerates on the slopes of the hills. Lumps of gold 2 lbs. in weight are sometimes found in these mines. Leaving Niya, the expedition crossed the border-ridge, which consists of several chains—the passes across them attaining heights of from 10,500 to 11,000 feet—and reached Polu, whence it returned to Keria. There M. Grombchevsky received the good news that the expedition would be allowed to continue its work till January 1, 1891, and that £200 had been granted for that purpose; so that M. Grombchevsky made arrangements to start for Rudok, in Tibet, in the first half of May.

The following telegram about M. Grombchevsky's expedition, dated Marghilan, July 19, has appeared in the Russian *Official Messenger*. The expedition had reached Polu, but had been stopped there by the Chinese authorities, who insisted upon the immediate return of the expedition to Kashgar, and ordered the population to leave their settlements and to camp in the mountains. Brought to despair, M. Grombchevsky spent his last money in bribing some inhabitants, and, without a guide, left Polu in the night of May 17, going further south into the depth of the unexplored wilderness.

The last number of the *Izvestia* of the Russian Geographical Society is of unusual interest, especially on account of its maps. It contains three reduced photographic copies of the hypsometric map of Russia, by General Tillo, and it is impossible not to admire the distinctness with which the two chief lines of upheaval, the south-west to north-east direction, and the north-west to south-east direction, appear on this map, even amidst the plateaus and the depressions of middle Russia. Another interesting map renders, on a scale of 7 miles to the inch, the surveys of M. Grombchevsky, made during his recent attempts to reach Tibet from the north. The map is accompanied by two letters from the explorer, written in December 1889, at the sources of the Khotan-daria and the Kara-kosh. The same issue contains a letter from the chief of the Tibet expedition, M. Roborovski, dated from Niya, December 11, 1889; a paper on the geodetical surveys in Russia; and a most interesting summary, by M. Kuznetsoff, of his several years' study of the flora of the Caucasus.

In a communication to the Société de Géographie of Paris, M. G. Marcel, who is one of the librarians of the Bibliothèque Nationale, has given some particulars of Louis Boulanger, an astronomer, geometer, and geographer of the sixteenth century. In 1511 he published at Lyons a work, "Equatorii Cœlestis Motus," of which only one copy is known. It is in the Bibliothèque Mazarin, and is described by M. Marcel as hitherto ignored by bibliographers. In 1514 he brought out a piracy of Muller's "Cosmographiæ Introductio." The globe accompanying this is regarded as the first on which the word "America" is found. Another globe has been found by M. Marcel at the Bibliothèque Nationale, which he regards as having been made by one of the school of Schoener between 1513 and 1518, and on it the then new name of the New World occurs four times. It is therefore either the first or the second cartographic document in which America is mentioned.

THE SCIENTIFIC PRINCIPLES INVOLVED IN MAKING BIG GUNS.[1]

III.

Part III.—Wire Gun Construction.

An inspection of Fig. 5 (p. 307), and of the serrated edge of the curve of circumferential tension, *t*, shows that only the inner fibre of each coil is doing its full share of resistance when the gun is fired.

Great economy of material can be effected if we can make all the circumferential fibres take up a full uniform working tension (say of 18 tons per square inch) when the gun is fired; but to secure this condition only approximately, the number of coils would have to be largely increased, and the cost, complication, and time of manufacture of a gun would be enormous.

But, by adopting Mr. J. A. Longridge's plan of strengthening the inner tube A by steel wire, wound round with appropriately varying tension, we are theoretically able to make the curve of circumferential firing tension, *t*, a straight line for a determinate powder pressure; and now all parts of the wire coil are equally strained, and take an equal share in the resistance.

The subject has been investigated theoretically by Mr. Longridge, assisted by Mr. C. H. Brooks, beginning in 1855; and his theories are set forth in papers in the Proceedings of the Institution of Civil Engineers in 1860, 1879, 1884, em-

[1] Continued from p. 334.

bodied in Mr. Longridge's "Treatise on the Application of Wire to the Construction of Ordnance," 1884 (Spon); and again in a paper in 1887, "Further Investigations regarding Wire Gun Construction."

Dr. Woodbridge, of America, claims to have originated the system of strengthening guns with wire, in 1850; but to Mr. Longridge belongs the credit of pointing out the proper mode of winding on the wire with initial tension so adjusted as to make the firing tension of the wire uniform for the maximum proof powder pressure.

Mr. Longridge's principle is applicable not only to engines of destruction, but also to peaceful purposes, such as strengthening the cylinders of hydraulic presses and lifts, and the copper pipes of steam-engines; for which a great, and, we hope, a profitable future is in store.

Returning to the application of the principle to artillery, the great object attained is the notable reduction in weight of the gun—a matter of importance in siege artillery, where the weight of the largest single piece of metal, the gun itself, is limited by the difficulty of transport over bad roads and rough country. By the use of Mr. Longridge's principle, the weight of a howitzer can be reduced from five tons to three and a half—quite sufficient to make all the difference between getting the gun into position, or being compelled to leave it behind.

It is also claimed as an advantage of the wire gun that the construction will be found cheaper and more expeditious, when once the appropriate machinery is erected; and that this machinery need not be nearly so elaborate and expensive as that required with the present system of construction with steel coils shrunk on over each other.

As we have seen in Part II., the appropriate initial state of stress is, in the coil gun, dependent on such delicate fitting as thousandths of an inch, and a slight irregularity in the texture of the metal may be sufficient to completely modify the initial stresses as designed. With the wire gun, on the other hand, the wire can be coiled on to the inner tube from an equal parallel coil of wire, and the appropriate tension given by means of a certain weight running on the free part of the wire, and incidentally testing the strength of the wire. Certain practical difficulties exist in securing the ends of the wire, and in providing for longitudinal strength, which experience will doubtless soon overcome.

Besides Mr. Longridge's "Treatise," the most important is a long article in the *Revue d'Artillerie*, on "Steel Wire Guns," by Lieutenant G. Moch, since published as a separate book, and also translated in the American "Notes on the Construction of Ordnance," No. 48, 1888.

