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THE METAL OF THE FUTURE.

Aluminium: its History, Occurrence, Properties, Metallurgy, and Applications, including its Alloys. By Jos. W. Richards. (London: Sampson Low and Co., Ltd., 1890.)

AS the recent improvements in the manufacture of aluminium have been so great as to enable it to be bought now at one-tenth the price it was only three years ago, and as its uses, especially in its alloys, are becoming constantly more extended and varied, a somewhat detailed review may be of service in directing attention to this, the latest book on the subject. It is intended by the author, who is instructor in metallurgy in Lehigh University, to lay before the general public as well as before metallurgists a full and accurate account of the aluminium industry as it exists at the present time. To do this, the author has found it necessary to make such numerous and extensive additions to the first edition, that the present volume may almost be regarded as a new book.

Passing in review the various parts of the book, we come first to an admirable *résume*, of 27 pages, of the history of the progress made in reducing aluminium metal; it contains much interesting information, not easily obtainable elsewhere, describing the founding of the various works for this manufacture from the time of Deville to the present electrical processes of Cowles, of Lockport, New York; of Hall, of Pittsburg; and of Heroult, of Neuhausen, Switzerland. The affairs of Frishmuth, of Philadelphia, here mentioned, may serve as a warning to those too ready to believe reports of success from enthusiasts or from the inventors of secret processes.

Chapter ii., of 7 pages, deals with the occurrence of the compounds of aluminium in Nature. It may be interesting to remind the reader of the existence of several precious stones that contain aluminium, but a list of "some other compounds occurring frequently" is surely very misleading when it contains the minerals turquoise, lazulite, wavellite, topaz, and even cryolite; these ought to have been replaced by such minerals as the sodium- and potassium-felspars, hornblende, augite, mica, kaolin, &c. These common aluminium minerals are described, curiously enough, however, in the chapter dealing with the artificial preparation of aluminium compounds. The statement "that aluminium has never been found in animals or plants" requires correction. The description of beauxite is accompanied by many analyses; but that of cryolite, which is directly used in the manufacture of aluminium, is accompanied by an incorrectly calculated percentage composition, and the one statement that "the so-called pure article was found by Prof. Rogers, of Milwaukee, to contain 2 per cent. of silica and 1 per cent. of iron," although further details are to be found on several other pages of the book.

Chapters iii. and iv., of 31 and 13 pages, deal with the physical and chemical properties of aluminium. A list is given of analyses, and an account of various specimens of commercial metal, showing the amount of the impurities, iron and silicon, that may be contained, and the effect on the physical properties is mentioned. The chapter on the chemical properties concludes with a paragraph headed "General Observations on the Properties of Aluminium"; this, being a quotation from Deville's general theoretical considerations, is very much behind the time indeed, and should be replaced by observations made with respect to Mendeleeff's classification of the elements, and coupled to the general considerations on the "structure of aluminium compounds" that introduces the next chapter.

Chapter v. describes generally the properties and preparation of aluminium compounds, but requires some alterations; thus, on p. 86 we read, "Alumina forms no carbonate," and p. 103 is a paragraph headed "Aluminium Carbonate," describing the preparation of the compound $Al_2O_3.CO_2$; and again, p. 88, we find diaspore is $Al_2O_3.H_2O$, beauxite is $Al_2O_3.2H_2O$, and gibbsite is $Al_2O_3.3H_2O$, whereas on p. 47 it is said that "beauxite is a combination between diaspor, $Al_2O_3.3H_2O$, and brown hematite, $Fe_2O_3.3H_2O$," and on the same page is also found "Diaspore, $H_2Al_2O_4$." We must certainly disagree with the names "aluminium-ammonium chloride" for the substance $Al_2Cl_6.3NH_3$, and "aluminium fluorhydrate" for $Al_2F_6.7H_2O$, and also think that the description of some dozen substances as the double chlorides of aluminium and sulphur, phosphorus and selenium, the above ammonia compound and the selenide and selenite of aluminium, might have been entirely omitted, and the space devoted with advantage to a more detailed description of the really important compounds.

Chapter vi., of 29 pages, is a well-written account of the "Preparation of Aluminium Compounds for Reduction," and describes the preparation of alumina from crude sulphates, from beauxite and from cryolite, the preparation of aluminium chloride, and aluminium sodium chloride, and the preparation of artificial cryolite and of aluminium fluoride, and also that of the sulphide of aluminium. The numerous processes here described give one much food for thought and comparison, and though no author is really responsible for the statements of others which he may introduce, yet where the statements of two authorities do not agree, the disagreement should be mentioned and suggestions made to explain the cause of it. Two cases may be cited. On pp. 113 and 118, analyses are given of alumina precipitated by carbonic acid from sodium aluminate solutions: the one shows 2·5 and the other 20 per cent. of sodium carbonate. Again, on p. 121 we find the method of Sauerwein for preparing alumina from cryolite, viz.,

$$Al_2F_6.6NaF + Al_2O_3.3Na_2O + 6H_2O = 2(Al_2O_3.3H_2O) + 12NaF;$$

while on p. 137 is described the very reverse reaction, a method of Berzelius for preparing cryolite from alumina, viz.,

$$2Al_2O_3.3H_2O + 12NaF = Al_2F_6.6NaF + Al_2O_3.3Na_2O + 3H_2O$$

(this last item is a mistake for $6H_2O$).

Chapter vii., of 39 pages, describes "The Manufacture of Sodium," giving a full account of the older processes, and also of the recent ones of Castner and Netto, in which not sodium carbonate, but hydrate, is reduced by carbon at a red heat. There is also reference

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made to the experimental preparation of sodium by electrolysis of fused salt.

The eighth chapter, 13 pages, considers "The Reduction of Aluminium Compounds from the Standpoint of Thermal Chemistry." After a short introduction, a list is given showing the heat developed in the oxidation of various metals. At the head stand magnesium and aluminium, and the author predicts the possibility of reducing alumina by magnesium under certain unknown conditions; and it is interesting here to note that C. Winkler, only a few months ago, in the course of a series of logical researches, has found that alumina, heated with magnesium, gives (according to the proportions) either finely-divided aluminium or a hitherto unknown oxide, viz. AlO, a perfectly black substance; and this was the substance for which Deville was searching in 1854, when for the first time he accidentally obtained pure aluminium in globules, an accident which led to his well-known labours in connection with this metal. The chapter concludes with an account of the thermal aspects of the formation and reduction of the chloride and sulphide of aluminium.

The next two chapters, ix. and x., of 26 and 24 pages, are headed, "The Reduction of Aluminium Compounds by Potassium or Sodium," although potassium has probably not been used for the preparation of aluminium since the experiments of Wöhler, in 1845. The first chapter is devoted to the double sodium chloride as source of the metal, and contains very full accounts of the process as practiced by Deville, and of the various improvements made up to the time of Paul Morin in 1882. Describing the patented process of Frishmuth, the author says: "In what the originality of the process consists . . . we cannot see, and we simply acquiesce blindly to the mysterious penetration of our Patent Office Board"; and the remark might fitly be applied to other patents than this particular one, and to other Patent Office Boards than that of the United States. The second chapter describes the reduction of the fluorine compounds. From the experiments and experience of H. Rose, Percy, Dick, Deville, Tissier Brothers, all fully described, the conclusion is drawn that the best use of cryolite is as a flux when reducing aluminium sodium chloride; but as a contrast to this is the account of the Alliance Aluminium Company's processes, by which 77 per cent. of the metal contained in the cryolite was extracted. The account of Grabau's processes, the reduction of aluminium fluoride by sodium, is very interesting, and especially so as he has been the first to produce on a commercial scale aluminium with less than half of 1 per cent. of impurities.

Chapter xi., of 70 pages, is one of the most important chapters in the book. It is an account of the "Reduction of Aluminium Compounds by the use of Electricity," and is introduced by an all too brief review of "the principles of electro-metallurgy as they apply to the decomposition of aluminium compounds." The method of calculating, from the heats of formation, the electromotive forces required to decompose aluminium chloride and alumina having been described, the number of volts thus found are explained to be

"the absolute minimum of intensity which would produce decomposition, and the actual intensity practically required would be greater than this, varying with the distance of the poles apart and the temperature of the bath as far as it affects the conducting power of the electrolyte. From this it would immediately follow that, if the substance to be decomposed is an absolute non-conductor of electricity, no intensity of current will be able to decompose it. If, on the other hand, the substance is a conductor, and the poles are within reasonable distance, a current of a certain intensity will always produce decomposition."

We are sure that such an explanation of phenomena that can only be successfully treated mathematically will not greatly enlighten the uninitiated, and hope that in the next edition the author will find it possible to give a more exact and fuller account of electric phenomena in so far as they apply to the subject in hand; as, for instance, an account of Ohm's law applied to electrolytes, of the chemical and thermal effects of electric currents upon electrolytes, of the chemical, electrical, and thermal effects of secondary reactions to which the products of the electrolysis may give rise, &c., and also even a brief description of the instruments and machines used to measure and generate the powerful currents used in the manufacture of aluminium. With the expression of this hope we will pass over many inaccurate and dubious expressions relating to electrical terms and descriptions.

Exceedingly curious is the account of some twenty patented processes for depositing aluminium or its alloys from aqueous solutions, and the following remarks of the author summarize the results obtained by all these enthusiastic labourers in Nature's unwilling fields:—

"We have inventors affirming in the strongest manner the successful working of their methods, while other experimenters have followed these recipes and tried almost every conceivable arrangement, yet report negative results. . . . No good authority testifies to the success of any process so far advanced, neither have I seen any so-called aluminium plating (from aqueous solution) which really was aluminium."

"The Electric Decomposition of Fused Aluminium Compounds" is treated, with the exception of a few cases, chronologically; in reviewing the chapter we shall, however, group them according to the electrolyte used, and we cannot but think that this very important chapter could have been presented more concisely in such a way.

First, then, there are accounts of the electrolysis of fused aluminium sodium chloride by Deville, Bunsen, Le Chatellier, Berthaut, and Grätzel, whose process was actually tried on a large scale, but abandoned. The processes of Omholt and Faure are amusing, inasmuch as the one melts aluminium chloride in a reverberatory furnace! and the other electrolyzes a bath of the same substance at 300°!

The remaining processes may be classified as follows: (1) electrolysis of cryolite without addition of alumina, but with or without addition of salt, &c.; (2) the same as No. 1, except that alumina is also added; (3) electrolysis of alumina dissolved in cryolite salt, &c.; (4) electrolysis of fused alumina; (5) electrically heating mixtures of alumina and carbon to such a temperature that they react upon each other chemically; (6) methods using crude clay, beauxite, or kaolin as the source of alumina, and not worthy of further consideration. To the first class belong the processes of Gaudin, Grabau, Feldman, and perhaps also that of Rogers; the products of the action are aluminium and chlorine or fluorine. To the second class may be ascribed the process of Kleiner, perhaps that of Rogers, and that of Bernard Brothers; the products of the action are the same as the first class, but the aluminium fluoride destroyed by electrolysis is in part restored to the bath "by causing the fluorine vapours evolved to act on alumina or beauxite placed somewhere about the anode." To the third class may be ascribed the processes of Henderson, Hall, and part of Heroult's patented process; here the products are said to be aluminium and oxygen, which by contact with the carbon anode is converted into carbon monoxide or carbon dioxide, and the cryolite, &c., used as solvent for the alumina are said to remain unchanged. The fourth class contains only Heroult's process, and of that only the latter half of his claims. The fifth class contains the process of Monckton, Cowles, Menges, and Farmer.

As regards the details of these various processes reference must be made to the book. The processes of Cowles, Hall, and Heroult are reported as being in active and very extensive use by the several companies, and if one is to believe the glowing reports that are published they are very successful indeed; thus Hall claims to extract 50 per cent. of aluminium from alumina, instead of the theoretical 52·94 per cent., while the fluorides used waste only very slightly, and require replenishing to the extent of a small fraction of the weight of the metal made; and with his latest improvements aluminium is not to cost more than half a dollar a pound!

The scientific investigation of these processes is either kept secret, or, alas, has scarcely been attempted; and yet the surest and quickest way to establish a process on a sound commercial footing is to thoroughly investigate the conditions regulating every reaction, and not merely those conditions relating to the principal reaction, for those relating to the ubiquitous "impurity" are at least of equal, if not of greater, importance. In describing the above processes, the author introduces scientific and numerical discussions on several points; but the work would have been more valuable to the increasing number of metallurgists interested in the subject if the book had bristled more with hard facts expressed in figures, and with references to volume and page where the original might be found.

Chapter xii., of 31 pages, is a summary of the very many processes that have been proposed for the "Reduction of Aluminium Compounds by other means than Sodium or Electricity." Many of the accounts record the partial success of actual trials, and deserve consideration; but many are but little more than written hopes and imaginations.

As far as the end of this last chapter, the subject-matter, with the exception of chapters iii. and iv., is purely chemical, and relates, indirectly or directly, to the primary production of aluminium or of certain of its alloys. From this point the book deals with the manner of working aluminium, the preparation of its alloys, and the properties which characterize them. This metallurgical part of the book may be considered as being introduced, as far as aluminium itself is concerned, by chapters iii. and iv. and some four pages of chapter xiii., which describe the "Purification of Aluminium," and refer very briefly to Mallet's preparation of the pure metal. The special methods found suitable for the analysis of aluminium and its alloys are described in the last chapter of the book.

Chapter xiii., of 29 pages, describes fully the methods of working in aluminium—casting, rolling, annealing, soldering, &c., &c. In speaking of the uses of aluminium, the author says, when referring to its lightness,

"but I would say a word or two about the popular fallacy of aluminium replacing steel as a constructive material, . . . or in any position where its strength is of importance, . . . it is forgotten that it is only one-third as strong."

The aluminium alloys are considered in the next three chapters. Chapter xiv., of 30 pages, describes many alloys, of which the following two classes are especially important, as they promise to enter largely into commerce. The alloys with copper and nickel mostly contain but a very small proportion of aluminium, but nevertheless are superior to ordinary German silvers for strength and fineness of grain. Those containing copper and zinc, and known as aluminium brass, possess exceedingly valuable working qualities, are three and four times as strong as ordinary brass, and containing mostly only 2 or 3 per cent. of aluminium are further recommended by their low cost. Chapter xv., of 32 pages, describes the alloys with copper; of these the most important contain 5 or at most 10 per cent. of aluminium, and are known as aluminium bronzes; and full accounts of the methods of working and tests of the strengths of the metals are given. Chapter xvi., of 31 pages, describes the "Aluminium-Iron Alloys," and is a very interesting account of a difficult but exceedingly important subject. The chapter is divided into three parts, dealing with the effects produced by adding trifling quantities of aluminium to steel, to wrought-iron, and to cast-iron; in almost all cases the castings are quite free from blow-holes; and in certain cases the metal becomes more fluid, allowing of castings being more readily made. Cast wrought-iron sounds like a paradox, but it is not one, for, by adding a small amount of aluminium to wrought-iron that has been heated until it has become pasty, the latter immediately liquefies, and can then be poured into moulds, making castings as sound as if they were of grey cast-iron. The author discusses at some length the probable explanations of the effect of adding aluminium to the various kinds of iron, and his conclusions may be very briefly stated as being: (1) addition of very small quantities of aluminium, *i.e.* 0·01 to 0·1 per cent., causes the destruction of carbonic oxide or dioxide, or of the oxygen compounds, as oxide of iron, disseminated mechanically, and which at the moment of setting give rise to the formation of these gases; hence the cast metal is free from blow-holes, and, owing to the removal of suspended oxides, the metals cease to be pasty and become quite fluid; (2) addition of aluminium in larger quantity, *i.e.* 0·2 to 0·5, or even several per cents., converts the combined carbon—that is, if there be any appreciable amount—into graphitic carbon, and, according to the quality of the iron operated on and the amount of aluminium added, has the effect of rendering the castings free from a chilled surface, of making the metal very uniform in texture and hardness, or of separating the graphite to such an extent that the metal becomes pasty and unfit for making castings. Wonderful, indeed, are the effects of traces of foreign substances on the physical properties of the metals, and, though much has been done towards studying the effect of foreign substances on the properties of iron—the metal of the past, the present, and the future also, notwithstanding all that has been said about aluminium—yet the effects of this new "impurity," aluminium, are so great that evidently not only the modern man of science, but also the time-honoured iron-master, has still much to learn.

H. Baker.

ELECTRIC DARKNESS.

Electric Light: its Production and Use. By John W. Urquhart. Third Edition. (London: Crosby Lockwood and Son, 1890)

THIS book has the characteristic defect of many scientific works that go through several editions—the old matter is fondly retained, while edition by edition, new bits of information are inserted here and there, until finally the paragraphs must feel as awkward in one another's company as ancient Britons and gentlemen in top hats. And unfortunately Mr. Urquhart gives no hint to the readers of "Electric Light" as to which are his aboriginal paragraphs painted in woad, and which of them wear the modern frock coat.

That section of his book which is devoted to arc-lamps almost starts with a description of the *latest* form of the Brockie-Pell lamp, followed by an account of the Siemens and Hefner Alteneck pendulum and differential lamps, the Thomson-Houston, and the Brush lamps, types which may all be met with in constant use at the present day; then the author, without a word of warning that he is becoming historical, dilates on the Wallace-Farmer and the Rapieff forms. Next comes the Crompton lamp, with only a page given to it, and not thought worthy of an illustration. The reader would hardly gather from this that the Crompton lamp is extensively used in railway stations and elsewhere at home and on the Continent, and that the streets of one of the few towns in England electrically lighted—viz., Chelmsford—obtain their light wholly from Crompton lamps. We have then the description of a very excellent lamp, the Pilsen, especially in view of the improvements introduced into it by Mr. Joel; these, however, are not even referred to, Mr. Joel's contribution to electric lighting being confined, according to Mr. Urquhart, solely to his semi-incandescent lamp of 1881. And the description of the Pilsen lamp only occupies a fraction of the space devoted to the rotatory disc, the Regnier, the Werdeman, the Wilde, the Jamin blowpipe lamp, and other obsolete specimens which close this section, wherein may be found some of the most important arc-lamps of the present day indiscriminately jumbled up with types that figure only in museums and text-books.