Lieutenant Moch resumes Longridge's and Brooks's calculations, and presents the mathematical work in a more concise and elegant form; he applies his formulas to the design of the wire guns, proposed in 1871 by Captain Schultz, who was unaware of Mr. Longridge's previous work.

We shall attempt here to present the essence of Lieutenant Moch's article in a concise and geometrical form, depending on the method and formulas of Parts I. and II., and illustrated by the design of one of Schultz's guns; referring the reader who wishes to pursue the subject in all its practical details to Moch's original article, and to Longridge's "Treatise."

(44) Taking the cross-section of the gun across the powder-chamber, as composed of the inner tube, A, the wire coil, B,

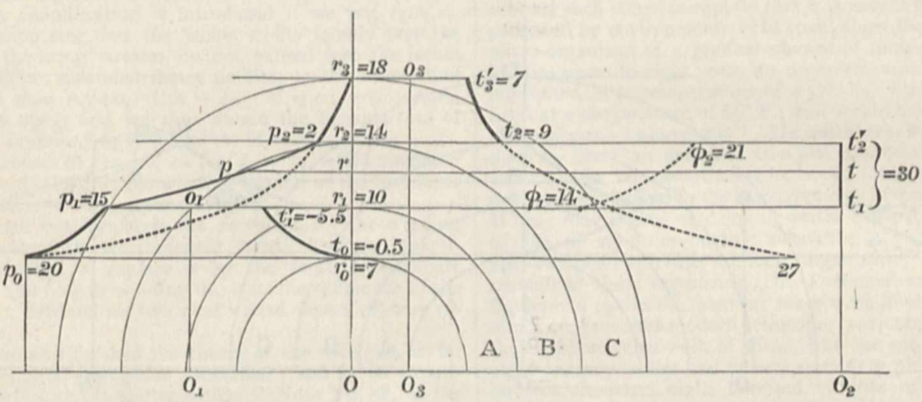


FIG. 9.

and an outer jacket, C, then in the ideal state, the firing stresses will be represented in Fig. 9, where the curve of circumferential tension, $t_1tt'_2$ is a straight line in the wire coil B.

The outer jacket, C, is merely required for protection of the wire from damage by shot, so that it may be supposed fitted over the wire without any appreciable shrinkage; when the gun is at rest, the jacket C will then be in a state of repose free from stress; but when the gun is fired, we may suppose the stresses in C to be the powder-stresses (§ 12, p. 306), on the assumption that the gun behaves as if homogeneous.

We denote by r_0 the internal radius of the tube, by r_1 and r_2 the internal and external radii of the wire coil, and by r_3 the external radius of the jacket, all measured in inches in our units.

Then in the jacket C the curves t'_3t_2 of circumferential tension and r_3p_2 of radial pressure, representing firing stresses, will be Barlow curves, the reflexions of each other in their medial axis O_3o_3.

(45) The continuation of the Barlow curve r_3p_2 in the dotted line up to p_0 will give graphically the powder pressure p_0; but now the curve of firing radial pressure between r_2 and r_0 will be the broken curve $p_2p_1p_0$, of which p_1p_0 in the tube A is the portion of another Barlow curve, but of which p_2p_1 in the coil B is easily seen to be a portion of a hyperbola.

For the curve of firing circumferential tension in the wire being the straight line tO_2, the condition of equilibrium of any cylindrical portion of the wire coil, bounded internally by the radius r, requires that the rectangle r_2t of circumferential resistance should be equal to the rectangle Op − rectangle Op_2; or, in other words,

the rectangle p_2t = rectangle Op,

or

the rectangle O_2p_2 = rectangle O_2p;

which proves that the curve p_2p is a hyperbola, with O_2O and O_2t as asymptotes.

(46) The tangent at any point of this hyperbola—say at p_2—is drawn by joining the point p_2 with points on O_2O or O_2t at double the distance of p_2 from O_2t or O_2O, by a well-known property of the hyperbola.

But to draw the tangent at p_2 of the Barlow curve r_3p_2, we must join p_2 with a point on O_3O at a distance from O_3 treble the distance of p_2 from O_3o_3.

Similarly we can draw at p_1 the tangent to the hyperbola p_2p_1, and the tangent to the Barlow curve p_1p_0, when we know the position of O_1o_1, the axis of this Barlow curve, p_1p_0.

(47) The position of O_1o_1 is fixed by the condition that the curve of circumferential tension in the tube A is the reflexion of the curve p_1p_0 in O_1o_1; and the position of this curve of circumferential tension, $t_0t'_1$, is settled by the condition that the rectangle Op_0 is equal to the sum of the areas of circumferential resistance, bounded by $t_2t'_3$ in the jacket C, by the straight line $t_1t'_2$ in the wire coil B, and by the curve $t_0t'_1$ in the tube A.

(48) It will be noticed in the diagram that, with the numbers given there, the curve $t_0t'_1$ lies to the left of the line r_0r_1, showing

that when the gun is fired the interior of the tube is still in a slight state of compression, so that the circumferential firing stresses of the tube are insignificant pressures, the chief stress being thrown upon the wire.

This theoretical result appears to be of great practical advantage in prolonging the life of the gun, as it is found that the tube of the wire gun has hitherto shown an unexpected vitality; a very gratifying result, when it is considered how short the life of our large guns is, in consequence of the erosion of the bore.

An empirical formula, $N = 2400 \div c - 50$, given by General Maitland (Proc. I.C.E., vol. lxxxix. p. 205) for the life of a gun, where c denotes the calibre in inches, and N the number of full charges that can be fired before the gun requires relining, will illustrate forcibly the comparative longevity of large and small guns: thus, if $c = 16$, $N = 100$; if $c = 12$, $N = 150$; but if $c = 0{\cdot}3$, as in the new magazine rifle, $N = 7950$.

We have now determined graphically the firing stresses in the wire gun, where the powder pressure, p_0, is exactly adjusted, so as to produce uniform t in the wire; a less powder pressure would obviously strain the inner fibres less, and less than the outer fibres; *vice versâ*, a powder pressure greater than p_0.

(49) But now the gun-maker has to determine the initial stresses in his gun from the above state of firing stress, by the operation of stripping off the powder stresses, assuming the gun to behave as if homogeneous.

As a first consequence, the initial stresses in the jacket C will be reduced to zero, as they should be; because we have supposed the jacket C slipped on with merely a mechanical fit.

Secondly, in the wire coil B, the state of initial circumferential tension will be obtained by subtracting the ordinates of the prolongation of the Barlow curve t'_3t_2 from the ordinates of the straight line t'_2t_1; whence we obtain the symmetrical Barlow curve $\phi_2\phi_1$, by reflexion of the Barlow curve $t'_3t_2 \ldots$, produced.

The curve of radial pressure $r_2\varpi_1$ in the wire coil B, obtained by subtracting the ordinates of the Barlow curve p_2p_0 from the hyperbola p_2p_1, is now easily plotted, but is of a more complicated analytical character.

Finally, we come to the state of initial stress in the tube A, obtained also by stripping off the powder stresses from the firing stresses; and consisting of the curve of initial radial pressure ϖ_1r_0, a Barlow curve, and its reflexion, $\tau_1\tau_0$, the curve of circumferential pressure in the tube A; the position of $\tau_1\tau_0$ being settled so as to make the area $r_1\tau_1\tau_0r_0$ equal to the area $r_1\phi_1\phi_2r_2$; and now the state of initial stress is represented in Fig. 10.

(50) We notice that τ_0 is considerable, and may with imperfect design become dangerously near the crushing pressure of the material of the tube A; practically, however, the great crushing pressure τ_0 is considered advantageous, as tending to improve the resisting power of the material against the great enemy, erosion.

In the Severn tunnel, as a different exemplification of these principles, the crushing effect in the brick tube, due to the head of water of the land springs, was not allowed for sufficiently; if the land water around the tunnel is not kept down by pumping, the head of water soon becomes sufficient to cause the bricks on the interior of the tunnel to crush and splinter; and until the interior is strengthened considerably with steel or cast-iron curbs, the expense of pumping cannot be avoided.

(51) There is considerable divergence of opinion as to the proportions to be given to the tube A and the wire coil B; Longridge preferring a comparatively thin tube, A, of some softer material, like cast-iron, while Schultz made his tube of steel, and considerably thicker in proportion, with the advantage of throwing the longitudinal strength into the tube.

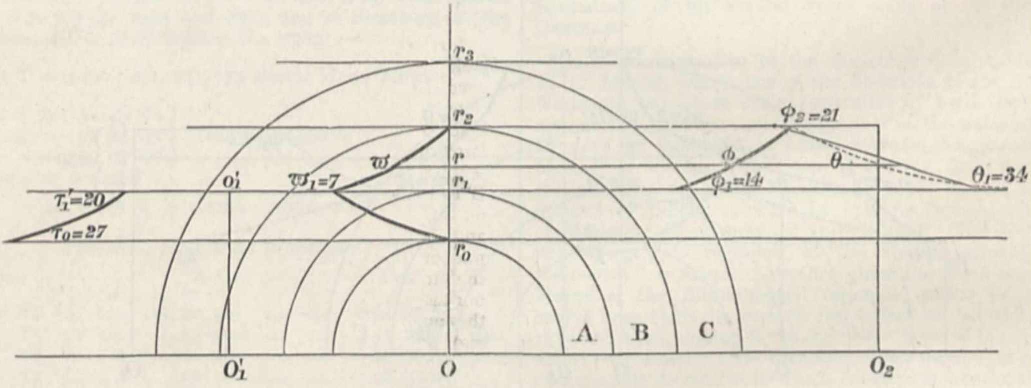


FIG. 10.

As the theory is considerably simplified if we take the tube A and the wire of the coil B of the same elasticity, we shall make Fig. 9 represent the design of one of the Schultz guns, as described by Moch, altering the dimensions and stresses to round numbers in inches and tons.

Now Figs. 9 and 10 represent the section across the chamber of the Schultz 34-centimetre ($13\frac{1}{2}$-inch) gun, in which we have made $r_0 = 7$, $r_1 = 10$, $r_2 = 14$, $r_3 = 18$, in inches, to the nearest integer.

(52) We assume that, under a powder-pressure, p_0, of 20 tons on the square inch, the wire coil is under a uniform circumferential tension of 30 tons on the square inch; a very moderate estimate for what steel wire is capable of sustaining, as 60 would not be excessive.

Numerical calculation by means of the formulas of Part I. gives the following values of the stresses, in round numbers:—
$p_2 = 2$, $p_1 = 15$; $t'_3 = 7$, $t_2 = 9$, $t'_2 = t_1 = 30$, whence $\phi_2 = 21$, $\phi_1 = 14$; $t'_1 = -5{\cdot}5$, $t_0 = -0{\cdot}5$, all in tons per square inch.

In Fig. 10 the initial stresses are represented; and we find, as before, $\phi_2 = 21$, $\phi_1 = 14$, $\varpi_1 = 7$, $\tau'_1 = 20$, $\tau_0 = 27$, while the initial stresses in the jacket C are *nil*.

(53) There still remains an important practical detail to be settled theoretically—the formula for the varying tension with which the wire must be wound on the tube A, in order that when the coil is complete the curve of initial tension of the wire should become finally $\phi_1\phi_2$.

The formula has been investigated in all its generality by Mr. Brooks in Longridge's "Treatise," but we shall follow Moch in his article in considering the very much simplified case of uniform modulus of elasticity.

As we have already used the word *initial* to distinguish the stresses in a gun in a state of repose when finished, we shall call the varying tension with which the wire is wound on the gun the *winding tension*, and denote it by θ, in tons per square inch.