Although the book is dated 1890, the description of Sir William Thomson's meters, to which only half a page is given, must have been written several years ago, before Sir William abandoned the use of iron, since, according to "Electric Light," all the assistance Sir William has contributed to the electric light industry is the invention of a voltmeter in which a stumpy bit of iron is attracted by a coil. The co-inventor of the Ferranti dynamo is, we learn, another man, a Sir William Thompson, with a "p."

With reference to the Deptford mains we are told, "The main is composed, first, of a copper tube of small diameter surrounded by a considerable thickness of insulating material, the whole being enclosed in a copper or other metallic tube about three inches in diameter. It is to be particularly observed that the 'return' is intended to be put in connection with the earth." We should like to hear what the Postmaster-General would say to this bit of intelligence after the opposition that he offered in the spring of 1889 to the original plan being carried out, and which led to the return of the Deptford mains being insulated.

Details are given of the electric lighting of the Albert Hall by 5 arc-lamps, the author not mentioning that the words, "At the Albert Hall a saving of gas is effected, &c.," and those that follow were written in the very early days of electric lighting. And yet, so anxious to be up to date does the author profess himself to be that he states, when dealing with high candle-power lamps, "We need not enter more deeply into the question how many, because . . . calculations made in 1889 would probably not apply in 1890."

This happy indifference that he displays to the distinction between the past and present tense may very likely lead people to unfairly condemn as useless, and out of date, a good deal of solid and valuable information which the book contains. The chapter on electric distribution is distinctly good, and the chapters on dynamos may be read with profit if we set down to the author's love of living in the past the accounts he gives of the Wallace-Farmer, of the Bürgin, and of other dynamos now practically abandoned; and if we attribute to a like cause such information as the following with reference to direct-current dynamos:—"The idea of making the armature a fixture, and of causing the field magnet to revolve within it, has, . . . in several lately-constructed machines, proved a most advantageous form of construction." The section on the management of the dynamo is particularly useful, and contrasts most favourably with the large amount of historical matter the book contains. We hope, however, that the author's statement regarding a shunt dynamo, as to its probably being impossible to burn up such a machine by short-circuiting, will not be brought forward as an excuse by some beginner for short-circuiting a shunt dynamo which has been running on open circuit; because the bill that will probably have to be paid for rewinding a burnt-up armature will forcibly illustrate the importance of taking into account what the author has neglected, viz. the residual magnetism of the field-magnet cores.

The detailed instructions which are given for making simple apparatus like batteries, a laboratory magneto Gramme machine, simple arc lamps, &c., will recommend the book to amateurs, but the author's views that the vertical slit down the cylindrical zinc of a cell is for the purpose of preventing local action, that "both sides of the zinc evolve electricity," that "electricity of opposite name is believed to flow off in contrary directions in equal quantities from the surface of generation, viz. the junction of the liquid with the positive plate," are very crude even for amateurs.

Mr. Urquhart's account of accumulators is a trifle mixed. On p. 47, "the negative grids are filled with litharge;" but on p. 48 we have "the litharge (positive) plate"; the capacity of an accumulator with 32 lbs. of plate is stated to be 50 ampere hours, whereas, as a matter of fact, it is about two and a half times that amount. The specific gravity of the solution, which Mr. Urquhart says should be 1·220 when the cell is fully charged, falls, he says, about 0·1 for every 5 ampere hours, no reference whatever being made to the size of the cell. The specific gravity, then, of the liquid of an accumulator from which 61 amperes could be taken, would fall to nought at the end of the first hour of discharge, though what that might mean we do not know. On p. 51 we are told in connection with the miner's lamp, that an accumulator weighing only 3 lbs. can "be made to light a small incandescent lamp for ten or twelve hours, yielding a light of two or three candles." Now 3 candles for 10 hours means about 120 watt hours, so that, if we assume that the box and liquid weigh together only 8 ounces, this marvellous accumulator stores something like 140,000 foot-pounds of energy per 1 pound of plate. On p. 294 the weight of the miner's accumulator and incandescent has gone up to 7 lbs., and the light has gone down to 1 or 1½ candle.

This sort of looseness runs through the book, "The legal ohm is the resistance presented by a column of pure mercury, 106 centimetres in length and 1 millimetre in section," the word square before millimetre, and all reference to temperature being omitted. After the definition of the watt it is stated that "An incandescent lamp is said to need 4 watts per candle power, or 60 watts in all to run it;" "said to need" looks as if it were a definition instead of being an experimental fact, and since the candle power of the 60 watt lamp is not mentioned, it might appear that all incandescent lamps from 2 to 2000 candles power required 60 watts. In speaking of the number of lamps a dynamo can maintain glowing, the author says, "More lamps could be maintained at 5 watts per candle than at 4;" we should very much like to know why. The phase of an alternate current is defined as its life. Under "Cost of Electric Light" we are told, "The Board of Trade unit, consisting of a kilowatt (a thousand watts for one hour) is the recognized standard of calculation," and that this is not a printer's error is shown by the author going on to say, "that a kilowatt can be sold at a fair profit at from *7d.* to *9d.*" Perhaps the author will favour us with the market value of one mile an hour.

A large amount of useful information has been collected together, the illustrations are abundant and well executed, and probably much time has been spent in the compiling of this book. Is it not a pity then that its value, both for the technical reader and for the electrically-lighted householder, should be much diminished by the unscientific vagueness that runs through it, and by the indiscriminate mixture of the antique with the modern in its pages?

COUES'S "HAND-BOOK OF ORNITHOLOGY."

Hand-book of Field and General Ornithology: a Manual of the Structure and Classification of Birds. With Instructions for Collecting and Preserving Specimens. By Prof. Elliott Coues, M.A., M.D., &c. Pp. 344. (London: Macmillan and Co., 1890.)

NATURALISTS are not unfrequently regarded as belonging to two categories—those of "the field" and those of "the cabinet." The "field naturalist" is too often little acquainted with scientific method, and apt to undervalue scientific research. On the other hand, the "cabinet naturalist" in many cases despises the labour of his brother of "the field," and thinks that he can solve all the problems of life without studying the living organisms. The best naturalists—it is not necessary to quote names in support of such a truism—have always been those who combine much experience in the field with great study in the cabinet. The author of the present work is well known to possess both these qualifications, without which, indeed, he could hardly have ventured on the task of writing it. His experience in the field, as he tells us in his prefatory remarks, reaches in time over thirty years, and extends in area over large portions of North America. Having made personal acquaintance with most of the species of North American birds, and having shot and skinned with his own hands several thousand specimens, he may reasonably claim to speak with authority on field ornithology. On the other hand, Dr. Coues is the author of the "Key to North American Birds," which has passed through many editions, and is generally recognized as the standard text-book of the American ornithologist. On this branch of his subject, therefore, Dr. Coues is likewise entitled to claim our full attention.

Dr. Coues commences his hand-book with "Field Ornithology," which, as he truly says, should lead the way to systematism and description, and devotes nearly ninety pages to this part of his work. The necessary implements for collecting, the various instruments and materials required for making skins, the proper modes of registration and labelling, and the right way to keep a collection when made, are all discussed in turn, and admirably explained and illustrated. "Labelling," we are glad to see, Dr. Coues expatiates upon at full length, and it is impossible to exaggerate its importance. How often are the best prepared and rarest specimens of natural objects rendered comparatively useless by the neglect of this requirement! We do not presume to say that all the twelve particulars insisted upon by our author should be given in every case, but the locality, the date, and the collector's name should at least never be omitted from the label of a scientific specimen.

A still more important part of Dr. Coues's hand-book is that of "General Ornithology," which occupies the remainder of the present volume. It is divided into four sections. In the first of these the author endeavours to define exactly what a bird is, and discusses the position of the class "Aves" in the series of Vertebrata. In the second section the principles of classification are reviewed, and it is shown that morphology or bodily structure is the only safe guide to a natural system. The third section is devoted to a description of the external characters of birds, and the fourth to the internal characters, or, as they are generally called, the anatomy of birds. These two essays form in fact the most important part of the volume, and occupy more than half its pages. Both of them are well drawn up, the various characters are described in plain and simple language, and the structures are illustrated by a large number of woodcuts introduced into the text. That Dr. Coues's statements are absolutely free from error we by no means affirm. Zoological science is progressing rapidly nowadays, and since these essays were written, five or six years ago, discoveries have been made that should have caused a modification of some of them as they now stand. But Dr. Coues is generally well up to the level of modern science, and seems to be acquainted with most recent views of experts on most points. On the whole, we know of no volume likely to be more useful to the student who wishes to become acquainted with birds, alike in the field and in the cabinet, than Dr. Coues's "Hand-book," and we are of opinion that the publishers have done a good deed in reprinting it for the use of British ornithologists. No other manual that we are acquainted with exactly takes its place, or contains such a well-arranged mass of useful and generally correct information on this subject.

OUR BOOK SHELF.

Swanage: its History, Resources, &c. (London: William Henry Everett and Son, 1890.)

SEASIDE guide-books are generally the production of some local tradesman, but the rising town of Swanage has issued one by no less than eight authors and an editor. Nothing but exceptional care could knit such a work into harmony, yet of editing there is no trace but the name. Though a full chapter by such an authority as Horace B. Woodward is devoted to geology, its interest is allowed to be forestalled earlier in the book by writers who are in apparent ignorance of the coming chapter, and who make no reference to it.

The book contains no itineraries, no suggestions as to how and in what time places of interest can best be reached; no guide as to hotels and lodgings, or tariffs for carriages and boats; no hints as to sea and river fishing; nothing of the birds; not a word on marine zoology. In place of these there are an introduction and conclusion, presumably editorial, worthy of a tenth-rate society paper, the latter containing a table of distances by a literary scaramouch. In this extraordinarily facetious table, Cowes is given as distant 27½ miles by water and 6½ by *land;* the Needles are 19½ miles nearer by *land* than Bournemouth; Parkstone and Poole, though well-nigh suburbs of Bournemouth, are no less than 24 miles nearer by land to Swanage; Bournemouth itself is said to be 34 miles distant, while everyone knows it is only 25 miles by rail; Southampton is actually less distant than Christchurch, and so on. With such editing we are not surprised to find the same place figuring as Branksea in the letterpress and Brownsea on the map.

It is impossible seriously to criticize the anonymous portions of such a book, except to say that the archæological information is evidently by an accomplished antiquary. It is a pity that his solid contributions are interwoven with adulatory remarks, perhaps by the editorial gentleman, which must be distasteful to Mr. George Burt, who, owning some 150 to 200 acres of the best building land "already laid out and ready for erecting residences," no doubt finds his account in what he does.

Of the specialist chapters, that relating to hygiene, by Dr. L. Forbes Winslow, is the longest, and we should have thought 27 pages more than ample to tell us that, being almost on a promontory on the south coast, and well sheltered from the north-east by a high range of downs, the climate of Swanage is mild, equable, and bracing, and with good water and drainage should be particularly healthy. Visitors should be warned, on the other hand, that the air is strong, and that the Purbeck Hill at the back is bleak and bare of trees, and being riddled with stone quarries presents a forbidding aspect.

The chapter on geology is of course excellent, and, had it been illustrated with a few sections and figures of fossils, would be sure to induce visitors with time on their hands to take the subject up. We cannot think, however, that the Wealden has the enormous thickness of over a third of a mile so close to its western limit, and rather believe that the same beds occur over and over again in a series of truncated folds. The author, like others who know the section, does not endorse the views of Prof. Judd on the so-called Punfield Beds. The section deserves notice as the only British locality for a gigantic Paludina, and all the beds up to the chalk are fossiliferous, and deserve more careful investigation than they have received. On the other side of the massive chalk barrier, the Lower Bagshot beds, though only 70 feet thick at Alum Bay, occupy about half a mile of the shore at high angles, and are as obviously plicated as the Wealden. They are so entirely grassed over, except at Redend Point, that nothing can be known of them, but inland masses of Middle Bagshot are present in the folds. The beds are very fossiliferous in places, but the pipe-clays have had such a squeezing, that the leaves are miniature geological models of faults and slickensides, and readily fall to pieces. The vegetation is much more characteristic of swamp life than at Alum Bay, the prevailing fossils being a large fan palm, reeds, and a tropical Chrysodium massed together, and more rarely leaves of *Aralia primigenia*, *Quercus lonchitis*, Acer and Salix, and occasional shells of Unio and elytra of insects. The poverty of the flora is in contrast with the enormous wealth of that of the Bournemouth beds just across Poole Harbour.

Of the admirable and careful lists of plants by Mr. J. C. Mansel-Pleydell, and of insects by Messrs. Herbert Goss and Eustace Banks, we have nothing to say except to lament that the book is so unworthy of them. Of course there is no index, and the illustrations are commonplace process plates, in which Mr. Burt's house and his big refreshment-room on the hill, perhaps the future Casino, figure prominently. Really interesting bits like the tower of the old church, or romantic scenes like the Pinnacles or Old Harry, are omitted. J. S. G.

Graphic Lessons in Physical and Astronomical Geography. By Joseph H. Cowham, F.G.S. (London: Westminster School Book Depot, 1890.)

THE method of teaching adopted in this work justifies itself for the subjects with which it deals. The lessons have been prepared to cover certain courses of instruction, among them being the Standard Code, pupil teachers' course of geography during the four years of their training, scholarship examinations preparatory to entrance into a training college, and for the entire course of physical geography laid down in the certificate syllabus for first and second year's students in training colleges.

The main features of the work lie in its arrangement, the note-like style adopted in the great variety of simple sketches and blackboard illustrations which demonstrate well the innumerable points for which they are required. Each item of matter is surrounded by abundant information, and teaching hints in the form of notes are given here and there for the benefit of those using this book.

The end of each section contains a short summary of the preceding subject matter, and concludes with questions for examination. The book will be sure to be well used, and we recommend it, and with the authors we hope "that it may stimulate others to make the teaching of physical geography a pleasant exercise for themselves and a valuable mental training for those whom they teach." W.

The Evolution of Photography. (Illustrated.) By John Werge. (London: Piper and Carter; John Werge, 1890.)

IN this work we have a most interesting account, arranged in chronological order, of the origin, progress, and development of the science and art of photography. The author has divided this time into four periods. The first deals broadly with facts bearing on the accidental discovery of photography, and on the early researches and ultimate success of the pioneers. The second embraces a fuller description of their successes and results, while the third is devoted to the consideration of patents and impediments, and the fourth to the final development of both photographic literature and art.

Although the author has not entered minutely into elaborate details of each process, yet he has given enough to form an interesting summary. Excellent illustrations of some of the chief photographic investigators, taken from paintings, daguerreotypes, &c., and reproduced by the callotype process, add greatly to the value of the book.

Following this there is a chronological record of inventions, discoveries, publications, and appliances connected with the development of photography, and the author concludes with the personal reminiscences, extending over a period of forty years.

This book will be an acceptable addition to our photographic literature, and will be found interesting not only by the practical photographer, but by many amateurs. W.

Geometrical Drawing for Art Students. By I. H. Morris. (London: Longmans, Green, and Co., 1890.)

ART students will be glad to find in this work a compendium of those parts of geometry which cover the necessary range for their course. Plane geometry and its applications, the use of scales, and the plans and elevations of solids, are treated concisely, and the method adopted throughout of placing the text on the left-hand pages, leaving the right-hand pages solely for figures, will be found most convenient. The figures are all neat and well drawn, those illustrating the problems on solid geometry being especially so.

The chapter on the construction and use of plain and diagonal scales and scales of chords, subjects which are generally stumbling-blocks to a great many students, is made very clear, and in chapter xv. good ideas are imparted in the applications of geometry to the construction of patterns and simple tracing.

Nearly six hundred figures are inserted in the book, together with a complete and exhaustive collection of exercises. Students interested in this subject other than those for whom the work is intended will find the arrangement adopted more convenient than in many other books on the subject. W.

An Elementary Text-book of Dynamics and Hydrostatics. By R. H. Pinkerton, B.A. Oxon. Second Edition. (London: Blackie and Son, Limited, 1890.)

WE are glad to see the appearance of a second edition of this serviceable little text-book, the first edition of which we reviewed some time ago. No material alteration has been made in any part of the work. The appendix has been extended by the introduction of the method of co-ordinates, the discussion of simple harmonic motion and its application to the pendulum, and the method of finding moments of inertia.

Several new examples have been fully worked out for the purposes of illustrating the methods of solving problems graphically, and some additional examination papers have been given.

At the beginning of the book tables of relative density and of the English and French measures will be found, and the work concludes with a newly added index. We can only repeat what we said formerly, that this is a book to be thoroughly recommended. W.

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.*]

The Pilcomayo Expedition.

IN view of the notice in the *Times* this week of the collapse of the Pilcomayo Expedition, the inclosed extract from a home letter of Mr. J. Graham Kerr, Naturalist with the Expedition, may be of sufficient interest for publication in NATURE. The letter was received in Scotland on September 2. It contains no mention of Captain Page, and must have been written before his death as recorded in the *Times*. The letter bears out the *Times* account of the difficulties encountered by the Expedition, and that the Pilcomayo is not likely to become a trade water-way; but it does not foreshadow disaster such as the *Times* account suggests, and it gives hope that the other members of the Expedition may not have shared the fate of Captain Page. ISAAC BAYLEY BALFOUR.

September 27.

"*s.s.* '*Bolivia*,' *Rio Pilcomayo, lat.* 24° 25' *S., long.* 58° 40' *W.*, "*Tuesday, June* 3, 1890.