(54) Now, to determine θ for any radius, r, of the coil B, Moch assumes that the winding tension of the wire is equal to the initial tension, ϕ, increased by the circumferential tension (pressure) due to the initial radial pressure, ϖ, at the radius r, acting on the partly finished tube and coil between the radii r_0 and r; and thus

$$\theta = \phi + \varpi\frac{r^2 + r_0^2}{r^2 - r_0^2}.$$

In other words, it is assumed that the tension of repose, ϕ, is less than the winding tension, θ, by the amount due to the pressure ϖ at a radius r, and zero pressure at the radius r_0, treating the material as homogeneous.

Now, by the formulas of § 7 (p. 305),

$$\phi = t - p_0 \frac{r^{-2} + r_3^{-2}}{r_0^{-2} - r_3^{-2}},$$

$$\varpi = p - p_0 \frac{r^{-2} - r_3^{-2}}{r_0^{-2} - r_3^{-2}}$$

$$= (p_2 + t)r_2 r^{-1} - t - p_0 \frac{r^{-2} - r_3^{-2}}{r_0^{-2} - r_3^{-2}},$$

where

$$p_2 = p_0 \frac{r_2^{-2} - r_3^{-2}}{r_0^{-2} - r_3^{-2}},$$

so that

$$\varpi = t(r_2 - r)/r - p_0 \frac{r^{-2} - r_2^{-2}}{r_0^{-2} - r_3^{-2}};$$

and the expression for the winding tension, θ, finally reduces to the form—

$$\theta = A + \frac{L}{r} + \frac{M}{r - r_0} + \frac{N}{r + r_0},$$

where

$$A = \frac{p_0 r_0^2 (r_3^2 - r_2^2)}{r_2^2 (r_3^2 - r_0^2)} = p_0 \frac{r_2^{-2} - r_3^{-2}}{r_0^{-2} - r_3^{-2}} = p_2,$$

$$L = -tr_2,$$

$$M = t(r_2 - r_0) - p_0 r_0 \frac{r_0^{-2} - r_2^{-2}}{r_0^{-2} - r_3^{-2}},$$

$$N = t(r_2 + r_0) + p_0 r_0 \frac{r_0^{-2} - r_2^{-2}}{r_0^{-2} - r_3^{-2}},$$

after considerable algebraical reduction.

(55) A great simplification is introduced if we put $r_3 = r_2$, equivalent to supposing that the jacket C fits loosely over the coil B, so that the firing stresses do not extend into the jacket C, which, therefore, now contributes nothing to the strength of the gun; and now $A = 0$, $L = -tr_2$, $M = tr_2 - (t + p_0)r_0$, $N = tr_2 + (t + p_0)r_0$; and we thus obtain the formula (51) of Longridge's "Treatise," or formula (50) of Moch's article.

With the numbers of Fig. 10, we find $\theta_1 = 34$, while obviously we always have $\theta_2 = \phi_2$, as the winding tension of the last layer of wire is the same as the tension in repose.

Having plotted out by points the curve $\theta_1\theta_2$ for the winding tension θ, a curve of the fourth degree, it will be found practically correct enough to replace it by the most approximate straight line; and now in winding the coil, the difference of the tension weights destined for two consecutive layers of wire remains constant.

(56) We have now finished the theory of the wire gun, so far as the circumferential strength is concerned; and for its experimental verification, an interesting article in Note No. 38, on the Construction of Ordnance, "On Winding and Dismantling an Experimental Wire-wound Gun Cylinder," by Lieutenant W. Crozier (Washington, June 1886), may be consulted; and according to recent reports a 10-inch gun has been recently constructed in America by Captain Crozier, on designs based upon his experimental results.

The theory of the longitudinal stresses in the wire gun has not been touched upon, because it is still a point of dispute as to whether the tube alone should provide the longitudinal strength, or whether it should be partly borne by the outside jacket, the wire coil being obviously unable, except in Canet's double coning system, of giving any assistance in this direction.

Mr. Longridge's principle of strengthening a tube with wire, wound with appropriately varying tension, will be found useful in peace and in war: he can claim credit that a gun strengthened on this principle, the 9·2-inch wire gun, was chosen from its great strength to test the extreme range of modern artillery in 1888, with what were called the "Jubilee rounds"; when, with an elevation of about 40°, a range of 21,000 yards, or 12 miles, was attained, the projectile weighing 380 pounds, and the muzzle velocity being about 2360 f.s.

The dimensions in the diagrams have been purposely taken in round numbers, so as not to represent invidiously any particular gun; in some cases, inappropriate stresses have made their appearance; and now it is the art of the gun-designer to modify slightly the dimensions of the parts of his first rough sketch, so as to attain to more uniformity of strength and a better theoretical result.

There is no claim to originality in the theory that has been given above, and we fear that due credit has not always been properly assigned to the right investigator; but the attempt has been made to present the essential points of the theory in as simple a form as possible, with a minimum recourse to algebraical formulas. The subject has been written about so much of late years that the reader is apt to be confused with the variety of notation and treatment; and it is hoped that the graphical method presented here will enable the theorist to present his results to the practical gun-maker in a more intelligible and convincing form.

A. G. GREENHILL.

ON PUTREFACTIVE ORGANISMS.[1]

THE author said his difficulty was to decide in which way to treat his subject. He might summarize the investigations of twenty years, and endeavour to show the original motives which led to their being undertaken, and then contrast this with the new meaning which has been derived from the investigations founded on recent methods and instruments; or, secondly, he might show the results of a series of continuous observations on certain saprophytic organisms placed under increasingly adverse environments, so as to endeavour to discover their behaviour in regard to the great Darwinian law. He inclined to this last as the view of his work that might have the broadest interest to a Society like that he was addressing; but the value of the improvements in recent lenses led him to give the priority to the results so obtained. In the case of larger animals, it was well known that a change of environment produced changes in the organism; but that these changes were hard to follow up, owing to the few generations that come under the notice of the student or observer. But in the case of micro-organisms the generations succeed each other so rapidly that it is easy to follow the changes produced by environment. He could show the effect on certain micro-organisms of a gradual change of temperature, and how in from seven to eight years an organism arose which lived and multiplied at a temperature of 157° F., whose ancestors had lived at a temperature of 65° F., and would have died if exposed to temperatures above 100°. He said there was nothing harder than to carry an audience to a just appreciation of the lower forms of life, but nevertheless he hoped to point out some of the practical results due to the improvements in modern microscopes. If they took a glass of drinking-water and put in it some shreds of fish, or any other organic substance, it soon became turbid and charged with the minutest organisms. To illustrate the number of these organisms, Dr. Dallinger said that visible to the human eye in the heavens there were in all probability with our most powerful modern telescopes 100,000,000 stars; and if they supposed that each of these, like our sun, was attended by eight primary bodies and twenty secondary planets, there would be two thousand eight hundred millions of bodies in space accessible to human research. The same number of these minute organisms to which he had referred would lie in a space equal to one ten-thousandth of a cubic inch. Any such a molecule of even dead matter must arrest the attention of the human mind; but when we remembered that these were complex *vital* forms, they had a significance of a high order, and their inconceivably rapid multiplication would make the mind pause and think. A decomposing mass of matter was a mass of beings endowed with life, and producing definite products. The life of the organism was not even an incidental product, the organisms were there for a purpose. They break up the decomposing organic matter into its elements, and so make it ready again for the purposes of life. Dr. Dallinger went on to describe some of the organisms which he has observed and examined. He said, that if they took some putrescent fluid from different putrefactive material, and mixed them, then put a very minute quantity of sterilized fluid on the microscope slide, and put into this the point of a needle which had been inserted into the mixture of putrefaction, and examined it with a sufficiently powerful microscope, the field of view in the microscope became, as it were, charged with life in an instant. There were many kinds of organisms, and they had many movements. There were rod-shaped organisms, spiral forms, a perfect oval form with two flagella, or whips. Another would be like the calyx of a papilionaceous flower, and have four flagella. Another would have a delicate egg-shape, and another be shaped like a double convex lens, and move with a beautiful wave motion. The fluid speck seen under the microscope was densely peopled. What were these organisms, and what their functions amid the denizens

[1] Abstract of an Address delivered before the Bristol Naturalists' Society, by the Rev. W. H. Dallinger, F.R.S.

of earth? They were extremely small, and the largest of them so small that one hundred millions could be packed within a cube whose side was equal to the diameter of a coarse human hair, and there were from ten to twenty less than this. This group were amenable only to the most powerful microscopes. It was known long ago that they carried on putrefaction; now they knew that the process was a fermentation. Dr. Dallinger then went on to contrast ordinary saccharine fermentation, like that of yeast, producing carbonic acid and alcohol, with the fermentation produced by these saprophytic organisms, and showed that both could be prevented by taking care to keep away any of the germs of the fermentation, that both could be arrested by the action of heat, and that both tended to break up the organic matter into simpler forms. In the case of the saprophytes, water and carbonic acid were produced eventually from the decaying mass on which they dwell, and thus by the vital functions of these organisms the chemical elements in the animal body were restored to nature, to become once more part of the protoplasm of living things. There were, however, two things in which these saprophytic ferments were different from ordinary ferments; in the latter a special organism produces a special product, whereas in the former there was no such definite product, and in the saprophytic ferment the final process was produced, not by one definite organism, but by a series of organisms. He did not think that these ferments destroyed one another; but between the beginning and the end of the putrefaction there was a definite incoming and disappearance of many forms. In from 50° to 60° north latitude, he believed these organisms were limited to ten forms, and of these eight were definitely determined, and their life-history made out. There were some present everywhere, and they acted at once. Dr. Dallinger said the object of his study was biological, and not pathological. Some of the results he discovered some time ago, but the large progress of recent years was due to the great improvements in our instruments. These organisms were all different, no two of them behaved alike. He said that if they added a very small quantity of putrescent fluid to a speck of water on a slide kept at 65° F., it was very easy to find some of these organisms almost directly, using a lens magnifying 1000 diameters; and they would be found to increase with a rapidity that no description could suggest. He then showed on the screen the first kind of organism that appears, and mentioned that when seen in reality, they were in a constant state of movement, and that the saprophytic ferment begins to split up and break down the organic tissues. This first organism, *Bacterium termo*, would produce profound changes in the putrefying tissues, and prepare the way for other organisms. It would be seen that this organism would be densest round the mass that was being broken up, forming a felt-like covering or garment to it; soon a new organism of a spiral form would make its appearance (this was shown on the screen), while *Bacterium termo* would become less abundant, and be diffused over the entire fluid. The new one, like *Bacterium termo*, would be densest next to the putrid matter, and would form a covering to it. The decaying tissue would now rapidly change, and would give off noxious gases. This form would continue for an indefinite time, and be succeeded by one or two new forms. (These were shown on the screen.) One of these new forms would have a single flagellum, and the other would have two; and they would move rapidly about and glide continuously over the decomposing matter. They increased very rapidly, one method of increase being by a process of division. In another method two bodies would unite together, and an amœboid condition ending in the *fusion* of two forms resulting in a sac from whence spore was produced, giving rise to new generations. Their rate of increase was inconceivably rapid, and it was not surprising that the putrid tissue was surrounded by a garment of these organisms. They had in all probability their food and suitable conditions for their life produced by the functions of their predecessors. Then a time came when this form died out, and a very remarkable organism appeared which also invested the putrid matter with a garment of living organisms; they stuck to the mass and waved to and fro. These were shown on the screen as they would be seen in the microscope, clustering round the matter. With this was shown the next organism—a most wonderful one. It has a rigid flagellum armed with a hook and a long trailing flagellum. The animal swims about, and when it comes to a piece of decaying tissue, it often anchors itself by the trailing flagellum, which is coiled into a spiral; then it darts up and down upon the decaying matter. The action of this was shown by a mechanical slide, the up-and-down motion and the coiling and uncoiling of the flagellum being seen. These were succeeded by a group which had a free flagellum without any hook, and which fastens itself down by means of its trailing flagellum, and hammers the decomposing tissue by throwing itself against it. This process was also shown on the screen by means of a mechanical slide. Dr. Dallinger said that this occurred at about the middle of the putrefactive action, the greater part of which is accomplished by this. The mass now gradually broke up. The next kind, which was also shown on the screen, and its process explained by a mechanical slide, has two trailing flagella by which it anchors itself; it then springs up and darts down, and further promotes the decomposition. At the close of this stage there is little left of the original tissue but some water charged with carbonic acid, and a slight deposit of fragments. Dr. Dallinger said that four years ago he found a new organism which acts as a gleaner, and gathers up the fragments of the *débris* left by the others. It is armed with six flagella, and swims about in the liquid, and when it comes within a certain distance of the solid remnants twists its middle flagella together, and springs up and down on the *débris*, removing entirely tiny particles. They move in a most beautifully rhythmic manner up and down. He showed a picture of these on the screen, and also a mechanical slide of a group of three, with their pretty rhythmic action. And thus the organic tissues were broken up into their ultimate elements. Dr. Dallinger mentioned that the last form was comparatively rare, and was more frequent in warm countries. It was clear, he said, that different climates had somewhat different forms. In conclusion, he said that twenty years ago, when in a state of ill-health, he took to this research, and found all these beauties and a thousand times more; and he urged those present to take up some field of microscopical research, and seek for the hidden beauties of Nature. They would find much pleasure in the doing of it. They need not be appalled by the high powers he had used; there were many facts to be found by the help of far lower powers. If they did this they would find that life would have a pleasure it had never known before.