"We entered the Pilcomayo on March 12, therefore we have been 3 months on the river. We have managed to penetrate about 300 miles by river in that time, but owing to the extraordinary tortuosity of the Pilcomayo, our distance in a straight line from Asuncion I don't suppose is more than, if it reaches, 100 miles. The river is very disappointing from the points of view of æsthetics, botany, zoology, geology, and anthropology. As regards the first, the scenery in the lower reaches is certainly beautiful, but of a type of beauty which soon palls upon one, and becomes intensely monotonous. The scenery is very much that of a sluggish flowing river at home. When we first entered the river, I was amazed at its small size—only about 50 yards in width. Up here it seldom reaches 20 yards, and is frequently not more than 10, and there is scarcely any water in it at all. For the last two months we have got forward not more than 10 leagues, at the very outside, and what little we have done has been by building dams, letting the water accumulate, and so getting forward for a short distance, when another dam was built, and so on. The larger steamer, the *General Paz*, we had to leave far down the river. The military detachment whom we had left a few miles down was discovered the other day to have flown, their provisions, no doubt, having run short. We brought a corporal and two men on with us. The other day, however, one of these deserted, and has, no doubt, either gone over to the Indians or been killed by them. To return, however, to the scenery. Here, and for a long distance down, we have had a type of scenery which is to be found in very few parts of the world—that of an immense palm forest, covering thousands of square miles. It consists typically of a perfectly level plain clothed with breast-high grass, over which are closely studded palm-trees with large fan-shaped leaves; all around, far as the eye can reach, an interminable vista of palm-trees, varied only by an occasional clump of brushwood, or near the river by a small patch of forest. In no way is the aspect of nature suggestive of the tropics here, *i.e.* when one has got over the first impression induced by the palm-trees. The Gran Chaco is in fact an immense wilderness. Large game occurs only in small numbers. I have managed to get only a couple of peccaries, and no one else has shot any large game. I have not even got a tiger yet, and have only once had anything approaching an adventure with one. Other adventures we have had absolutely none. Intense monotony and uninterestingness are the chief characteristics of the river. Botanically speaking, it is an absolute desert. In an ordinary summer's afternoon walk at home one sees more species of plants in flower than I have seen since we entered the river. . . . However, this may improve, as it is now the dead of winter here, and with the advent of spring I hope to see many new and interesting flowers appear. Zoologically, too, it is disappointing, except in the case of birds. In the lower parts of the river not a bird was to be seen, but now they are rather more frequent, and I have already observed 116 species, of which I believe about 30 have not before been collected in Argentina. Owing to the desert nature of this part of the Chaco, its human inhabitants are very few, scattered, and nomadic. We have not seen a single Indian or canoe on the Pilcomayo. But we know they are about, for nearly every day we see their great fires for hunting all around us, and we occasionally come across a chipped palm, or the remains of an old *tolda*, the rude shelter which serves them as a tent; now and again, too, we see a human footprint, sometimes of immense size, impressed upon the muddy margin of a lagoon. So we are always on the alert, the four Britons of the Expedition keeping watch at night, fully armed and wide awake. The four said Britons are Poole, Kenyon (English), Henderson the chief engineer, and myself. When I go away collecting also, as I do every day, I always go with loaded revolver and knife—ready for emergencies. For in addition to Indians there are abundance of tigers about, which one has to be prepared for. Yesterday we got an alligator close to the boat, 8 feet long. The alligators here are all small, 8 feet being the largest we have seen. . . .

"As regards food we are on very short rations, being within a month or so of the end of our provisions. The canoe is to be sent down soon, I believe, to hurry up the fresh supplies of provisions, and by it I shall send this letter, although it is very doubtful whether you will ever get it. The health of the men is not good; we have always two or three of the 17 on board ill. I have, however, had excellent health. The only thing disagreeable is the fearful cold. In the mornings the thermometer is often nearly at freezing-point, and I feel quite benumbed. Fortunately, it generally gets a little warmer during the day, the temperature rising in the afternoon to between 70° and 90° F. The river-water is regular brine here, quite as salt as sea-water, and when occasionally we run out of fresh water for a few days, it is very disagreeable having to take coffee, &c., made with the salt water. Of fruits here, there are none worth eating. The young parts of the palm-trees are eatable, and we use a good deal of it in order to economize the rice, &c. I don't expect at all that we can possibly reach Bolivia, and I don't think the river could ever be made navigable."

Protective Colours.

Mr. Poulton, in his book entitled "The Colours of Animals," seeking a reason for the glistening metallic colours of many chrysalides, after showing that the colour is probably protective in its origin, states "that it has arisen from the protective resemblance to rough dark surfaces of rocks."

He comes to this conclusion after failing to find other more probable examples of glistening bodies in nature.

Are such not, however, very common (i.) in the slime or mucous covering many of the Invertebrata, and which snails and slugs leave on all surfaces over which they have passed; (ii.) the webs of spiders and their allies, especially if moist; (iii.) the exudation or excretion of many plants; (iv.) decomposing bodies; (v.) the bark of many trees?

Perhaps the commonest places to find glistening chrysalides are on palings, tree trunks, and various plants; all of which structures are usually resplendent with one or more of the above metallic hues, and among which the chrysalides are very hard to find.

May not these more common objects be those of attempted resemblance, rather than the less frequent pieces of broken rock?

Grosvenor Club, Bond Street, W. Walter K. Sibley.

Mr. Sibley's letter appears to me to contain valuable suggestions as to the meaning of the metallic appearance of certain chrysalides. It is probable that a resemblance to the objects he suggests does aid in concealing the pupæ. Mr. Roland Trimen has similarly concluded that certain brilliant beetles (*Cassididæ*) are protected by resembling drops of dew. At the same time I think that there is some evidence that the metallic appearance of the pupæ of *Vanessidæ* may have been originally acquired in order to favour concealment against glittering mineral surfaces. The evidence is as follows:—(1) In shape and character of the surface these pupæ strongly resemble a rough and broken piece of rock. (2) They appear in two forms, resembling grey and weathered as well as freshly exposed and glittering rock surfaces. (3) When they seek green leaves for pupation they either conceal themselves with the greatest care (*V. atalanta*), or a glittering variety of other species is represented by a green variety which is inconspicuous against the leaves (*V. Io*). (4) Another species (*V. urticæ*), which lacks the habit of *V. atalanta* and the green variety of *V. Io*, is, as far as my experience goes, very rarely found on the leaves of its food-plant, and when so found, is, as a rule, diseased.

I mention the chief lines of evidence upon which I have relied in order to show that it was not merely the failure "to find other more probable examples of glittering bodies in nature" which led me to adopt the view alluded to by Mr. Sibley. Although I still consider that my hypothesis is probable, at any rate for the *Vanessidæ*, I am convinced that the resemblance to other glittering objects, such as those mentioned by Mr. Sibley, has favoured the development and especially the persistence of the metallic appearance. E. B. Poulton.

September 19.

The Aryan Cradle-land.

"It will be for the benefit of our science," said the President of the Anthropological Section of the British Association, "that speculations as to the origin and home of the Aryan family should be rife; but it will still more conduce to our eventual knowledge of this most interesting question if it be consistently borne in mind that they are but speculations." With the latter, no less than with the former opinion, I cordially agree. And as, in my address on the Aryan cradle-land, in the Anthropological Section, I stated a greater variety of grounds in support of the hypothesis of origin in the Russian steppes than has been elsewhere set forth, I trust that I may be allowed briefly to formulate these reasons, and submit them to discussion.

(1) The Aryans, on our first historical knowledge of them, are in two widely separated centres, Transoxiana and Thrace. To Transoxiana as a secondary centre of dispersion the Eastern Aryans, and to Thrace as a secondary centre of dispersion the Western Aryans, can, with more or less clear evidence, or probable inference, be traced, from about the fourteenth or perhaps fifteenth century B.C.; and the mid-region north-west of Transoxiana and north-east of Thrace—and which may be more definitely described as lying between the Caspian and the Euxine, the Ural and the Dnieper, and extending from the forty-fifth to the fiftieth parallel of latitude—suggests itself as a probable primary centre of origin and dispersion.

(2) For the second set of facts to be considered reveal earlier white races from which, if the Aryans originated in this region, they might naturally have descended as a hybrid variety. Such are the facts which connect the Finns of the north, the Khirgiz and Turkomans of the east, and the Alarodians of the south, with that non-Semitic and non-Aryan white stock which have been called by some Allophyllian, but which, borrowing a term recently introduced into geology, may, I think, be preferably termed Archaian; and the facts which make it probable that these white races have from time immemorial met and mingled in the South Russian steppes. Nor, in this connection, must the facts be neglected which make great environmental changes probable in this region at a period possibly synchronous with that of Aryan origins.

(3) In the physical conditions of the steppes characterizing the region above defined, there were, and indeed are to this day, as has been especially shown by Dr. Schrader, the conditions necessary for such pastoral tribes as their language shows that the Aryans primitively were; while, in the regions between the Dnieper and the Carpathians, and between the Oxus and the Himalayas, the Aryans would, both in their south-western and south-eastern migrations, be at once compelled and invited, by the physical conditions encountered, to pass at least partially from the pastoral into the agricultural stage.

(4) The Aryan languages present such indications of hybridity as would correspond with such racial intermixture as that supposed; and in the contemporary language of the Finnic groups Prof. de Lacouperie thinks that we may detect survivals of a former language presenting affinities with the general characteristics of Aryan speech.

(5) A fifth set of verifying facts are such links of relationship between the various Aryan languages as geographically spoken in historical times, such links of relationship as appear to postulate a common speech in that very area above indicated, and where an ancient Aryan language still survives along with primitive Aryan customs. For such a common speech would have one class of differentiations on the Asiatic, and another on the European side, caused by the diverse linguistic reactions of conquered non-Aryan tribes on primitive Aryan speech, or the dialects of it already developed in those great river-partitioned plains.

(6) A further set of verifying facts are to be found in those which lead us more and more to a theory of the derivative origin of the classic civilizations, both of the Western and of the Eastern Aryans. Just as, between the Dnieper and the Carpathians, and between the Oxus and the Himalayas, there were such conditions as must have both compelled and invited to pass from the pastoral into a partially agricultural stage; so, in passing southward from each of these regions, the Aryans would come into contact with conditions at once compelling and inviting to pass into a yet higher stage of civilization. And in support of this all the facts may be adduced which are more and more compelling scholars to acknowledge that in pre-existing Oriental civilizations the sources are to be found, not only of the Hellenic and the Italic, but of the Iranian and the Indian civilizations.

(7) Finally, if the Hellenic civilization and mythology is thus to be mainly derived from a pre-existing Oriental or "Pelasgian" civilization, it is either from such pre-existing civilizations, or from Aryans such as the Kelto-Italiots, migrating northward and southward from Pelasgian Thrace, that the civilization of Western and Northern Europe would, on this hypothesis, be traced: and a vast number of facts appear to make it more probable that the earlier civilization of Northern Europe was derived from the south than that the earlier civilization of Southern Europe was derived from the north.

The three conditions of a true solution of the problem either of Semitic or of Aryan origins appear to be these. First, the locality must be one in which such a new race could have ethnologically, and secondly philologically, arisen as a variety of the Archaian stock of white races; and thirdly, it must be such as to make easily possible the historical facts of dispersion and early civilization. And I venture to submit the above sets of facts as not inadequately, perhaps, supporting the South Russian "speculation as to the origin and home of the Aryan family."

J. S. STUART GLENNIE.

The Shealing, Wimbledon Common, September 22.

Mr. Dixon's Mode of Observing the Phenomena of Earthquakes.

MR. HAROLD DIXON's letter in NATURE of Sept. 18 (p. 491) is exceedingly interesting to seismologists. On two occasions he was able to make the only kind of observation which is of any value unless seismographs are actually employed; he has been able to make these in England, where earthquakes are rare, and I know of no record of such definite information being given by any of the trained observers in Japan, where earthquakes are so numerous. It requires great coolness to make such observations at such a time.

Seismographic records show that even in destructive Japanese earthquakes the vertical displacement of the ground is usually less than one millimetre, so that the mere *difference* in vertical displacement observed by Mr. Dixon between two points in the same room must have approached five hundred times the greatest *absolute* vertical displacement in Japan. Mr. Dixon truly says that, if the displacement observed by him had been due to the movement of the hill itself, it must have meant a good deal, for it would have meant some hundreds of thousands of times the greatest vertical earth movement recorded by any seismograph.

When I say that Mr. Dixon's letter is interesting, I make the assumption that what he observed was not merely what anybody observes who raises his head when looking at a distant hill through a window.

JOHN PERRY.

31 Brunswick Square, W.C., September 24.

Butterflies Bathing.

IN NATURE of August 21 (p. 402) is a note taken from the *Victorian Naturalist* describing an observation made by Mr. G. Lyell, Jun., of Melbourne. He states that several butterflies (*Papilio macleayanus*) were seen to enter the water backwards, remain partly submerged for about half a minute, and then fly off to the hill-sides refreshed with their bath. The heat of the weather is given as the cause of their action.

I should like to suggest that the insects were probably engaged in *depositing their eggs*. Perhaps some one who has the opportunity will ascertain if the larva of this butterfly is aquatic, or feeds on plants growing at the water's edge.

G. A. FREEMAN.

St. Olave's Grammar School, Southwark.

Surface-tension and Surface-viscosity.

IF an oiled needle be placed on the surface of pure water, it will be supported, but if it be washed in a solution of potash, it will sink. In the first case the effect cannot be due to the surface-tension, which is much diminished by the oil. Has the viscosity of the oil anything to do with it? Also in the case of a soap-bubble, is the effect due to viscosity, and not to surface-tension; and what is the difference between surface-tension and surface-viscosity? They are both, no doubt, due to cohesion, but it is difficult to form definite conceptions of the two properties. Would any of your readers kindly answer the above questions, and give references to any works bearing thereon? Maxwell's "Theory of Heat," on capillarity and viscosity, does not seem to throw any light on the matter.

W. P. O.

Leicester, September 25.

ON STELLAR VARIABILITY.[1]

II.

I HAVE before stated that the variability phenomena observed in stars of the Groups I. and II. and VI. are produced by the same cause; all differences in the details of the effects being due to the different physical nature of the central body. In Groups I. and II. it is a swarm of meteorites with which we have to deal; in Group VI. it is a condensed star of low radiation surrounded by a dense atmosphere containing carbon in some combination.

In both cases the bodies are normally dim; in Groups I. and II. they are so because the meteorites when undisturbed are relatively free from collisions; in Group VI. they are so for the reason stated above, the star being on the verge of extinction.

I insist upon this dimness, because the dimmer the central body the more important becomes the luminosity caused by, or set up in, secondary swarms. Further, such variability as we are now considering is unknown in the case of the hotter stars.

It is clear that phenomena produced in either group *by the action of two swarms* should strongly resemble each other, and that if it be found that this explanation holds good in one case it should be found to hold equally good in the other. It is to be expected then that phenomena observed in each may throw light upon the other, and that the view advanced may be tested by the differences observed.

Let us consider two hypothetical cases, to start with, in Groups I. and VI.

In Group I. we have a condensing nebula the light of which when undisturbed is say 6 mag. Round this there revolves a cometary swarm say in six time units. At periastron collisions occur which raise the light of the combined swarms to 3 mag. There is also another similar swarm revolving in say twelve time units. The conditions are such that this second swarm produces a smaller disturbance which only raises the light to $4\frac{1}{2}$ mag. We will assume the periods to be exactly commensurable, and the apastra to occur together. It is obvious that alternate minima will be raised by this second revolving swarm, *but the maxima will be constant.*

In order to put results of this nature into diagrammatic form we must consider that we are dealing with certain

[1] Continued from p. 419.

additions of light to the constant light of the star. These additions must be shown as such.

It is very important that I should point out that for this method of direct integration to be adopted a scale of light units must be employed, *for the reason that the amount of light which is sufficient to produce a change of a magnitude in a faint star would only produce a change of a fraction of a magnitude in a brighter star.*

Taking the light of a star of magnitude m as a unit, and using the formula

$$L_{m-n} = (2\cdot512)^n L_m,$$

in which L_m represents the light of a star of magnitude m and L_{m-n} the light of a star n magnitudes brighter, we get—

$$L_{m-1} = 2\cdot51\ L_m$$
$$L_{m-2} = 6\cdot31\ L_m$$
$$L_{m-3} = 15\cdot85\ L_m$$
$$L_{m-4} = 39\cdot78\ L_m$$
$$L_{m-5} = 100\cdot02\ L_m$$

The amount of light to be added for the different magnitudes will therefore be as follows :—

Additions for one magnitude $= (2\cdot51 - 1)L_m = 1\cdot51\ L_m$
,, ,, next ,, $= (6\cdot31 - 2\cdot51)L_m = 3\cdot80\ L_m$
,, ,, ,, ,, $= (15\cdot85 - 6\cdot31)L_m = 9\cdot54\ L_m$
,, ,, ,, ,, $= (39\cdot78 - 15\cdot85)L_m = 23\cdot93\ L_m$
,, ,, ,, ,, $= (100\cdot02 - 39\cdot78)L_m = 60\cdot24\ L_m$

It is obvious that these differences are in exactly the same proportion to each other as the numbers representing the light of the stars of different magnitudes, and if in our diagrams we take a certain length of line to represent the added light equivalent to one magnitude, about $2\frac{1}{2}$ times this will represent the added light for the next magnitude, and each succeeding magnitude will be represented by a line $2\frac{1}{2}$ times as long as the preceding one. A scale of this kind must be adopted in integrating the effects of two sources of added light, for the reason already stated.

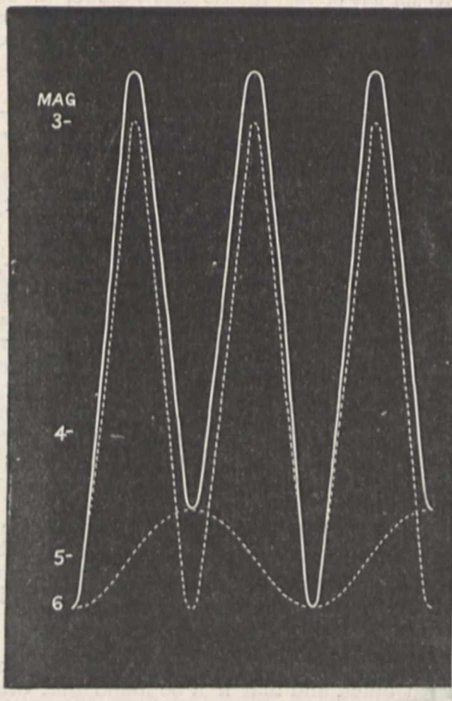


FIG. 1.—Hypothetical curve in light-units.

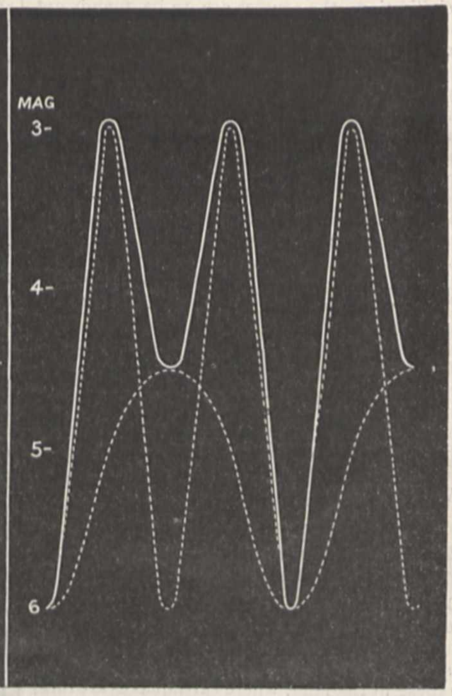


FIG. 2.—Hypothetical curve in magnitudes.

Thus while the amount of light to be added to a sixth magnitude star, to take an instance, to increase it to the fifth is $1\frac{1}{2}$ units, the number of the same units to be added to a fourth magnitude star to make it a third is $9\frac{1}{2}$. Hence the $1\frac{1}{2}$ units which raise a star of the 6th to the 5th magnitude—that is, one whole magnitude—would only increase a fourth magnitude star by about one-sixth of a magnitude.

To graphically represent what happens when by cometary action a star is raised three magnitudes above magnitude m, we get, in the above light-units—

1·512 additions for one magnitude
3·80 ,, ,, the next magnitude
9·54 ,, ,, ,, ,,

The sum of these numbers = 14·85, represents the *added* light.

The plan on which the following curves have been drawn will be gathered from the table given below, which shows how on the above basis the light-units and magnitudes correspond :—

Magnitude step.	Light addition for Integral part of step.	Light addition for Fractional part of step.	Total light addition.
½	0	0·58	0·58
1	1·51	0	1·51
1½	1·51	1·46	2·97
2	5·31	0	5·31
2½	5·31	3·66	8·97
3	14·85	0	14·85
3½	14·85	8·61	23·46
4	38·78	0	38·78
4½	38·78	23·08	61·86
5	100·02	0	100·02
&c.	&c.	&c.	&c.

In the hypothetical case represented in Fig. 1 the constant light of the central swarm may be taken as 6 mag., and the added light of the two secondary swarms as varying from nil to 3 mag. and from nil to $4\frac{1}{2}$ mag. respectively. It is then obvious that the integrated effects of the light added produce constant maxima of 14·85 units, and minima alternately 0 and 2·97. We can in this way represent the light-curve of a star which changes its magnitude from 3 to $4\frac{1}{2}$ and 3 to 6 alternately.

The relative scales of light-units to brightnesses shown

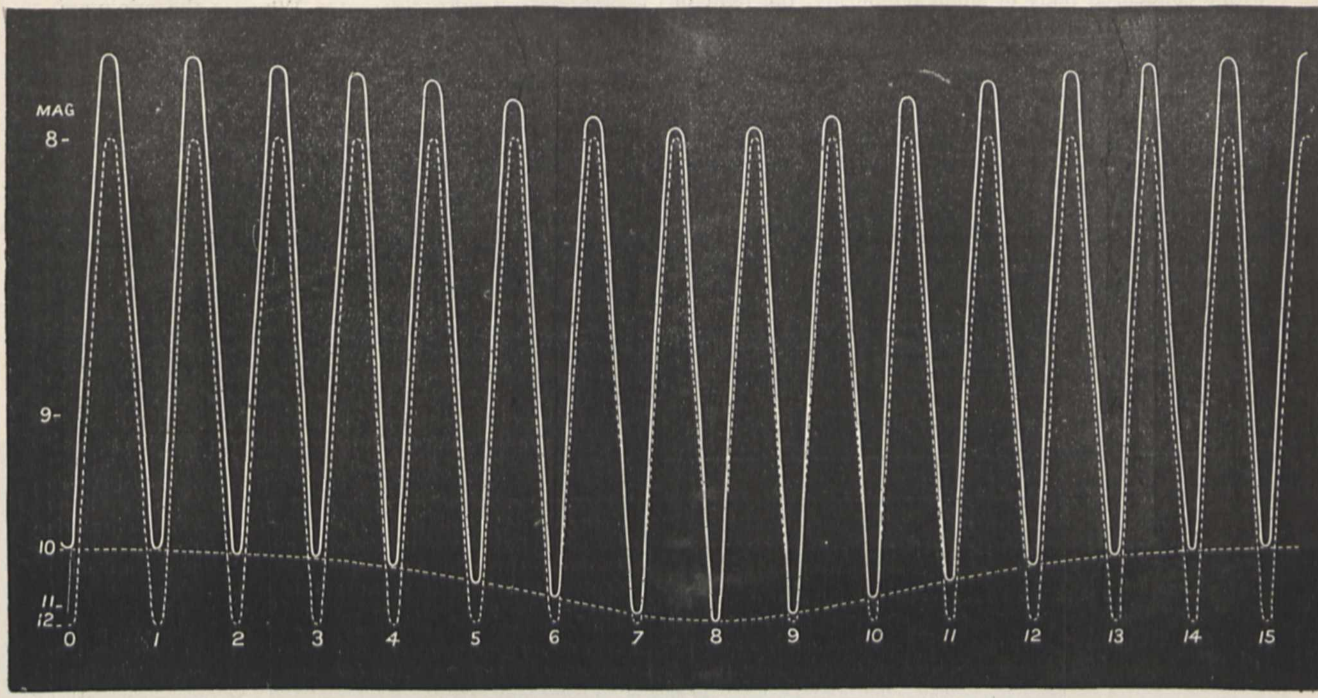


FIG. 3.—Hypothetical curve in light-units.

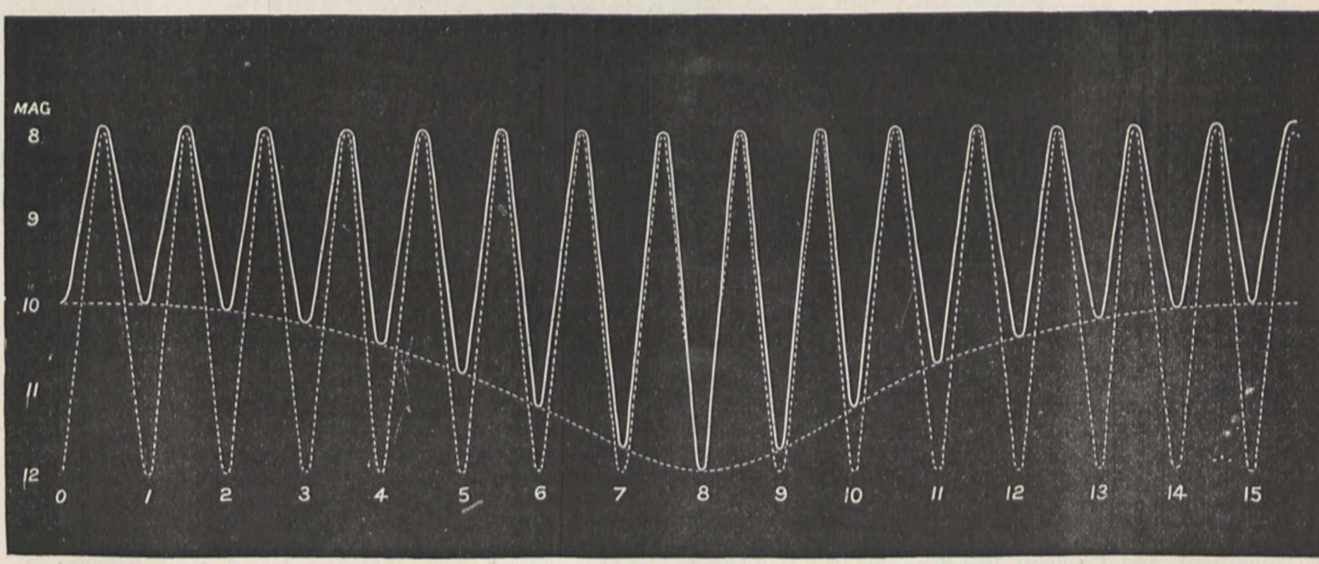


FIG. 4.—Hypothetical curve in magnitudes.

by the foregoing figures, however, enable us to transpose the diagram to one in which equal spaces represent equal differences of magnitudes. This is shown in Fig. 2.

In the diagrams, the light-curves of the two subsidiary swarms are represented by dotted lines, and the integrated result by the continuous line. One of the revolving swarms has a period of 6 units of time, and the other a period twice as long. The eccentricity of the primary swarm is such that it adds, at maximum, 14·85 light-units, while the secondary swarm adds 2·97 light-units.

A comparison of the two diagrams will make clear what has already been said about the relative value of the light of one magnitude at the top and bottom of the curve.

We next take a hypothetical case from Group VI.

Here, instead of a nebula, dim owing to absence of collisions brought about by disturbances, we have to deal with a condensed body of small luminosity, the light of which is strongly absorbed by a carbon atmosphere.

We first consider the action of two subsidiary swarms, one producing more light with a short period, the other less light with a period say fifteen times longer. In fact we have one comet with an orbit of great eccentricity and short period, and another of small eccentricity and long period. We will assume the periastra to be coincident.

As the light is generally feeble, we may take the constant luminosity of the star as of the twelfth magnitude, and that it is raised to the eighth magnitude by the added light of the swarms at perihelion. We have then a difference of four magnitudes.

Proceeding as before we have :—

1·51	addition for one magnitude
3·80	,, the next
9·54	,, ,,
23·96	,, ,,

The sum of the added light gives us 38·81 of the light-units adopted = $(2·512)^4 - 1$.

The continuous curve represents in Fig. 3 the integrated effects expressed in light-units of the two added light sources, and it will be seen that the result is a variable with both maxima and minima also periodically variable. But although both maxima and minima are variable by an equal number of light-units, the effect on magnitude is totally different. Whereas the minimum varies by two magnitudes, the maximum only varies by about one-tenth of a magnitude.

In the hypothetical case represented, the maximum varies between 7·8 and 7·9, whilst the minimum varies between 10·0 and 12.

Like the curve for the variable of Group II., this may also be transferred to one in which equal differences of magnitudes are represented by equal spaces.

This is shown in Fig. 4, and here again it will be seen that, as in the former case, in adding a change of magnitude at the bottom of the curve to the top of the curve the magnitude-change is diminished according to the ratio of light-units.

The question now arises, Are there any stars in the heavens the phenomena of which can be represented by the hypothetical curves which we have just given? If so, we shall be justified in tracing a *vera causa* in the hypothesis under consideration. It may be here stated that one of the received explanations of such a variability as

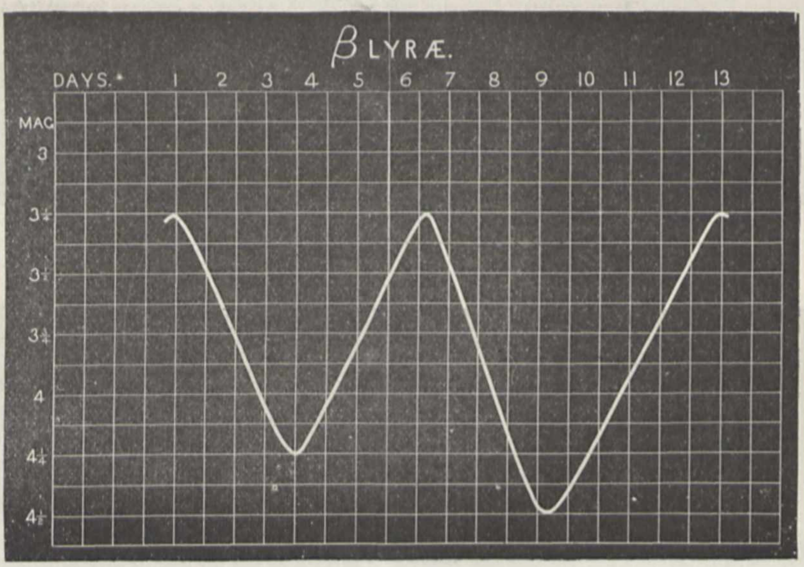


Fig. 5.—Light-curve of β Lyræ.

is represented on our first hypothetical diagram is that due to Prof. Pickering, who conceived that the observed effect might be produced by a surface of revolution; the ratio of the axes being 5 : 3, with a dark portion at one of the ends and symmetrically situated as regards the longer axis.[1]

A reference to Fig. 5 will show that the hypothetical curve shown in Fig. 2 strikingly represents the actual light-curve of β Lyræ (actual magnitudes are not in question), and I submit therefore that the well-known phenomena of that star are produced by the causes I have suggested rather than by the complicated apparatus suggested by Prof. Pickering, to say nothing of the earlier suggestions of Maupertius and others.

I append another diagram (Fig. 6) to show that the second hypothetical curve is a close approximation to the light-curve of U Cygni, one of the best observed variables in Group VI.; and here I must express my obligations to Mr. Knott, who has freely communicated all his observations of this star to me, and has permitted me to publish them in this form.

Unfortunately, though the observations are of such a high order of exactness, they are not continuous. The parts of the curve in which the line is continuous represent the actual observations. The dotted lines added are for the purpose of enabling a comparison to be made with Figs. 3 and 4, in which the probable relations of the periods and intensities of the two hypothetic swarms are shown in light-units and magnitudes respectively.

The similarity between the hypothetic case represented and Mr. Knott's actual observations greatly strengthens my view.

It follows very clearly from the above considerations that on my hypothesis there should be frequently found rhythmical variations at the minimum, while the change at maximum is so slight that our best observers fail to notice it.

[1] Gore in "Astronomy for Amateurs," p. 238.

The smaller the range, the more will both maxima and minima be affected by the subsidiary swarms. W Cygni is a case in point.

It has been before remarked that the hypothesis demands that in sparse swarms of meteorites (Groups I. and II.) the ascent to maximum, due to the sudden action of the colliding swarms, should be much more rapid than the descent to minimum, for the reason that the descent must represent a *gradual* cooling down of the disturbance. This more rapid ascent has been noted in

R Piscium	Known Group II. stars.
S Vulpeculæ ...	
R Leonis Minoris	
R Ursæ Majoris	
R Corvi	
W Cygni	
S Cassiopeiæ ...	Group not yet determined.
R Arietis	
R Orionis	
T Delphini ...	
T Vulpeculæ ...	

I have also suggested that the short minimum is a measure of the indirect disturbance, but it is easy to imagine that this short minimum will not be invariable under all conditions, and accordingly we find in R Persei with a period of 212 days, a long minimum.

In stars of Group VI., on the other hand, where we have simply to deal with the added light of comets passing perihelion, there is no reason why this should happen, indeed, it ought to be rather the other way, since comets put on their greatest brilliancy after perihelion. As a matter of fact, so far as my inquiries have gone, I have not yet come across a case of a Group VI. star showing any great difference in the times spent in rising and falling.

On the hypothesis a *perfectly* constant period can only occur in the case of those double swarms in which the central one has a regular figure and density. The moment this condition is departed from, seeing that the central swarm is certain to be in rotation, variation of period as well as of maximum must be expected.

Nor is this the only variation which depends upon the central body. In the absence of knowledge in each case, we must assume that the structure of the central swarm resembles that of those which have been examined in Andromeda, Ursa Major, and Canes Venatici—that is, *the meteoritic density will vary locally* (S Aquilæ), and

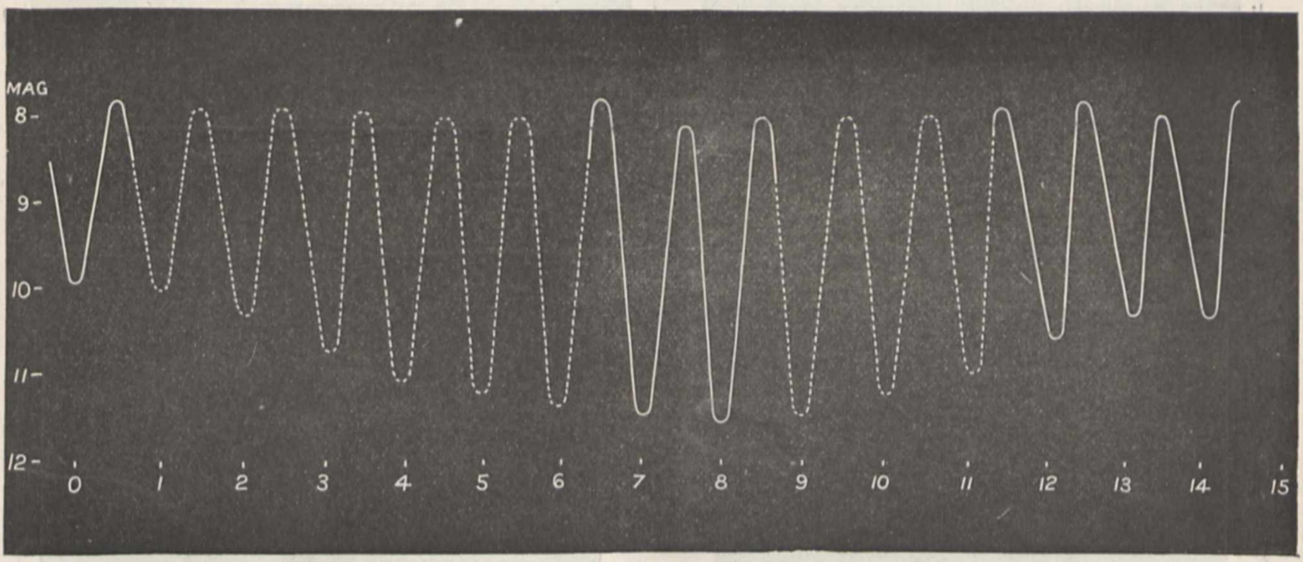


FIG. 6.—Light-curve of U Cygni, showing Mr. Knott's actual observations.

some of the observations made may be explained on the supposition that the subsidiary swarm breaks into regions in which the density is suddenly increased, as if we were noting the result of a ring being pierced (R Aurigæ).

We have only to look at Mr. Roberts's photograph of the nebula in Andromeda, and consider under what different conditions a secondary swarm might reach the same periastric distance if there were any rotation in the nebula or any movement of the nodes, to recognize the importance of taking the above points into consideration.

If there be a condition of the central body anything like that of the nebulæ named, it must be borne in mind that in the struggle for existence those swarms moving in the plane of the intakes and in the same direction, will be those that will longest survive; hence we ought to be able to explain the light-curves on the supposition that the conditions of the secondary swarms are as stated above, and it is seen that we can so explain them.

When we have more than one subsidiary swarm it is easy to see that certain relations of the regular periods of their orbital motions will produce an irregularity in the compound period; so that a rhythmic change of period will enable us to learn somewhat of the relation of the relative intensity and period of each of the swarms. We are really in presence of a *light-tide*, the elements of which can be found by analysis, as occurs with other tides nearer home.