HIGHLAND PLANTS FROM NEW GUINEA.

As we have already noted, Baron von Mueller contributes to the Transactions of the Royal Society of Victoria (vol. i., Part 2) some important records of observations on Sir William MacGregor's highland plants from New Guinea. The following are his general conclusions:—

"The memorable expedition, so valiantly and circumspectly carried out by His Excellency Sir William MacGregor, the Governor of British New Guinea, for the ascent and exploration of the Owen Stanley's Ranges, has for the first time brought also the flora of the temperate and the sub-Alpine zone of that great island within the reach of elucidation. In a brief preliminary report, written in July last, attention was drawn to the extraordinary commigration, by which plants of Asiatic, of far southern and even of sub-Antarctic types had mingled together in the Papuan highlands. From the material thus brought together only a commencement could be made to study the vegetation of the higher mountains regarding geographic points of view; in order to obtain a full insight into the Papuan Alpine flora, it would require to explore the hitherto inaccessible more central culminations in the island, where on tiers still some few or perhaps several thousand feet higher in yonder latitudes, according to varied physical conditions, a glacier flora would be more fully reached. To form extensive conclusions on the nature of the Papuan Alpine flora would at present be premature; but from what we have now seen, it promises to be eminently interesting. On this occasion I shall merely group these highland plants on geographic principles, with a hope that it may yet fall to my own share to carry on these comparisons more amply at some future time from fuller material, the total sub-Alpine and Alpine flora of New Guinea in all likelihood comprising several hundred species of vascular plants. Such future researches will be to myself all the more fascinating, as from 1853 to 1855 the whole flora of the Australian Alps became elucidated by field-work of my own, it being utterly unknown before. In these pages is alluded only to those plants, which Sir William MacGregor gathered in altitudes between 8000 and 13,000 feet, therefore in the region above the mountain zone, involved in almost permanent clouds.

"Of the 80 plants, specifically and distinctly recorded in these pages as emanating from the most elevated regions, nearly half the number seems endemic, so far as hitherto can be judged, while not yet all the highlands of South-Eastern Asia are explored, and while we yet remain in uncertainty about the constancy of some of the characteristics on which the adopted new specific forms are systematically established. Of these restricted Papuan plants, two—namely, *Ischnea elachoglossa* and *Decatoca Spencerii* represent new genera, the one allied to the exclusively Italian Nananthea, the other to the Australian and chiefly Alpine Trochocarpa. Of the other endemic plants 17 are of Himalayan types—namely, *Hypericum Macgregorii*, *Sagina donatioides*, *Rubus Macgregorii*, *Anaphalis Mariæ*, *Myriactis bellidiformis*, *Vaccinium parvulifolium*, *V. amblyandrum*, *V. Helenæ*, *V. Macbainii*, *Gaultiera mundula*, *Rhododendron gracilentum*, *R. spondylophyllum*, *R. culminicolum*, *R. phæochiton*, *Gentiana Ettingshausenii*, *Trigonotis Haackei*, and *T. oblita*, though some of these show also a touch of the Sundaic vegetative element; and here at once may be alluded to the extensive display of Ericaceous (inclusive of Vaccinaceous) plants, which forms of vegetation are in Australia so very scantily developed, and then only in Alpine regions. Contrarily, however, we now perceive otherwise almost a preponderance of upland Australian or New Zealandian or sub-Antarctic types in the highlands vegetation of New Guinea, so far as already revealed; this is demonstrated by the endemic occurrence of *Ranunculus amerophyllus*, *Metrosideros Regelii*, *Rubus diclinis*, *Olearia Kernotii*, *Vittadinia Alinæ*, *V. macra*, *Veronica Lendenfeldii*, *Libocedrus Papuana*, *Phyllocladus hypophyllus*, *Schœnus curvulus*, and *Festuca oreobaloides*; furthermore this repetition of the features of the southern flora so far north is rendered still more expressive and significant by the occurrence of numerous plants absolutely identical with our southern species—namely, *Epilobium pedunculare*, *Galium australe*, *Lagenophora Billardierii*, *Styphelia montana*, *Euphrasia Brownii*, *Myosotis australis*, *Sisyrinchium pulchellum*, *Astelia alpina*, *Carpha alpina*, *Carex fissilis*, *Uncinia riparia*, *U. Hookerii*, *Agrostis montana*, *Danthonia penicillata*, *Festuca pusilla*, *Lycopodium scariosum*, *Gleichenia dicarpa*, and *Dawsonia superba*—most of these being now shown for the first time to approach so near to the equator. Four Borneo plants, hitherto only known from lofty altitudes of Kini-Balu, have now been traced to the Papuan highlands also, viz. *Drimys piperita*, *Drapetes ericoides*, *Rhododendron Lowii*, *Phyllocladus hypophyllus*, three being of far southern type. Even a few of such British plants, not almost universally cosmopolitan, have now come like messengers from home before us from New Guinea as there also indigenous; thus, *Taraxacum officinale* and *Scirpus cæspitosus*, these being wanting even in the Malayan islands and in continental Australia, irrespective of the widely distributed *Aira cæspitosa*, *Festuca ovina*, *Lycopodium clavatum*, *L. Selago*, and perhaps *L. alpinum*, as well as *Hymenophyllum Tunbridgense* and *Aspidium aculeatum*. For the familiar northern genus Potentilla a truly indigenous position in the southern hemisphere has been gained now for phytogeography, as well as for Myriactis and Trigonotis, while Astelia, Uncinia, and Dawsonia are now seen to enter equinoctial regions in the eastern hemisphere. The *Styphelia montana*, the Astelia, and the Carpha mentioned indicate the commencement of a truly Alpine flora.