The explanation suggested by the hypothesis of the variability of stars of Group VI. seems also to throw light upon the strange colours of some of them. R Leporis, for instance, one of the most marked variables in the group, is the famous crimson star observed by Mr. Hind. Now crimson = red + blue. All these stars are red, and in many of them the absence of the blue is one of the most emphasized characteristics of the spectrum.

But suppose that the secondary swarm which adds its light at maximum is a comet with the usual carbon bands, we shall get this condition of things :—

	Blue.	Green.	Citron.
Bands in star	masked by continuous absorption	absorbed ...	absorbed
Bands in subsidiary swarm ...	bright ...	bright ...	bright

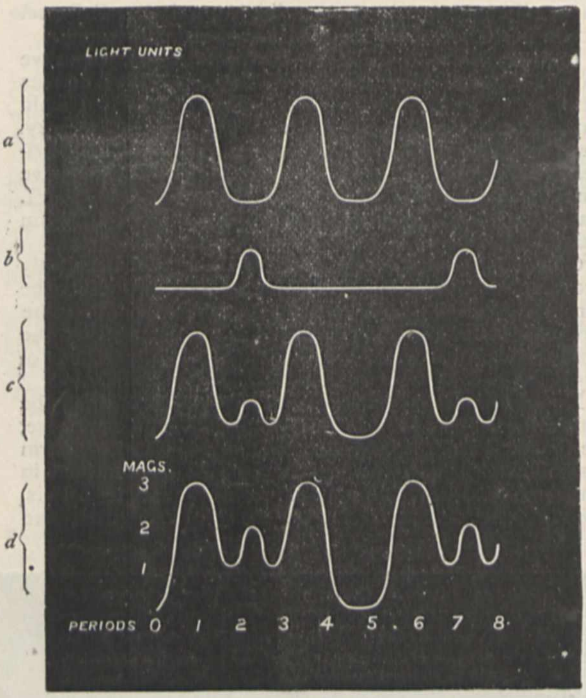


Fig. 7.—Periods 2 to 1. Apastra coincident.

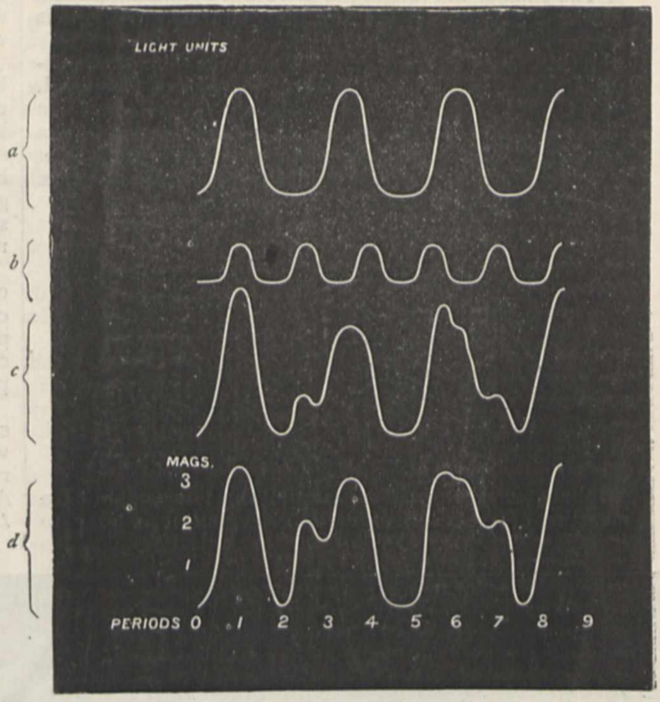


Fig. 9.—Periods 5 to 3. Periastra coincident.

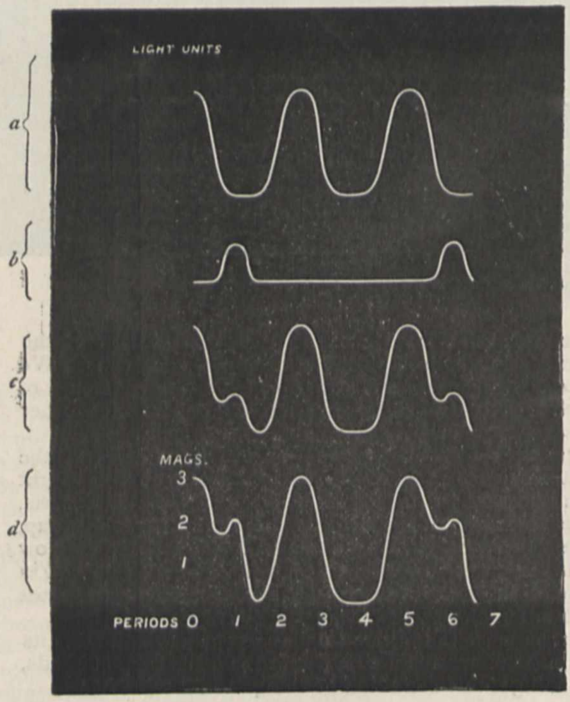


Fig. 8.—Periods 2 to 1. Apastra not coincident.

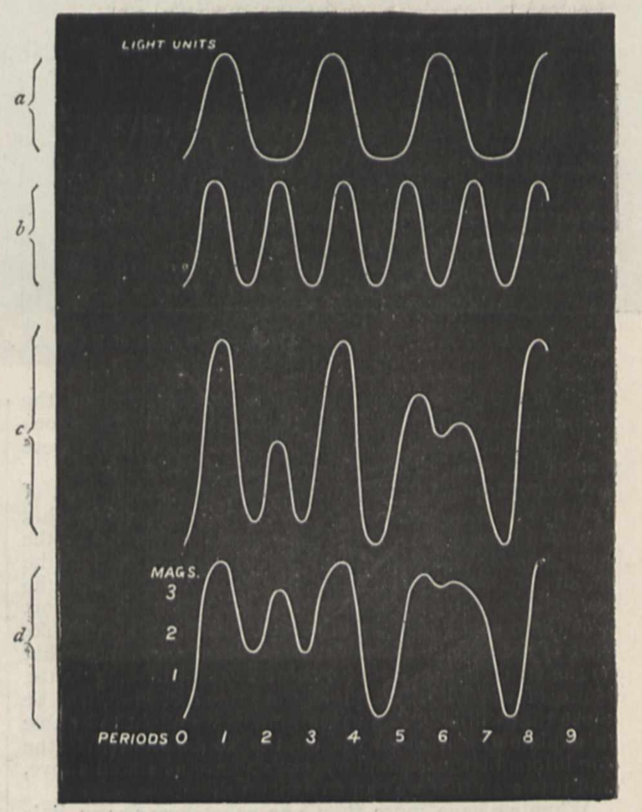


Fig. 10.—Periods 5 to 3. Periastra not coincident.

a Principal swarm. *b.* Subsidiary swarm. *c* Result in added light-units. *d.* Result in added magnitudes.

in other words, the bright fluting of carbon in the green and blue of the subsidiary swarm will just *mask* the absorption bands. They will *pale*, and the colour of the star (red) will be but slightly affected from this cause; but the blue flutings will be clear gain to the blue end of the spectrum, and crimson will result.

If this explanation be conceded, it is clear that comets travelling round such stars are conditioned very much like comets travelling round our own sun.

The general colour of the stars in Group VI. indicates that they are near the point of invisibility, the conditions being no doubt a red or white hot crust with a strongly absorbing atmosphere. It is worth while to point out that the cessation of all radiation of light from the central body need not prevent its passing on as a variable star to Group VII. As we must assume comets to be shreds of nebulæ, *i.e.* meteoritic fields or streams, filched by masses which pass near them; and as the mass remains after the light has gone, there will be the same attraction at work, and we have no right to assume that it will not act in the same way as heretofore.

We can gather from this that practically there can be no permanently dark bodies in space; they *must* at one time or another be accompanied by comets, and they must therefore be variables.

Here a most interesting point comes in: if the phenomena of the repulsion of comets' tails, or, in other words, the repulsion of carbon in some form or other from cometary swarms, depends upon the thermal energy of the central body, this result can no longer happen when the central body has cooled down. The effect of this upon the spectrum of such a compound system is well worth inquiring into.

In the hypothetical curves I have already given, I have dealt with simple cases. But in the stars there will be certain to be complex ones brought about by the successive periastra or apastra not being coincident in the two swarms (to deal only with two), and by different relationships in the periods.

I append (Figs. 7–10) some hypothetical curves worked out both in light-units and magnitudes, the conditions being stated for each. The paucity of actual light-curves available prevents any inquiry as to the stars in which the conditions here imagined actually exist, but in the absence of such knowledge it is still easy to gather that different periods separating maxima, secondary minima of unequal periods, and great variations in the rise to and fall from maximum, instead of necessarily being the result of "irregularity," are all demanded by the most perfect regularity, provided we have more than one swarm to deal with under conditions anything like those employed in the hypothetical curves above given.

If there is anything of value in what I have advanced, it is quite clear that the observations of variable stars and variable star catalogues require considerable revision. First, arrangements should be made with the observatories of America and India so that the observations of a certain number of stars in the northern hemisphere should be observed as continuously as possible. The relative brightening of the bright carbon flutings in stars of Groups I. and II., and the paling of the dark carbon flutings in Group VI., should be spectroscopically watched in each case.

It is highly important also that the precise group to which each variable belongs should be determined at once, and that this datum should take the first place in the working catalogues employed.

The observations should also be recorded when made on light-curves, the time ordinate being contracted as much as possible in order that the genesis of the compound curve may be suggested as soon as possible, so that future observations can be controlled, and the greatest attention be given at the critical periods.

The colour-observations have done their work and have had their day: less attention need now be directed to them, and much time will be liberated thereby.[1]

J. NORMAN LOCKYER.

THE LABYRINTHODONTS OF SWABIA.[2]

SWABIA, it need scarcely be said, lies to the south-east of Stuttgart—the classic ground of the Triassic Labyrinthodonts of Germany—and since it contains the same Triassic deposits, we should naturally expect to find therein the same species of this group of Amphibians. The present memoir, remarkable alike for the splendid plates with which it is illustrated, and for the care with which the specimens have been described, is devoted to making known to the scientific world the magnificent collection of Labyrinthodont remains which have been from time to time obtained from the Swabian and Würtemberg deposits, and are now preserved in the Museums at Stuttgart, Tübingen, and Munich. Of the seventeen plates with which this work is illustrated, a large proportion are folded ones of very considerable size, while all are especially noticeable for their beauty of execution. They appear to have been printed by some special process from photographs, the finely-preserved specimens of skulls standing out with wonderful clearness from a black background. Even more noteworthy than the unrivalled execution of the plates is the perfection and beauty of the specimens themselves; and we would especially direct attention to the magnificent skull of *Metopias*, represented in plates xii. and xiii. of the work before us, as being the finest Labyrinthodont specimen that has ever come under our notice.

In the introduction to his memoir, the author, after summarizing what has been previously written on the subject, glances at the chief groups into which it has been proposed to divide the Labyrinthodonts. The forms treated of in the present memoir all belong to the typical group, the Euglypta of the British Association Committee of 1874, and the Stereospondyli of Prof. von Zittel. This group has been generally characterized, among other features, by the fully ossified centra of the vertebræ; but Dr. Fraas remarks that it is very difficult to be sure of the nature of their vertebræ, and that, at least in *Mastodonsaurus*, either the caudal vertebræ, or the vertebræ of young individuals, are of that imperfectly ossified and segmented type to which the term "rhachitomous" has been applied, so that fully ossified vertebræ only occur in the trunk region of the adult. This seems to us to indicate very clearly that the pre-Triassic *Archegosauridæ*, in which the vertebræ are always "rhachitomous," can only be separated from the *Anthracosauridæ* and *Mastodonsauridæ* by characters of family value.

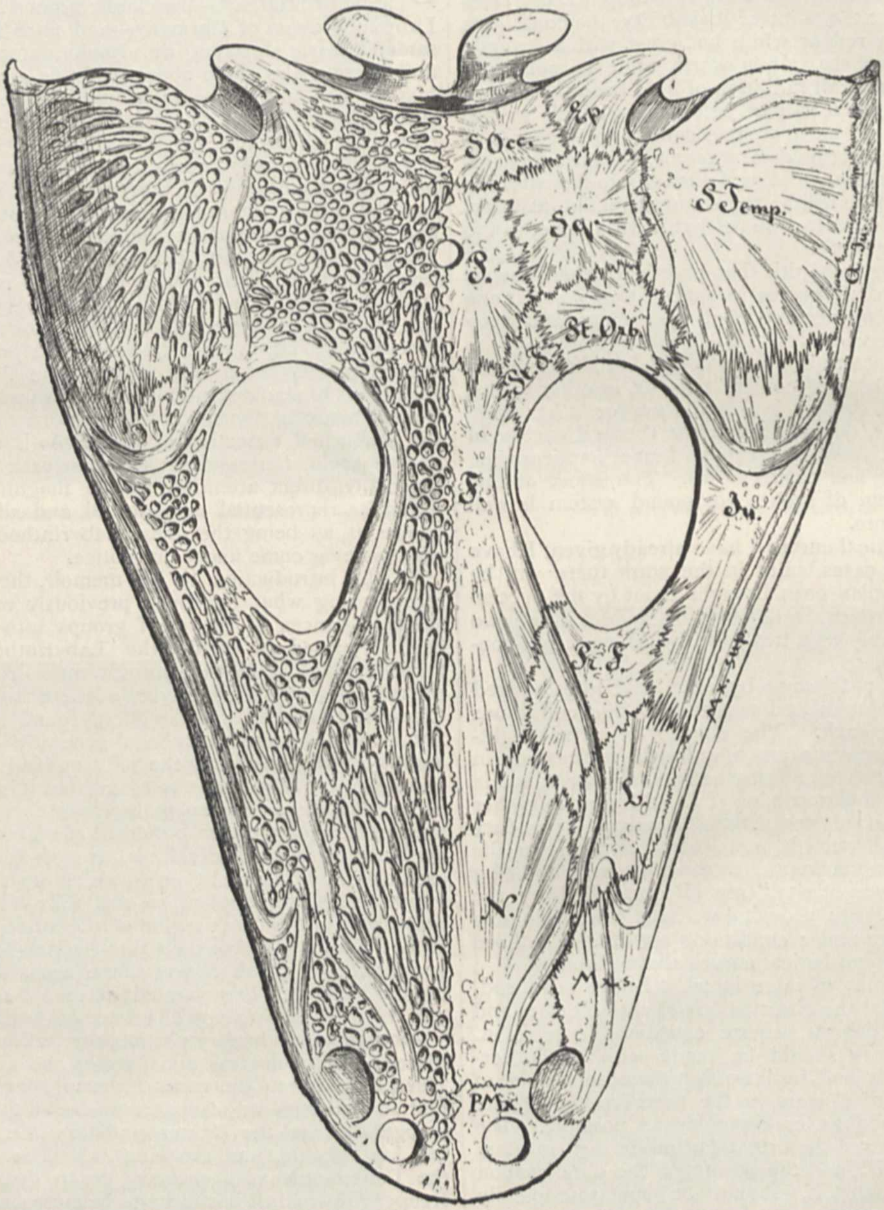
After the introductory portion, the author proceeds to discuss the geological divisions of the German Trias. Here, contrary to the views hitherto generally adopted, four main stages or groups (exclusive of the Rhætic) are recognized, viz. the Bunter-sandstein, the Muschelkalk, the Lettenkohle, and the Keuper. The separation of the Lettenkohle as a primary group distinct from the Keuper (in which it has hitherto been generally included) appears to rest on the ground that it contains many forms of Vertebrates common to the underlying Muschelkalk which do not occur in the typical Keuper. Thus the Sauropterygian genera *Nothosaurus* and *Simosaurus* range up into the Lettenkohle, but stop short of the true Keuper.

[1] I have to thank the Astronomer-Royal and Prof. A. S. Herschel for the correction of an error into which I had fallen in the part relating to light-units in the first draft of this article. The table on p. 546 I have extracted from one of the valuable letters with which Prof. Herschel has favoured me on this subject; it is fuller than the one it replaces.

[2] "Die Labyrinthodonten der schwäbischen Trias," by Eberhard Fraas. *Palæontographica*, vol. xxxvi. (1889), pp. 1–158, plates i.–xvii.

The same is true of *Mastodonsaurus giganteus*, although that form is succeeded by a closely allied species in the proper Keuper; the latter species, by the way, being not improbably the one occurring in the Bristol Rhætic, which was identified by the British Association Committee with *M. giganteus*. A table, with the names of the forms characteristic of each horizon, fully explains the author's views on all these points of geological classification.

Passing to the descriptive portion of the work, we may first of all observe that Dr. Fraas sees no reason to depart from the generally accepted homology of the bones forming the hinder part of the Labyrinthodont cranial roof; and he does not, therefore, accept the view of Dr. Baur that the bone usually termed the squamosal (*Sq.* of figure), is really the supra-temporal, and *vice versâ*; neither does he adopt the suggestion of the same palæontologist that the bone usually termed epiotic (*Ep.*) really represents the opisthotic of other Vertebrates. The arrangement of the Labyrinthodont cranial bones is well shown in the woodcut of the skull of *Mastodonsaurus* given on p. 44 (reproduced here), in which we notice that the squamosal has a more rhomboidal form given to it than in the restoration published by the British Association Committee in 1874.



Skull of *Mastodonsaurus giganteus*, one-fifth natural size. *S.Occ.*, supra-occipital; *Ep.*, epiotic; *P.*, parietal; *Sq.*, squamosal; *S.Temp.*, supra-temporal; *Pt.F.*, post-frontal; *Pt.Orb.*, post-orbital; *F.*, frontal; *Pr.F.*, pre-frontal; *N.*, nasal; *P.Mx.*, pre-maxilla; *Mx. sup.*, maxilla; *L.*, lachrymal; *Ju.*, jugal; *Q.Ju.*, quadrato-jugal.

Of the several species described, the first is the well-known *Mastodonsaurus giganteus*, of the Muschelkalk and Lettenkohle, of which the author gives a new figure of the fine skull found in the Lettenkohle of Gaildorf in 1833, and so well known in all Museums by means of plaster-casts. This magnificent specimen, we learn, has recently been thoroughly cleaned from matrix, by which means the true relations of the bones can be more clearly seen. A woodcut of the pelvis of the same species is especially valuable, and shows (as, indeed, had been previously well displayed in Prof. Cope's figure of the pelvis of *Eryops*) that the ossified pubis is very small, and takes no part in the formation of the acetabular cavity for the head of the femur. Another species of this genus from the Muschelkalk and Lettenkohle is described as *M. granulosus*, a second from the Lettenkohle as *M. acuminatus*, and a third from the true Keuper as *M. keuperinus*.

The genus *Capitosaurus* was originally described upon the evidence of a specimen of the skull from the Keuper of Franconia, a second species being subsequently described from the equivalent beds of Würtemberg as *C. robustus*; while *C. nasutus* and *C. fronto* are smaller forms from the Bunter of Bamburg. (It may be observed, in passing, that, in the Report of the British Association Committee, all mention of these two species from the Bunter is omitted, and it is thus only suggested that the genus might possibly be represented in these beds.) Dr. Fraas describes and figures a beautifully preserved skull of *C. robustus* from Stuttgart, which exhibits the very remarkable specific peculiarity that the epiotic gives off a process to join the supra-temporal, and thus converts the auditory slit into a foramen. The author would regard this feature as of sufficient importance to form a generic character, and he accordingly proposes to separate this species from *Capitosaurus*, with the appropriate designation of *Cyclotosaurus*. We are, however, rather inclined to agree with Prof. von Zittel, who regards the feature in question merely as a well-marked specific one.

Of still more importance are the skull and skeleton of *Metopias*. Hitherto, the occipital region of the skull of this genus has been undescribed; and the magnificent skull to which allusion has already been made shows that the restoration of this part by the British Association Committee was not altogether correct. The type species of *Metopias* must have been a huge creature, only second in point of size to *Mastodonsaurus*, its skull being some 2 feet in length. In addition to the skull, the affinities of this genus are illustrated by a slab showing both surfaces of the anterior half of the skeleton. In this beautiful specimen the three plates of the thoracic buckler are preserved in their natural position, and show well-marked differences from the corresponding bones of *Mastodonsaurus*. Thus, the median plate (interclavicle), instead of ending in a sharp posterior process like the corresponding bone (entoplastral) of a turtle, is rounded; while the lateral plates (interclavicles) meet in a long suture in advance of the median plate.

In thus making accessible to the scientific world the wonderful specimens of Triassic Labyrinthodonts preserved in the Museums of Germany, Dr. Fraas has laid all students of this branch of zoology under a deep obligation to him; and his work forms a fitting companion to the volumes containing Dr. Fritsch's description and illustrations of the smaller Labyrinthodonts of the older Permian beds of Bohemia. R. L.

NOTES.

THE proceedings of the Iron and Steel Congress seem to have excited much interest in America. About four hundred members of the Iron and Steel Institute and of the German Metallurgical Association are in New York, taking part in the meetings. The sittings of the American Institute of Mining Engineers began on Monday, those of the Iron and Steel Institute on Wednesday. According to the New York correspondent of the *Times*, the foreign delegates are much pleased with the arrangements made by the Americans for their reception.

THE Harveian Oration will be delivered by Dr. Andrew, at the Royal College of Physicians, on Saturday afternoon, October 18, at four o'clock.

THE eleventh annual "fungus foray" of the Essex Field Club will be held on Friday and Saturday, October 10 and 11, in Hatfield Forest, near Great Hallingbury, a remnant of about 1000 acres of the great forest of Essex. The head-quarters for the meeting will be at Bishop's Stortford. Papers will be read, and an exhibition of fungi and other botanical specimens held, under the direction of Dr. M. C. Cooke and Mr. George Massee. Any of our readers wishing to attend, should communicate with Mr. W. Cole, Hon. Sec., Essex Field Club, Buckhurst Hill, Essex.

THE Fruiterers' Company will hold an exhibition of fruit, at the Guildhall, London, on October 6, 7, and 8. Their objects are (1) to show what excellent fruit can be grown in this country; and (2) to afford information respecting the best sorts to plant, and how to cultivate them advantageously.

AT the annual meeting of the friends of the Manchester Technical School, held on Monday, it was resolved that the property and effects of the school should be transferred to the Whitworth Institute. A letter from Mr. Chancellor Christie, one of the trustees of the late Sir Joseph Whitworth, was read. In this letter he referred to the property of the Institute, and said the trustees were prepared absolutely to give and convey their property in Peter Street, of which at present the Technical School has the use. Upon the representations made to them that it was impossible for the Technical School to be carried on for the present unless it obtained from some source a subvention of £1000 a year, or thereabouts, the legatees had undertaken to provide that sum, if necessary, for a few years, and they had already made some annual payments of this amount. As, however, the Corporation of Manchester, under the powers conferred by the recent Act, had arranged for the payment of £2000 a year to the Technical School, the amount conditionally promised by the legatees would not be required. They were willing, in lieu of this, to contribute the sum of £5000 towards the building fund. The writer added, that while he should like to see a building in every respect adequate and satisfactory, he thought it would be a mistake to contemplate the immediate erection of a building on the scale of that of which plans were prepared about a year since. "The design, indeed, should embrace everything that could be needed for many years to come, but it should be so planned that a portion only could, and should, be immediately erected, leaving the rest for the future. In fact, it would follow the lines upon which the Owens College has been partially built. An expenditure of less than £100,000 should, I think, be sufficient for all the immediate purposes of the Technical School."

WITHIN the last few days, telephonic communication has been established between London, Manchester, Liverpool, and Lancaster by the National Telephone Company, Limited. The line is not yet open for use by the public, but it was placed at the disposal of the Manchester Field Naturalists' Society on Monday evening, when a discussion on the effects of fog and town atmosphere on plant-life was held between members in Manchester and a number of corresponding members in London. Dr. Bailey, of Owens College, proposed a scheme for the chemical examination of fog, with reference to its injurious effects on animal and vegetable organisms. Colonel Mackenzie, Superintendent of Epping Forest, denied its evil effects as far as plants were concerned; Prof. R. Meldola thought that the atmosphere of London was becoming more and more harmful to plants, and that this effect was probably due to the absence of light; Mr. Philip Hartog suggested that an attempt should be made to photograph the absorption spectrum of fog, and that a *daily* analysis of the air in large towns should be made in laboratories devoted to that purpose. A sub-committee was appointed to consider the subject further.

ANOTHER determination of the atomic weight of the element beryllium has been made by Drs. Krüss and Moraht, with the purest oxide that has probably ever been prepared (*Berichte*, No. 13, 2552). The result is eminently satisfactory to those who entertain a certain amount of belief in a modified "Prout's law," for the value obtained, 9·05 when oxygen is considered 16, is almost exactly a whole number, much nearer the round number 9 than the value obtained by Nilson and Petterson, 9·11, and the still earlier one of Awdejew, 9·22. The method employed consisted in igniting under special conditions the sulphate $BeSO_4 + 4H_2O$. The advantages attending the use of this salt are that it is capable of preparation by a method detailed in a former communication in an almost absolutely pure state, and it is not hygroscopic. The powdered crystals lose two molecules of their water of crystallization at 105° C., and the remaining two molecules at 250°–260°. When heated to redness the residual anhydrous sulphate is decomposed, beryllium oxide remaining. The last traces of sulphuric acid are completely removed by ignition to bright redness in a stream of air saturated with ammonia gas. The beryllia used for the preparation of the sulphate was obtained from three distinct minerals—leucophone, beryl, and gadolinite. Sixteen separate determinations were made, about 20 grams of the sulphate being ignited in each case. The excellent agreement between the results is seen from the fact that the maximum value obtained was 9·08, and the minimum 9·03, when oxygen = 16. It appears, therefore, that in the case of beryllium the value obtained for the atomic weight approximates the more closely to the whole number 9 the purer the materials and the more perfect the method employed in the work.

WRITING to us on the subject of sonorous sand, Mr. Henry C. Hyndman asks whether Prof. H. C. Bolton is aware of an inland locality in South Africa, where it is stated the sands are sonorous. In a recent letter to the *Scotsman*, Mr. Hyndman mentioned that he had come across a paragraph in a work entitled "Twenty-five Years in an African Waggon," by Andrew A. Anderton, published in 1887, in which the author said, "Before leaving this part of the Griqualand West I should like to describe that peculiar sand formation on the west side of the Langberg mountain, which is in fact part of it. I heard from many of the Griquas and Potgielet living near it, that the lofty hills are constantly changing; that is, the sand hills, 500 and 600 feet in height, in the course of a few years subside, and other sand hills are formed where before it was level ground." And then in a footnote it is added, "I regret very much the description of this sand formation has been left out, it being the only extraordinary geological formation known in Africa, and fully describes the musical sand."

THERE is an interesting article in *Education* on the University Correspondence College (London and Cambridge) and its founder. Mr. William Briggs is the principal and founder, and the idea of teaching by correspondence first suggested itself to him while holding the appointment to a Marquis of Bute Professorship in a Scotch College. The idea soon took root, and the general method of work now adopted is as follows:—Students every week receive a scheme of work, consisting of selections from text-books, indications of important points, hints, notes on difficult portions of each subject that is under consideration. At the end of the first week, in addition to the above, a test paper is sent on the work of the preceding week, the answers to which are sent to the tutor on an arranged day. These are then examined and returned with corrections, hints, and model answers in each subject and solutions of all the difficulties. The advantage this method has over oral teaching is that all difficulties, &c., are committed to writing, and can be looked at over and over again and kept for future reference. The staff employed consists of forty tutors, whose academical careers were exceptionally brilliant, twenty-six of them having taken first places at London University examinations. The best judgment as to the work of the students may be formed from the following information:—In the Intermediate and B.A. examinations, 79 and 70 passes were obtained in one year. In the Honour and M.A. examination, 105 at the recent June examination passed, including the tenth, thirteenth, and seventeenth places in the Honour list; at Intermediate Arts, twenty took honours, one with a first and two with second places; at B.A., sixteen took honours, one being University Prizeman.

THE Durham College of Science, Newcastle-upon-Tyne, has issued its Calendar for the session 1890–91. The schedules for the A.Sc. and B.Sc. degrees have been re-modelled, and are now on the same lines as the corresponding examinations in the London and Victoria Universities. Attention may also be drawn to the fact that the list of subjects on which courses of lectures are delivered includes agricultural botany.

THE Calendar of the University College of North Wales for the year 1890–91 has been published.

WE have received the calendar of the Imperial University of Japan (Teikoku Dargaku) for the year 1889–90 (22nd–23rd year of Meiji), published by the University at Tokyo. This University is under the control of the Minister of State for Education, and depends for its revenue upon annual allowances from the Treasury of the Imperial Government. An accumulation fund, made up of tuition fees and other sources, helps to pay the current expenditure of the University when the cases are of such a nature as to demand the outlay. The whole University, consisting of offices of the University, library, colleges of law, medicine, engineering, literature, and science, the first hospital of the College of Medicine, &c., are situated in the grounds at Molofujicho, Hongo, Tokyo, known as Kaga-yashiki. The Botanical Garden Observatory and the second hospital of the Medical College are all situated within the city bounds, and the Marine Biological Station is situated at Misaki. The Calendar contains information on everything concerning the University, viz. University offices, regulations for colleges, courses of instruction, examinations, scholarships, fees, &c. The appendix gives the address delivered by President Watanabe on the occasion of the annual graduation ceremony, July 10, 1889.

M. E. DRAKE DEL CASTILLO has recently published a memoir, rewarded by the French Academy of Sciences, on the Flora of Polynesia.

A CATALOGUE of numerous works in every branch of astronomy has been issued by Felix L. Dames, Berlin, W., Taubenstrasse 47. To those who may wish to have copies of rare and standard astronomical publications at a reasonable price it will be found extremely useful.

MESSRS. G. PHILIP AND SONS, Fleet Street, have published a portable sun-dial adjustable for all latitudes and fitted with a compass. The model has been designed to illustrate simply and accurately the principle of the sun-dial. The equation of time on the 1st, 11th, and 21st of each month is given, so that civil time may be found. No table is given of magnetic variation, hence the fixing of the instrument in the magnetic instead of the geographical meridian involves a certain amount of error. The box into which the model fits is made exactly one cubic decimetre in capacity, and is intended to illustrate the decimal system of weights and measures.

THE *Engineer* of the 19th inst. contains an important article on "Railway Axles in India," due to a remarkable statement in the Indian technical press, to the effect that steel railway axles had not given satisfaction, and that at considerable expense iron axles were to be substituted for them. Our contemporary observes that questions have, naturally enough, been asked, and publishes Sir A. M. Rendel's reply:—"I originally," he says, "recommended the use of steel for axles on the Bombay, Baroda, and Central India metre gauge, because I thought that steel was not only better than iron, but because its price was not more than half that of the class of iron suited for axles. I was further moved to do so by an opinion that, whilst steel was improving in quality, and daily taking the place of the best classes of iron, the quality of those classes of iron must deteriorate, because the price obtainable for them must diminish. In respect to the relative price of steel and iron, I was quite right; in respect to their relative suitability for axles, I have been wrong, or, at any rate, premature. *Commercial steel, when used in axles, seems subject to deterioration, which makes it very brittle after a few years' wear.* The consequence is that we must do now what we should certainly have done at first, had all the facts been then before us—I mean, we must substitute iron for steel. It being also desired that our waggon loads should be increased, it has been found necessary to increase the size of our axles, and their weight in iron is now 231 lbs., instead of 198 lbs. in steel; and their present cost is £2 6*s.*, instead of about £1 2*s.* 6*d.* Had we originally supplied the large iron axles, capital would have been charged, for every such axle supplied, the sum of £2 6*s.* or thereabouts, instead of £1 2*s.* 6*d.*, and I can see no reason why, because we attempted an economy in the first instance, which experience has proved to be impracticable, capital should escape the larger charge now. It appears to me indisputable that the difference between the cost of the axles originally supplied and those now sent out should be charged to capital and not to revenue." The italics in this quotation are those of the *Engineer*, and the statement is a grave charge against steel, and one that the steel manufacturers will no doubt combat strongly. The *Engineer* does not tell us where these metre gauge axles have usually failed, and it is therefore difficult to find a reason for the wholesale rejection of steel as a suitable material for axles, always bearing in mind the general use of this material in this country for that purpose, with the greater mileage run with steel axles, be they crank or straight axles, over that obtainable from iron axles. It is to be hoped that the matter will be thoroughly thrashed out. The question of manufacture must not be overlooked. Steel rails occasionally fail at the ends owing to insufficient "crop" being cut off the rolled rail, *i.e.* the steel is not considered sound for about 3 feet from each end of the rail as it leaves the rolls, and is therefore usually rejected as "crop ends." If these axles are rolled ones, probably this might explain the failures, if they usually took place at the ends and not in the middles.

THE autumn series of science lectures at the Royal Victoria Hall began on Tuesday with a lecture on "Nebulæ," by Mr. J. D. McClure. The arrangements for lectures during the month of October are as follows:—October 7, "The Sun," by J. D. McClure; October 14, "Bees as Florists and Fruit Producers," by Rev. Prof. Cheshire; October 21, "The Colours of Animals and their Uses," by Dr. W. D. Halliburton; October 28, "Mountaineering," by H. G. Willink.

THE additions to the Zoological Society's Gardens during the past week include a Brown Bear (*Ursus arctos* ♂) from Russia, presented by Mr. G. W. Robinson; a Golden Eagle (*Aquila chrysaëtus* ♀) from the Rocky Mountains, Wyoming, U.S.A., presented by Mr. Percy Cooper; two Common Squirrels (*Sciurus vulgaris*), British, a Reticulated Python (*Python reticulata*) from Siam, purchased; five Viperine Snakes (*Tropidonotus viperinus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on October 2 = 22h. 46m. 16s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 4827	—	—	22 36 13	+60 42
(2) G.C. 4883	—	—	22 55 43	+29 33
(3) β Pegasi	2	Yellowish-red.	22 58 12	+27 29
(4) π Aquarii	5	Yellowish-white.	22 19 42	+ 0 49
(5) η Aquarii	4	White.	22 29 42	− 0 41
(6) α Pegasi	2	White.	22 59 18	+14 37
(7) 257 Schj.	9	Reddish-yellow.	21 51 9	+49 59

Remarks.

(1) In the spectrum of this nebula Dr. Huggins has recorded only the chief nebula line near λ 500. It is remarkable that Herschel describes it as easily resolvable, and if this be correct the nebula must be regarded as a cluster of nebulous stars. This important result is well worth checking, both by telescopic and spectroscopic observations.

(2) This nebula is described as "considerably bright; considerably large; little elongated; gradually much brighter in the middle; mottled as if with stars." The spectrum of the nebula is rather vaguely described by Dr. Huggins as follows: "The spectrum does not consist of one or two lines only; I believe it is continuous." The doubt should be removed by a more definite observation.

(3) The spectrum of this star is a very fine one of Group II. The dark bands, however, are by no means so strongly developed as they are in α Herculis or Mira, but still they are well marked, and, in addition, the spectrum abounds with lines. The relative feebleness of the bands, and the presence of so many lines, indicates that the star is well advanced in condensation, and this is further confirmed by my own observation of the comparatively feeble bright flutings of carbon. Most of the lines are identical with those seen in Aldebaran. D is partly hidden by a dark fluting, but lines in other places stand out prominently. They are not quite like those seen in the solar spectrum, and hence the spectrum of the star is one from which useful information relative to the criteria between Groups III. and V. may be derived.

(4) Prof. Pickering has found by photography that the spectrum of this star contains bright lines. Vogel, however, describes the spectrum as a well-marked one of the solar type, and makes no mention of bright lines. In my own observations of the star I found the dark lines characteristic of the spectrum of a star like the sun, but detected no bright ones. It is quite possible, therefore, that the bright lines are not always visible, and the spectrum should be examined with reference to a possible periodicity.

(5) According to the observations of Konkoly, this star has a well-marked spectrum of the solar type, but Gothard and Vogel describe it as one of Group IV. My own observations confirm those of Vogel.

(6) A star of Group IV.

(7) This faint star has a spectrum of Group VI., and Dunér states that the dark carbon band which separates the green and yellow zones is wider than he has seen it in any other star. The blue zone is scarcely perceptible. It seems as if this is a star which has cooled down until it is almost non-luminous, and the observation is important as indicating to a certain extent what the spectrum will be at the last stage of visibility. It appears that the carbon absorption intensifies, until finally all the remaining light is absorbed. A. FOWLER.