"On the Finisterre Range, the ascent of which was accomplished by Mr. Zoeller and his party during 1888 (this enterprise being inspired by myself in a lengthened interview with the leader), tree vegetation exists to the summit, therefore up to 11,000 feet, as indeed already telescopically ascertained by M. Mikluho Maclay. I can, however, furnish no data, which might assist our present purpose, on the nature of the vegetation there, as—against my expectation—no botanic specimens whatever, resulting from that courageous exploit, came to me as one who since many years has been engaged occasionally on connected elucidations of the Papuan flora. Sir William MacGregor found the arboreous vegetation to cease on the Owen Stanley's Ranges at 11,500 feet (despatch, July 1889, p. 10), and this cessation was not due to a change of geologic formation. The limits of tree vegetation may, however, on some other Papuan culminations under altered physical conditions be somewhat higher so near to the equator, in comparison to zones of vegetation in the Himalayas at and near the verge of the tropics.

"As regards prospective utilitarian gain from the world of plants likely to emanate from this expedition, we may look forward to the acquisition of the 'cypress' (*Libocedrus Papuana*), which constitutes the principal forests on the summit of Mount Douglas and Winter's Height, for arboreta even of countries of the cool temperate zone, and with this cypress-like tree could doubtless be associated in parks far outside of the tropics also the tall 'bamboo' (see Sir William MacGregor's despatch, p. 8), with which the dry region above the nebular zone begins at (about 8500 feet). The several hardy and gaudy rhododendrons could aptly be consociated by dissemination with the many Sikkin species, now so frequent as garden favourites. The dwarf raspberry would give us an additional table-fruit. How far the Korthalsia palm would bear actual frigour, remains to be ascertained. The species of Papuan highland grasses are rather gregarious than numerous.

"Why so many plants from cold southern latitudes suddenly reappear on the Papuan and perhaps also on the Bornean highlands in evidently coæval forms of common origin; why the highest regions, and these almost only, should, like in New Zealand, reiterate plant-life, otherwise typical of Tasmania, of continental Australia, of islands in the Southern Ocean, and also of Fuegia and Patagonia; whether this indicates a continuity of portions of the Papuan Island with a once vastly extending southern land, now mostly submerged; what clues can be obtained for all this from the study of glacial drifts occurring during former enormous telluric changes, such as geologic science endeavours to explain; what part possibly could have been taken by any migratory birds in effecting so wide a dispersion of some of these plants even into so exceptional isolations; all this and other momentous considerations involved in these questions must be reserved for future discussions and generalizations in a special essay, perhaps under the advantage of access to ampler working material, and at not too distant a day."

SCIENTIFIC SERIALS.

THE *American Meteorological Journal* for July contains an article by Prof. H. A. Newton on the late Prof. E. Loomis, of Yale College, U.S. (see NATURE, vol. xl. p. 401). In early life he paid much attention to terrestrial magnetism, and published the first magnetic charts of the United States; but his most important contributions were to meteorology. In a discussion of the storms of 1842, he adopted the use of synchronous charts very much like those now generally employed. The later years of his life were spent in discussing the materials collected by the Signal Service, and he published twenty-three memoirs upon them, entitled "Contributions to Meteorology." A large portion of his estate was bequeathed to the endowment of an astronomical observatory.—Prof. H. A. Hazen has an article setting forth the observations most needed in the study of tornadoes. He points out that, after fifty years' observations, our knowledge of this subject is very unsatisfactory.—Lieut. Finley gives tornado statistics for the States of Florida and South Carolina. The observations for the latter extend over 128 years. The month of greatest frequency in Florida is September, and in South Carolina, March.—M. H. Faye continues his articles on trombes and tornadoes, dealing especially with their action upon forests, and the carrying of heavy *débris* to great distances.—Prof. W. A. Rogers continues his article concerning thermometers, dealing principally with the pulsatory movements of a mercurial column found to exist in nearly all the thermometers investigated.—The last article is devoted to American opinions on the relation of the influenza epidemic to meteorological conditions, being abstracts of papers read at the meeting of the American Medical Association in May last.

SOCIETIES AND ACADEMIES.

LONDON.