THE TELLURIC SPECTRUM.—The current number of *Comptes rendus* (September 22) contains an account of the expedition lately made to the summit of Mont Blanc by M. Janssen, for the purpose of observing the spectrum of the sun from an elevated station. Two years ago M. Janssen ascended Mont Blanc as far as the Grands-Mulets, a station having an altitude of 3050 metres. The spectroscopic observations then made showed that a diminution took place in the intensity of the groups of lines A, B, and a, due to the action of the oxygen in the atmosphere, and indicated very definitely that at the limits of our atmosphere these groups would disappear. To confirm these results it was resolved this year to repeat the observations at a greater elevation, and after considerable difficulties the Cabane des Bosses was reached on August 18. The altitude of this station is 4400 metres. Work was commenced four days later, and precisely similar results obtained. The B group, which appears to consist of ten well-defined doubles when observed at Meudon, and was almost reduced to the last double at Grands-Mulets, had disappeared altogether.

These observations, in conjunction with those made last year between the Eiffel Tower and Meudon, those made by M. de la Baume Pluvinel at Candia during the annular eclipse of June 17, and those made in the laboratory at Meudon, definitely demonstrate the absence of oxygen from the sun, or, at least, of oxygen in the state that we know it.

M. Janssen thinks that, in the interests of astronomical and terrestrial physics and of meteorology, an Observatory should be established on the summit of Mont Blanc. The difficulties to be overcome in the erection of a station at such an elevation are great, but that they are not insurmountable is evidenced by the observations that have just been made.

Astronomy and Numismatics.—Dr. A. Vercoutre, in *L'Astronomie* for September, points out how astronomical knowledge may be of service to numismatical science. It is known that on many antique medals, and notably on the coins of the Roman Republic, stars and members of the solar system figure sometimes as symbols and sometimes as heraldic allusions to the magistrate by whom the coin was struck. Thus, on a coin struck by L. Lucretius Trio, 74 B.C., the seven stars in Ursa Major are shown, and this constellation, being named Septem Triones, was evidently used as a phonetic allusion to the surname (Trio) of the magistrate. Again, on a coin struck in B.C. 43, Dr. Vercoutre noticed five stars, one of which was much larger than the others. He therefore concluded that the constellation represented on the coin was Taurus, as this was the only group of five stars known to the ancients in which one was more brilliant than the others. On this account he was enabled to attribute the coin to P. Clodius Turrinus, who apparently used the constellation Taurus or Taurinus as a phonetic signification of his surname. A coin struck by Manius Aquillus, B.C. 94, has figured upon it the first four stars in the constellation Aquila. They are shown in nearly the same relative positions occupied in reality, hence the coin contains the oldest known representation of a portion of the celestial vault. It is therefore possible that an inspection of the stars figured on old coins may be the means of ascertaining the identity of the magistrate under whom they were struck, or, knowing this and the constellation represented, they may be useful for the determination of proper motion.

GEOGRAPHICAL NOTES.

M. Andrusoff, whose researches into the geological history of the Caspian Sea have been mentioned more than once in Nature, gives now some interesting preliminary results of his exploration of the Black Sea. After having carefully studied all that was previously known about that sea and embodied it in an excellent paper (published in the last issue of the *Izvestia* of the Russian Geographical Society, vol. xxvi., 2), he induced the Hydrographical Department of the Russian Navy to send out a special gunboat for the exploration of the Black Sea, under Captain Spindler and Captain Wrangel. The sea was thus carefully explored from Odessa to Constantinople, and thence to Batum and Sebastopol. It appears that great depths are found everywhere within a short distance of the shore; and that from a depth of 200 metres the water of the Black Sea begins to contain sulphuretted hydrogen resulting from the decomposition of decaying organisms, so that no organisms either vegetable or animal, are met with at depths exceeding 200 metres. The Black Sea, he concludes, is not a sea, properly speaking, but an immense stagnant pond (reaching a maximum depth of 1200 fathoms) which is covered on the surface by the water of the Mediterranean and the rivers which flow into it. The full report of M. Andrusoff is expected soon, and is sure to be full of interest.

A telegram, dated Tashkend, September 15, gives some extracts from a letter written by M. Grombchevsky on July 20, at Sel-kilian. The expedition had at last reached Tibet from the north; but the hostility of the ruler of Keria compelled them to undertake the journey too early in the spring. On May 21, they were on the Tibet plateau, but weather was most inclement at that time. Hard frosts (20° C. below zero), terrible snow-storms, and a complete want of water—the snow in the mountains not having yet begun to thaw—compelled the expedition to return to Kashgaria without having accomplished the proposed programme of exploration. Later on, the want of money prevented them from returning to Tibet in the summer. M. Grombchevsky also adds that the ruler of Kanjut has entered into vassal relations to the Government of India, and that the fort Shahidulla-hodja is occupied by a garrison of Kashmerees, thus commanding the drainage area of the Raskem-daria and its pasture grounds. Besides, in April last, the beck of Kanjut took possession of the Pamir and Dangarym-bash forts, formerly occupied by Chinese garrisons; so that the fort Pamir, which is now practically under English influence, and the Russian fort Kara-kul are separated by but a three days' march over a territory densely peopled with Kirghizes. We may thus expect that the veil which has for so many centuries concealed those regions from science will soon be entirely lifted, and Northern Tibet will become as well known as Central Asia.

"THE AGE OF SCIENCE."

On Friday evening last, Lord Derby, before distributing the awards of the Liverpool School of Science, delivered a clear, vigorous, and interesting address on some aspects of science. Ours, he said, would be remembered as pre-eminently the age of science. Our successors might excel us as writers, as politicians, as soldiers; they might surpass even the industrial energies of the present time, but it was not likely—it was scarcely possible—that in the region of science the twentieth century should witness advances greater than, or as great as, those of the nineteenth. The general experience of the world had been that brilliant but brief epochs of advance had been followed by long intervals of stagnation, and sometimes even of retrogression. Retrogression was not likely, but stagnation was quite possible. There was one phrase much employed when people talked on these subjects which, to his mind, contained a fallacy. He meant the common phrase of popularizing science. To popularize science was simply impossible. Anybody could cram up, with the help of an average memory and of easily acquired hand-books, a summary of what had been done in astronomy, in chemistry, or other sciences, but when that result was accomplished he would be very little nearer to any real gain which science could bring to him. It was only labour and perseverance, added to natural capacity, that could give a scientific mind. Some tincture of scientific knowledge was desirable for every educated person. The result might not be great, but the process was valuable. An entire absence of the scientific spirit was no doubt compatible with brilliant talent and high distinction. We did not find fault for a deficiency of that kind in a novelist, a poet, or a writer of light literature, but it was a deficiency notwithstanding. If asked what he meant by a scientific spirit, he thought he knew, but he must confess that it was more easily described in vague and general terms than precisely defined. He meant by it, in the first place, a habit of accuracy and exactness in matters of fact. In the next place, he meant that temper of mind which seeks for conclusions, but does not jump at them—which is equally opposed to the stupid incredulity of ignorance, refusing to accept any idea which is not familiar; to the reverential credulity which accepts as true any statement coming down from old or high authority; and to the careless indifferentism which, so long as a theory looks and sounds well, and especially if it flatters some previously existing feeling of prejudice, does not care on what foundation of reality that theory rests. That the world is governed by laws which we did not make and cannot abolish—laws which will operate whether we recognize or ignore them, and which it is our wisdom therefore to study that we may obey. and in obeying utilize them—that was what was taken to be the outcome of scientific teaching, and if anybody thought that a useless or an unimportant or unnecessary lesson he did not agree with him. Something else science, rightly understood, would teach us to know—what it is that we can hope to know and to understand; and to recognize how little that is, and how much lies, and probably always will lie, beyond the reach of our faculties. One word only he would add—that, having known men of many professions, he should say, as far as his observation went, the happiest lives were those which had been devoted to science. "Every step," said Lord

Derby, "is interesting, and the success of those who do succeed is lasting. What general, what orator, what statesman, what man of letters can hope to leave a memory like that of Darwin? An invalid in health, a man who seldom stirred from home, a man until his later years very little known to the outer world, but who, from his quiet study, revolutionized the thought of Europe, and will be remembered as long as Newton and Bacon. If fame be ever worth working for—I do not say it is—that kind of fame is surely, of all, the most durable and the most desirable. Well, I have perhaps digressed from our proper subject, for it is not likely that we have a future Darwin in this room, but it is no exaggeration to say that, as a rule, no man who has taken to science as the work of his life regrets the choice, while men who have done important work in other lines feel like Renan, who, at the height of his literary eminence, tells us in his autobiography that he has often regretted that science, rather than historical research, had not been the object of his early pursuit."

MIMICRY.[1]

THE relationship of mimicry to other animal colours can only be explained by giving a short account of the latter.

I. The commonest use of colour is for concealment (*cryptic*), enabling an animal (1) to escape its enemies, or (2) to approach its prey. In these (1) protective (*procryptic*) or (2) aggressive (*anticryptic*) resemblances, animals seek concealment by a likeness to some object which is of no interest to enemies or prey respectively. Similar effects may be produced by the use of foreign objects with which the animal covers itself to a greater or lesser extent (*allocryptic*).

EXAMPLES.—(1) *Procryptic Colours.* A green pipe-fish (*Siphonostoma typhle*) conspicuous in the water, but well concealed among the leaves of *Zostera:* the brown lappet moth (*Gastropacha quercifolia*), conspicuous on a smooth deal board, but well concealed among dead leaves.

(2) *Anticryptic Colours.* A large frog (*Ceratophrys cornuta*) from tropical South America, which almost buries itself in a hole in the ground, while the head, which is exposed, harmonizes with the surroundings. In this position it waits till the small animals on which it feeds approach or even walk over it.

(3) *Allocryptic Colours.* A small English crab (*Stenorhynchus phalangium*) which decks itself with pieces of seaweed: another small English crab (*Hyas coarctatus*) was shown with and without its covering of pieces of seaweed (*Ulva*, &c.).

Mimicry is closely related to the colours illustrated above, but differs in that the animal resembles an object which positively repels its enemies or positively attracts its prey rather than one which is of no interest to either. It is better, therefore, to defer its consideration until after the description of the colours which form the models for mimicry.

II. The second great use of colour is to act as a warning or signal (*sematic colour*), repelling enemies by the indication of some unpleasant or dangerous quality (*aposematic* or *warning colours*), or signalling to other individuals of the same species, and thus assisting them to escape from danger (*episematic* or *recognition colours*). In a very interesting group of cases (*allosematic*), the animal warns off its enemies by associating with itself some other animal with unpleasant qualities and warning colours.

EXAMPLES.—(1) *Aposematic Colours.* The two unpalatable English moths (*Spilosoma urticæ* and *S. mendica*, female), when disturbed, assume attitudes which serve to display their conspicuous yellow and black colours. Portchinski has recently shown that an unpalatable European chrysalis (*Limenitis populi*) bears the most detailed resemblance to a chrysalis which has been pecked and rejected by a bird. The American skunks (*Mephitis mephitica*, *Conepatus mapurito*, &c.) possess the power of emitting an intolerable stench, and are extremely conspicuous black and white mammals.

(2) *Episematic Colours.* In the common rabbit the white tail serves as a beacon to other individuals, pointing the way to the burrow.

(3) *Allosematic Colours.* A hermit crab (*Pagurus bernhardus*) is commonly found with a sea anemone (*Sagartia parasitica*) attached to its shell; in another hermit crab (*Pagurus prideauxii*) the association is more constant, and the sea anemone (*Adamsia palliata*) is specialized for life on the shell of the crustacean. Two crabs (*Polydectus cupulifer* and *Melia tessellata*), described by Möbius in some of the islands round Madagascar, invariably held a sea anemone in each claw. Two other groups of animals, sponges, and ascidians, in addition to sea anemones, are avoided by the enemies of the Crustacea, and these are also made use of by the latter. Thus the hermit crab (*Pagurus cuanensis*) is found in shells which are covered with a (generally) brightly-coloured sponge (*Suberites domuncula*): Möbius also describes a hermit crab (*Ascidiophilus caphyræformis*) which lives in a case formed by an ascidian.

III. Mimicry may be defined as false warning or signalling colours (*pseudosematic*), repelling enemies by the deceptive suggestion of some unpleasant or dangerous quality (*pseudaposematic*) or attracting prey by the deceptive appearance of something attractive to them (*pseudepisematic*). Even foreign objects commonly associated with some well-defended and aggressive species may be mimicked by a comparatively defenceless form (*pseudallosematic*).

EXAMPLES.—(1) *Pseudaposematic Colours.* The various degrees of complexity with which protective mimicry occurs in insects was shown by examples of Indian and African Lepidoptera.

(*a*) Both sexes of the Indian *Papilio agestor* closely resemble the much commoner and nauseous butterfly *Euplœa tytia.*

(*b*) An Indian moth (*Epicopeia philenora*) similarly mimics an unpalatable butterfly (*Papilio protenor*), but in this case the male moth mimics the appearance of the male butterfly, and the female moth that of the female.

(*c*) If the mimicking species became common relatively to the mimicked, the deception would be liable to be detected. We therefore find that two or more models are often mimicked by the same species. Thus the male of the Indian *Elymnias leucocyma* mimics *Euplœa binotata*, while the female mimics the female of *Euplœa linnæi.* Both these Euplœas are also imperfectly mimicked by day-flying moths (*Amesia midama*). So also the male of the Indian *Papilio castor* mimics *Papilio chaon*, while the female mimics *Euplœa core:* in the south, *Papilio chaon* is absent, and BOTH sexes of the species (*Papilio dravidarum*) which represents *P. castor*, mimic *E. core.*

(*d*) Female butterflies are exposed to more dangers than the swiftly-flying males, and we find many instances in which the former are mimetic, although the latter are not. Thus the female of *Hypolimnas bolina* mimics *Euplœa core*, while the male is non-mimetic. The same is true of *Hypolimnas misippus*, the female of which mimics *Danais chrysippus.* Two forms closely allied to the latter (some regard them as merely varieties) are also mimicked by the former.

(*e*) The mimetic females also often resemble two or more different species of nauseous butterflies. Thus the female of *Papilio pammon* appears in two forms, mimicking respectively *Papilio hector* and *P. aristolochiæ;* while the females of *Euripus halitherses* (the male of which is probably mimetic) mimic *Euplœa rhadamanthus* and *Euplœa deione.*

(*f*) There are also striking examples in which the non-mimetic ancestor of a mimetic species has been preserved, *e.g.* in an adjacent island. Thus the female of *Elymnias undularis* mimics *Danais genutia* in Sikkim and North-East India; in Rangoon and Burmah there is a variety of the latter with white hind wings which is as common as the typical form, and the female of *E. undularis* is beginning to mimic this variety; in South India *E. undularis* is represented by *E. caudata*, in which the male is also beginning to mimic *D. genutia*, and the female is a more perfect mimic than in the other localities; in the Andaman Islands *E. cottonis* represents *E. undularis*, and both sexes appear to be non-mimetic, while *D. genutia* has never been recorded from this locality. A still more wonderful example is found in Africa and adjacent islands. *Papilio meriones* of Madagascar is non-mimetic, and the sexes are alike; the same is true of a closely-allied species, *P. humbloti*, recently discovered in Grand Comoro, and of *P. antinorii* recently found in Abyssinia. A very nearly related species in West Africa has a closely similar non-mimetic male, while two forms of female mimic *Danais chrysippus* and *Danais niavius.* In South Africa *Papilio cenea* has an almost identical male, while the females mimic *D. chrysippus*, the southern form of *D. niavius*, and two varieties of *D. echeria.*

(*g*) There are also examples which show us the origin of mimicry, in which the resemblance is very imperfect, but, nevertheless, sufficient to afford protection. The blue Euplœas of

[1] Abstract of Lecture delivered by Edward B. Poulton, F.R.S., on Friday, September 5, at the Leeds meeting of the British Association.

India, &c. (such as *E. harrisi*, *E. linnæi*, *E. splendens*, and *E. irawada*) form a very characteristic group, while their general type of appearance is imperfectly mimicked by a group of day-flying moths (*Amesia midama*, *A. aliris*, *A. sanguiflua*). It is extremely probable that the wonderfully close likeness of many mimetic species arose by gradual stages from some general resemblance to a type of colour or pattern possessed by some large group of unpalatable insects.

The above-cited examples are some of them well-known, they were chosen to illustrate the various different ways in which mimicry occurs.

Evidence for the evolution of mimetic resemblance has also been forthcoming as the result of recent and hitherto unpublished work.

Many moths have lost the scales which are characteristic of the order of insects to which they belong, so that their wings become transparent, and they mimic stinging insects such as wasps or hornets. This is the case with two British hawk-moths (*Hemaris fuciformis* and *bombyliformis*). It is known that when these moths emerge from the chrysalis, the transparent parts of their wings are thinly covered with scales which are shaken off during the first flight. The loss of the scales has now been shown to be due to the rudimentary nature of the stalk at the base of the scale and of the socket in which the stalk is inserted; a closely-allied Indian moth (*Hemaris hylas*) was still more completely denuded of scales, but in it also the rudimentary sockets were found to be thinly scattered over the transparent part of the wing. These facts suggested that all moths with transparent wings may be found to repeat, in the course of their own individual lives, the history of the change by which the transparency has been attained by the species. Investigation has supported this suggestion. The examination of two British moths which resemble hornets or wasps was especially instructive. In one of these (*Sesia apiformis*) the mimicry is not so perfect as in the other, and is therefore presumably of more recent date; in this moth the rudimentary scales which fall off are comparatively perfect, while in the other species (*S. bembeciformis*) they are far more degenerate, inasmuch as they have been useless to the species for a far longer period of time. It is interesting to note that these degenerate scales have not been reduced in size in either species, but are, on the contrary, much larger than the scales which are retained for the whole life of the moth. In the allied "clearwings" of the genus *Trochilium*, the transparency of the fore wing has been attained by the transparency of scales which are retained as well as by the loss of scales.

(2) *Pseudepisematic Colours.* This division not only includes the examples of aggressive mimicry in which an animal resembles another, and so is enabled to approach and injure it in some way, but also the cases of alluring colouring in which an animal possesses a lure which is attractive to its prey.