Entomological Society, August 6.—Captain H. J. Elwes, Vice-President, in the chair.—Prof. Meldola, F.R.S., exhibited a male specimen of *Polyommatus dorilis*, Hufn., a common European and Asiatic species, which had been taken at Lee, near Ilfracombe, in August 1887, by Mr. Latter. At the time of its capture Mr. Latter supposed the specimen to be a hybrid between *Polyommatus phlæas* and one of the "Blues," and had only recently identified it as belonging to a well-known species. Mr. Stainton, F.R.S., Mr. Jenner-Weir, and Colonel Swinhoe made some remarks on the specimen, and commented on the additions to the list of butterflies captured in the United Kingdom which had been made of late years.—Mr. W. F. H. Blandford exhibited, and made remarks on, five specimens of *Athous rhombeus*, Ol., recently collected by himself in the New Forest.—The Rev. Dr. Walker exhibited a large collection of Coleoptera which he had recently made in Iceland. The following genera, amongst others, were represented, viz. *Patrobus*, *Nebria*, *Byrrhus*, *Aphodius*, *Philonthus*, *Barynotus*, *Chrysomela*, *Agabus*, *Creophilus*, and *Carabus*. Mr. Champion, Dr. Sharp, F.R.S., and the Chairman made some remarks on the collection.—Captain Elwes exhbited three species of the genus *Atossa*, Moore, three of the genus *Elcysma*, Butl., and three of the genus *Campylotes*, West.,—all from the Himalayas and North-Eastern Asia. The object of the exhibition was to illustrate the remarkable differences of venation in these closely-allied forms of the same family. Colonel Swinhoe, Mr. Warren, and Mr. Moore took part in the discussion which ensued.—Mr. P. Crowley read a paper entitled "Descriptions of Two New Species of Butterflies from the West Coast of Africa," and exhibited the specimens, which he proposed to name respectively *Charaxes gabonica* and *Cymothoe marginata*. He also exhibited several other new species from Sierra Leone, which had been recently described in the *Annals and Mag. of Nat. Hist.*

PARIS.

Academy of Sciences, August 4.—On the exhaustion of land by culture without manure; study of drainage waters, by M. P. P. Dehérain.—Observations of Coggia's comet (July 18, 1890) made with the Brunner equatorial of Toulouse Observatory, by M. E. Cosserat. Observations of position were made on July 21 and 22.—Elements and ephemeris of Denning's comet (July 23, 1890), by M. Charlois. The elements have been calculated from observations made at Nice on July 24, 28, and 30.—*Résumé* of solar observations made at the Royal Observatory of the College of Rome during the second quarter of 1890, by M. P. Tacchini. (See Our Astronomical Column.)—On the density of nitrogen and oxygen according to Regnault, and the composition of air according to Dumas and Boussingault, by M. A. Leduc. The author draws attention to a difference between the results obtained by Regnault and by Dumas and by Boussingault. If x = the proportion of oxygen in 100 volumes of air, d and d' the densities of oxygen and nitrogen, then

$$dx + d(100 - x) = 100, \text{ and } x = \frac{100(1 - d)}{d - d'}.$$

Replacing d and d' by Regnault's values ($d = 1{\cdot}10563$ and $d' = 0{\cdot}97137$), we get

$$x = 21{\cdot}324,$$

and for the percentage composition of air by weight,

$$\text{Oxygen} = 23{\cdot}58, \text{ and Nitrogen} = 76{\cdot}42.$$

Dumas's mean value was $23{\cdot}0 \pm 0{\cdot}1$, and the author throws out several suggestions as to the probable cause of the discordance. He has also made some determinations of the density of nitrogen, and obtained values comprised between 0·972 and 0·973.—Electrical resistances of gases in a magnetic field, by M. A. Witz. The author has previously communicated his researches on the action of magnetic fields on Geissler tubes (May 12, 1890), and has studied the effects produced by variations in the intensity of the magnetic field and the position of the tube with respect to the lines of force; he has now determined the influence exercised by changes in the pressure of the gas in the tube. The experiments have led to the conclusion that the action of magnets upon Geissler tubes is due to a variation in the capacity of the tubes, so that they constitute true condensers, and their illumination is the result of an oscillatory discharge of the same order as that of a Leyden jar, of which the period T is a function of the capacity C of the jar, and of the coefficient L of self-induction of the conductor of small resistance, and $T = \pi\sqrt{CL}$. A variation of the capacity C would thus modify the vibratory state of the, gas and would be the cause of the differences observed in the luminous phenomena in intense magnetic fields.—Reactions of alkaloid salts, by M. Albert Colson. Some investigations on heats of formation are given.—On the division of sulphuretted hydrogen between the metals of two dissolved salts, by M. G. Chesneau.—On some derivatives from acetylacetone, by M. A. Combes.—Experimental researches on thermic sensibility, by M. Charles Henry.—Experimental researches on the affected nerves of chronic lead poisoning, and on the causes determining their appearance, by MM. Combemale and François.—On the combinations of hæmoglobin with carbonic acid, and with a mixture of carbonic acid and oxygen, by M. Christian Bohr.—On the colouring of the silkworm by feeding, by M. Louis Blanc. From the investigations it would appear that very soluble and diffusible substances, such as fuchsin, are absorbed by the epithelium intestinal of the silkworm, and colour the cells of the secretory organs, but not the product of secretion.—On the cellular division of *Spirogyra orthospira*, and on the rearrangement of the colouring matters driven to the ends of the spindle, by M. Degagny.—The treatment of black rot, by M. A. de l'Ecluse.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

La Photographie Judiciaire: A. Bertillon (Paris, Gauthier-Villars).—British Cage Birds. Part 4: R. L. Wallace (U. Gill).—The Canary Book, Part 4: R. L. Wallace (U. Gill).—The Elements of Solid Geometry: R. B. Hayward (Macmillan).—Les Facultés Mentales des Animaux: Dr. F. de Courmelles (Paris, J. B. Baillière).—English-Eskimo and Eskimo-English Vocabularies: R. Wells and J. W. Kelly (Washington).—Photogravure: W. T. Wilkinson (Iliffe).—Bulletin from the Laboratories of Natural History of the State University of Iowa, Vol. i., Nos. 3 and 4 (Iowa).—Journal of Physiology, Vol. xi., Nos. 4 and 5 (Cambridge).

CONTENTS.