Examples of the former are seen in the flies of the genus *Volucella*, which are enabled to lay their eggs in the nests of humble-bees, &c., because of their close resemblance to the latter. The larvæ of the fly feed upon those of the bee.

Examples of alluring colouring. An Asiatic lizard (*Phrynocephalus mystaceus*) possesses pink flower-like structures at the corners of its mouth, it is probable that flies, &c., are thus allured. A terrapin (*Macroclemmys Temminckii*) from the Southern States of America, when hungry, opens its mouth and moves about two filaments at the anterior end of its tongue. These look like worms moving in a crevice in the rocks, and attract prey. The animal is otherwise perfectly motionless, and resembles a weed-covered rock. The fish *Lophius piscatorius* (the angler or fishing-frog) attracts its prey by a brightly coloured lure placed over its large mouth, the rest of the body being concealed. Certain deep-sea fishes allied to *Lophius* (*Ceratias bispinosus*, *C. uranoscopus*, &c.) have a phosphorescent lure which attracts the other fish on which they feed.

(3) *Pseudallosematic Colours.* A very striking instance was discovered by Mr. W. L. Sclater in tropical South America. The well-defended and abundant leaf-carrying ants (*Œcodoma*) are mimicked by an immature Homopterous insect possessing a shape and colour which closely resemble the ant together with the piece of leaf it is carrying.

IV. *Epigamic colours* are the bright tints and patterns displayed during courtship. As in other classes of colours the same effects may be produced by the use of foreign objects (*Allepigamic*). Examples are found in the various beautiful or curious objects collected by bower-birds for the decoration of their bowers. Especially interesting in this respect is the *Amblyornis inornata* of New Guinea.

Mutual relationship of the above-mentioned classes of colours. It is clear that I. (*Cryptic*) and III. (*Pseudosematic*) colours are closely related; they may be conveniently grouped under one head:—*Apatetic* or deceitful colours. The following scheme will be found to represent the mutual relationships:—

I. *Apatetic Colours.* (Resembling the environment, or some other species, or acting as a lure.)		II. *Sematic Colours.* (Warning and Signalling.)	III. *Epigamic Colours.* (Displayed in Courtship.)
A. *Cryptic Colours.* (Protective and Aggressive Resemblances.)	B. *Pseudosematic Colours.* (False Warning and Signalling Colours.)		
(1) *Procryptic Colours.* (Protective Resemblances.)	(1) *Pseudaposematic Colours.* (Protective Mimicry.)	(1) *Aposematic Colours.* (Warning Colours.)	
(2) *Anticryptic Colours.* (Aggressive Resemblances.)	(2) *Pseudepisematic Colours.* (Aggressive Mimicry and Alluring Colouring.)	(2) *Episematic Colours.* (Recognition Markings.)	
Allocryptic Colours. (Concealment gained by use of foreign objects.)	*Pseudallosematic Colours.* (Resemblance to some foreign object associated with mimicked species.)	*Allosematic Colours.* (Warning Colours of another Animal made use of.)	*Allepigamic Colours.* (Display of foreign objects in Courtship.)

The comparatively new terms employed in the lecture were due to the kind help of Mr. Arthur Sidgwick. The beautifully painted lantern slides were due to the great skill and patience of the artist, Mr. H. M. J. Underhill. The examples of *Allocryptic* and many of those of *Cryptic* and of *Allosematic* colours were painted from the living animals in the Marine Biological Laboratory at Plymouth. Colonel Swinhoe had very kindly suggested good examples of mimicry among Indian butterflies, and had lent from his beautiful collection the specimens for copying. Mr. H. Grose-Smith had kindly lent the African examples. Rev. F. J. Smith had most kindly helped in photographing the examples selected. Mr. W. R. Morfill had kindly translated Portchinski's Russian paper, thus rendering possible the use of some very interesting examples.

FORTHCOMING SCIENTIFIC BOOKS.

MESSRS. LONGMANS AND CO. announce the following:—"The Principles of Chemistry," by D. Mendeléeff, translated by George Kamensky, of the Imperial Mint, St. Petersburg, and edited by A. J. Greenaway; "Text-Book of Chemical Physiology," by Dr. W. D. Halliburton; "Human Physiology," being the substance of lectures delivered at the St. Mary's Hospital Medical School from 1885 to 1890, by Dr. Augustus D. Waller; "Elements of Materia Medica and Therapeutics," by C. E. Armand Semple, illustrated; "Notes on Building Construction," arranged to meet the requirements of the Syllabus of the Science and Art Department of the Committee of Council on Education, South Kensington—Part IV. "Calculations for Structures," illustrated; "Preliminary Survey, including Elementary Astronomy, Route Surveying, Tacheometry, Curve-ranging, Graphic Mensuration, Estimates, Hydrography, and Instruments," by Theodore Graham Gribble, illustrated; "Optical Projection: a Treatise on the Use of the Lantern in Exhibition and Scientific Demonstration," by Lewis Wright.

Among the scientific works promised by Messrs. Macmillan and Co. are the following:—Dr. Lauder Brunton's Croonian Lectures, "On the Connexion between Chemical Constitution and Physiological Action, being an Introduction to Modern Therapeutics"; "A Manual of Public Health," by A. Wynter Blyth; "Dictionary of Political Economy," edited by R. H. Inglis Palgrave, F.R S.; "The Scope and Method of Political Economy," by I. N. Keynes, second edition; "Outlines of Psychology," by Dr. Harald Höffding, translated by M. G. Lowndes; "The Meteoritic Hypothesis," by J. Norman Lockyer, F.R.S., illustrated; "Electricity and Magnetism," a popular treatise, by Amédée Guillemin, translated and edited, with additions and notes, by Prof. S. P. Thompson, illustrated; "Popular Lectures and Addresses," by Sir William Thomson—Vol. III. "Papers on Navigation"; "Are the Effects of Use and Disuse Inherited?" by W. Platt Ball (Nature Series); new editions of Dr. Russel Wallace's "Contributions to the Theory of Natural Selection: and Tropical Nature and other Essays," and "The Malay Archipelago: the Land of the Orang Utan and the Bird of Paradise"; "The Myology of the Raven (*Corvus corax sinuatus*): a Guide to the Study of the Muscular System in Birds," by R. W. Shufeldt, illustrated; "Text-book of Comparative Anatomy," by Dr. Arnold Lang, translated by Henry M. Bernard and Matilda Bernard, with preface by Prof. Ernst Haeckel, two volumes, illustrated; "Lessons in Elementary Biology," by T. Jeffrey Parker, illustrated; "A Text-book of Physiology," by Prof. Michael Foster—Part III. "The Central Nervous System and its Instruments"; a new edition of "The Chemistry of the Hydrocarbons and their Derivatives, or Organic Chemistry," Vol. III. Part III., by Sir H. E. Roscoe and Prof. C. Schorlemmer; "The History of Chemistry," by Prof. Ernst von Meyer, translated by George McGowan; "Elements of Physics for Public Schools," by C. Fessenden; "Sound, Light, and Heat: an Elementary Text-book," by D. E. Jones, illustrated; "Elementary Applied Mechanics," by James H. Cotterill and J. H. Slade; a new edition of Todhunter's "Plane Trigonometry," revised by R. W. Hogg; "The Geometry of Position," by R. H. Graham, C.E., illustrated; "Manual of Logarithms," by G. F. Matthews; a new edition of "Class-book of Geology," by Archibald Geikie, F.R.S.; two volumes of "Macmillan's Geographical Series," edited by Archibald Geikie—"A Geography of Europe," by James Sime, and "Maps and Map Drawing," by William A. Elderton; and a "Physical and Political School Atlas," by J. G. Bartholomew.

The Clarendon Press announce "Mathematical Papers of the late Henry J. S. Smith, Savilian Professor of Geometry in the University of Oxford," with portrait and memoir, in two volumes; "A Treatise on Electricity and Magnetism," by J. Clerk Maxwell, new edition; "An Introduction to the Mathematics of Electricity," by W. T. A. Emtage; "A Manual of Crystallography," by M. H. N. Story-Maskelyne; "Translations of Foreign Biological Memoirs"—III. "Contributions to the History of the Physiology of the Nervous System," by Prof. Conrad Eckhard, translated by Miss Edith Prance, and a translation of Prof. Van't Hoff's "Dix Années dans l'Histoire d'une Théorie," by J. E. Marsh; and Count H. von Solms-Laubach's "Introduction to Fossil Botany," translated by the Rev. H. E. F. Garnsey, and edited by I. Bayley Balfour, F.R.S.

The Pitt Press announce "The Collected Mathematical Papers of Arthur Cayley, F.R.S.," Vol. III.; "Mathematical and Physical Papers," by Sir W. Thomson, Vol. III.; "A Treatise on Plane Trigonometry," by E. W. Hobson; "A Treatise on Analytical Statics," by E. J. Routh, F.R.S.; "A Treatise on Statics and Dynamics for Schools," by S. L. Loney; and two volumes of the "Pitt Press Mathematical Series"—"The Elements of Geometry after Euclid, Books III. and IV.," edited by H. M. Taylor, and "Elementary Algebra, with Answers to the Examples," edited by W. W. Rouse Ball.

Messrs. Smith, Elder, and Co. have in preparation a new work by Prof. Ferrier, being "The Croonian Lectures on Cerebral Localization," delivered before the Royal College of Physicians, June 1890.

Messrs. Sampson Low, Marston, and Co. announce "The Structure of Fibres, Yarns, and Fabrics: a Practical Treatise for the Use of all Persons employed in the Manufacture of Textile Fabrics," by E. A. Posselt, illustrated; and "Directory of Technical Literature: a Classified Catalogue of all Books, Annuals, and Journals published in England, America, France, and Germany, including their Relations to Legislation, Hygiene, and Daily Life," by Fritz von Szczepanski.

Messrs. Bell and Sons announce a revised edition of Deighton's "Euclid," Books I. and II., and Books I. to III.; "The Elements of Trigonometry," by J. M. Dyer and the Rev. R. H. Whitcombe, assistant masters of Eton College; "Solutions to the Problems in Dr. Besant's Elementary Hydrostatics"; a Key to "Examination Papers in Trigonometry," by G. H. Ward; "Colour in Woven Design," by Roberts Beaumont; and "Structural Mechanics," by R. M. Parkinson.

Messrs. Philip and Son will issue "Commercial Geography," a series of lectures by J. Scott Keltie, Librarian of the Royal Geographical Society, with numerous coloured maps and diagrams; "Across East African Glaciers, being an Account of the First Ascent of Mount Kilima Njaro," by Dr. Hans Meyer; "The Development of Africa," by A. Silva White, Secretary of the Scottish Geographical Society, illustrated with a set of 14 maps, specially designed by E. G. Ravenstein; "Magellan and the Pacific," by Dr. F. H. H. Guillemard, illustrated, forming Vol. IV. of the "World's Great Explorers and Explorations"; "Home Life on an Ostrich Farm," by Mrs. Annie Martin, illustrated; "The Unknown Horn of Africa, an Exploration from Berbera to the Leopard River," by the late F. L. James, illustrated, new and cheap edition, containing the narrative portion and notes only.

Mr. Fisher Unwin will publish a book on "Gypsy Sorcery and Fortune Telling," by Charles Godfrey Leland, illustrated; a second edition of Mrs. Brightwen's "Wild Nature Won by Kindness," with additional matter; and "Everyday Miracles," by Bedford Pollard, a work designed to present the wonders of science to young readers.

"Methuen's Science Series," edited by Mr. R. Elliot Steel, will include, among other volumes, "The World of Science," "Elementary Light and Sound," "Elementary Electricity and Magnetism," and "Elementary Heat."

Messrs. Charles Griffin and Co. will issue Dr. A. E. Garrod's "Treatise on Rheumatism and Rheumatoid Arthritis"; Dr. A. E. Sansom's "The Diagnosis of Diseases of the Heart"; "Foods and Dietaries: a Manual of Clinical Dietetics," by Dr. R. W. Burnet; "Railway Injuries: with Special Reference to those of the Back and Nervous System," by H. W. Page; "Outlines of Practical Histology," by Prof. W. Stirling, and a second and rewritten edition of "Outlines of Practical Physiology," by the same author; a laboratory course on "Pharmacy and Materia Medica," by W. Elborne; "Scientific Amusements," a variety of experiments illustrating some of the chief physical and chemical properties of surrounding objects, and the effect upon them of light and heat, by Dr. C. R. Alder Wright, F.R.S.; Prof. Roberts-Austen's "Introduction to the Study of Metallurgy"; Dr. C. Le Neve Foster's "A Text-book of Ore and Stone-Mining"; "A Text-book of Coal-Mining," by H. W. Hughes; "Aids in Practical Geology, with a Section on Palæontology," by G. A. J. Cole; "A Text-book of Electro-Metallurgy," by W. G. Macmillan; "The Design of Structures: a Practical Treatise on the Building of Bridges, Roofs, &c.," by S. Anglin; "A Zoological Pocket-book; or, Synopsis of Animal Classification," by Dr. Selenka and J. R. A. Davis; the complete volume of Prof. Jamieson's elementary manual of "Magnetism and Electricity"; a thoroughly revised edition of "Seaton's Manual of Marine

Engineering"; "Sewage Disposal Works: the Construction of Works for the Prevention of Pollution of Rivers and Estuaries," by W. Santo Crimp; and the eighth annual issue of the "Year-Book of Learned and Scientific Societies."

Messrs. Cassell promise "Hygiene and Public Health," by Dr. Arthur Whitelegge; "Medical Hand-Book for Colonists," by E. Alfred Barton; new editions of "Climate and Health Resorts," by Dr. Burney Yeo, and "The Story of the Heavens," by Sir R. S. Ball; "The Art of Cooking by Gas," by Marie Jenny Sugg, illustrated; "Nature's Wonder-Workers: being some Short Life-Histories in the Insect World," by Kate R. Lovell; "Object Lessons from Nature: a First Book of Science," by L. C. Miall; "Commercial Botany of the Nineteenth Century," by J. R. Jackson; two new volumes of "Cassell's Agriculture Series," edited by John Wrightson—"Soils and Manures," by Dr. J. Munro, and "Crops," by Prof. Wrightson; and "The Year-Book of Treatment for 1891: a Critical Review for Practitioners of Medicine and Surgery."

Messrs. Whittaker will publish a new and revised edition of Mr. Gisbert Kapp's "Electric Transmission of Energy"; "Electro-Motors," by S. R. Bottone: "Metal Turning," by the author of "Practical Ironfounding"; a fourth and popular edition of Colonel Findlay's "The Working and Management of an English Railway"; and "A Manual of Wood-Carving," by Charles G. Leland.

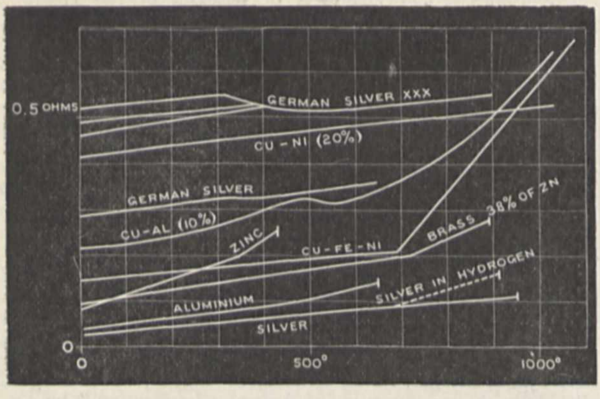
A work on "Animal Life and Intelligence," by Prof. C. Lloyd Morgan, Dean of University College, Bristol, is in the press, and will be published by Mr. Edward Arnold in October.

Mr. Stanford will publish "The Philosophical Basis of Evolution," by Dr. James Croll, and "Through Magic Glasses" by Arabella B. Buckley (Mrs. Fisher). This will be a sequel to the same author's "Fairyland of Science."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 22.—M. Duchartre in the chair.—Account of a scientific expedition to the summit of Mont Blanc, by M. J. Janssen. (See Our Astronomical Column.)—On the modular equation for the transformation of the eleventh order, by Prof. A. Cayley.—On some curious phenomena produced in a current of water, by M. Daniel Colladon. The author presented two photographs taken at Geneva above a river bridge having a grating stretched across its arches. By moving certain of the bars, miniature water-spouts and other phenomena are produced. These forms are conspicuously visible and have been photographed in plan and elevation. The paper contains some observations of their average dimensions.—M. Berthelot announced the death of M. F. Casorati, Professor at the University of Pavia.—Observations of the new minor planet (297) made with the equatorial *coudé* of Algiers Observatory, by M. F. Sy. The observations extend from September 11 to 13.—On the electrical resistance of metals, by M. H. Le Chatelier. The accompanying figure expresses the results obtained with various metals and alloys:—



On the excretory apparatus of some crustacean decapods, by M. Paul Marchal.—Comparative influence of anæsthetics on chlorophyllian assimilation and transpiration, by M. Henry Jumelle. The researches of the author seem to show that anæsthetics increase the transpiration of plants exposed to the light, when sufficient is given to suspend assimilation. This increase of transpiration is evidently due to the action of the ether on the chlorophyll which is exposed to the light, because, from experiments made in the dark, it has been found that the ether acts in an opposite manner on the protoplasm.

SYDNEY.

Royal Society of New South Wales, June 4.—Dr. Leibius, President, in the chair.—The following papers were read:—A compressed air-flying machine, by L. Hargrave.—On the treatment of slips on the Illawarra Railway at Stanwell Park, by W. Shellshear.—On native names of some of the runs, &c., in the Lachlan district, by F. B. W. Woolrych.—Remarks on a new plant rich in tannin, by C. Moore.—The following exhibits were shown and described: two new filmy ferns, by C. Moore; the Narraburra meteor found in 1854—specific gravity 7·57, weight 70 lbs. 14 oz., by H. C. Russell, F.R.S. (of which an account was given in NATURE of Sept. 25, p. 526).

July 2.—Dr. Leibius, President, in the chair.—Record of hitherto undescribed plants from Arnheim's land, by Baron Ferd. von Mueller, F.R.S.—A new mode of demonstrating the manner in which the mind judges of objects in the outer world, also working models demonstrating the value of the spinal curve in diminishing the evil effects of mechanical violence, by Prof. Anderson Stuart.—Charles, third Earl Stanhope's arithmetical machine, bearing date 1780, also his "demonstrator," an instrument for the performance of logical operations, by Rev. Robert Harley, F.R.S.

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