THURSDAY, MAY 10, 1888.

FORMS OF ANIMAL LIFE.

Forms of Animal Life. A Manual of Comparative Anatomy, with Descriptions of Selected Types. By the late George Rolleston, D.M., F.R.S., Linacre Professor of Anatomy and Physiology in the University of Oxford. Second Edition, Revised and Enlarged by W. Hatchett Jackson, M.A., Natural Science Lecturer, St. John's College, Oxford. (Oxford: Clarendon Press, 1888.)

THE first edition of Prof. Rolleston's "Forms of Animal Life" was published in 1870. Avowedly an educational work, and written expressly for students, it came at a time when the teaching of zoology was in a very different position from that which it now holds, and opportunities for systematic laboratory instruction were rare.

At Oxford there already existed an admirably equipped Museum, in the arrangement of which the wants of students received special attention; facilities for laboratory work were also offered, and among the Linacre Professor's pupils were men destined to become the leaders of the younger school of English zoologists. Elsewhere, however, the conditions were less favourable. The Cambridge school of biology, which has made for itself so great and honourable a reputation, as yet had no existence. Indeed, it was not till the year of publication of Prof. Rolleston's volume that the Trinity Prælector in Physiology entered on the duties of his new office; and it was in October of the same year that the late Prof. Balfour commenced his brilliant University career.

In other centres the state of things was very similar. Zoology was taught almost exclusively by lectures, often indeed of great value, but supplemented at most by demonstrations. Individual students worked hard at dissections or in museums, but organized laboratory instruction, in direct connection with systematic lectures, existed on a very small scale, if at all.

There was, however, a firm conviction on the part of those most directly and intimately concerned, that a great change was necessary; and a determination to carry out this reform at the earliest possible opportunity. In 1872, Prof. Huxley entered into possession of the new Biological Laboratories at South Kensington, and at once inaugurated a system of combined lecture and laboratory instruction which has formed the model on which all subsequent courses have been framed. Three years later he published, in conjunction with Prof. Martin, the "Course of Elementary Instruction in Practical Biology," and from that time the teaching of biology by lectures only became impossible.

This same year, 1875, witnessed the commencement of Prof. Balfour's systematic courses of practical morphology at Cambridge, and the introduction, by its newly elected Professor of Zoology, of the reformed system into one of the most eminent of the London medical schools. The change spread rapidly throughout the country, and the adoption of the new methods of teaching, pushed to its logical conclusion, led to the establishment of numerous appointments, and to the building and equipment of the splendid Laboratories at Cambridge, Manchester, and elsewhere.

It would not be wise to attempt to estimate too accurately to what extent Prof. Rolleston's book was instrumental in bringing about this reform, by which the whole scope and method of biological teaching were altered. It must be noted, however, that the time of its appearance was most opportune, and that the two leading principles of the book, in which it differed most markedly and most deliberately from all other works of the time, were precisely the characteristic features of the new school. These are, in the first place, the insistence on accurate and practical examination of selected types before a student is allowed to proceed to the systematic study of the groups to which the types belong; and, secondly, the importance of direct reference to the original sources of information. On the first of these points, Prof. Rolleston says, in his preface:—

"The distinctive character of the book consists in its attempting so to combine the concrete facts of zootomy with the outlines of systematic classification as to enable the student to put them for himself into their natural relations of foundation and superstructure. The foundation may be made wider, and the superstructure may have its outlines not only filled up, but even considerably altered, by subsequent and more extensive labours; but the mutual relations of the one as foundation and of the other as superstructure, which this book particularly aims at illustrating, must always remain the same."

On the importance of direct reference to the original authorities he speaks very positively:—

"In some cases, even the beginner will find it necessary to consult some of the many works referred to in the descriptions of the preparations and in the descriptions of the plates; but the bibliographical references have been added with a view rather to the wants indicated in the words 'Für akademische Vorlesungen und zum Selbststudium,' so often prefixed to German works on science, than to those of the commencing student."

"Forms of Animal Life" was the first student's text-book in which these principles were distinctly formulated and deliberately adopted; and there can be no doubt that it played a most important part in stimulating and enforcing a direct study and accurate acquaintance with type forms as a necessary prelude to systematic zoological work: just as the admirable series of preparations by Mr. Robertson, the description of which forms so characteristic and important a feature of the book, have furnished a model from which other museums have copied freely and to their great advantage.

Prof. Rolleston took great interest in his book: during the later years of his life he was actively engaged in preparing the second edition; and very early in this work he asked Mr. Jackson to act with him as joint author. Some progress was made in this joint work, but it was soon interrupted by the illness which, in the winter of 1880, compelled Prof. Rolleston to go abroad, and which proved fatal only a few months later.

"When Prof. Rolleston went abroad," says Mr. Jackson, "he put me in possession of his plans for the rest of the work, handed his papers to me, and expressed a hope that, if he were disabled from completing the new edition, I might be the person to do it in his stead. It is almost needless for me to add that in fulfilling this sacred trust

I have endeavoured to carry out his wishes, which were mainly three: (1) to enlarge the descriptions of the preparations and accounts of the various classes of animals, and to bring them to the standard of contemporary knowledge; (2) to add to each class or group a brief classification; and (3) to give as full a bibliography as space would admit."

The new edition which is now before us has been most carefully revised throughout; very considerable additions have been made, especially in the systematic portion, which has been entirely re-written by Mr. Jackson; and the volume is more than double the size of its predecessor—extending to upwards of 900 pages.

The book, as before, consists of three main sections: the descriptions of the selected preparations; the descriptions of plates illustrating the salient features in the anatomy of certain of these types; and, thirdly, the systematic accounts of the several groups into which the animal kingdom is divided. The arrangement of these sections has been altered; for while in the former edition the descriptions of the preparations and plates were placed after the systematic part, the relative positions have in the new edition been reversed. The present arrangement is a more natural one, and the change, which was contemplated by Prof. Rolleston, is certainly an improvement.

The selected preparations, the description of which forms the first section of the book, are for the most part the same as those of the former edition. The skeleton and certain parts of the muscular system of the rabbit, and the alimentary canal, urinary, and generative organs of the same animal, have been added; the privet hawk moth has been substituted for the death's head; and the skeleton of the pigeon and a few invertebrate preparations have been omitted. Though the number of the preparations remains practically the same as before, this portion of the book has been increased by nearly a hundred pages; the expansion being due mainly to the insertion of much fuller accounts of allied forms, and partly to a large addition in the bibliography.

It would be an easy matter to take exception to the plan of this part of the book, and to urge that the space devoted to the description of particular specimens, which the majority of readers can never have a chance of seeing, might have been allotted, with far greater advantage to students, to thorough descriptions of the anatomy of typical animals selected as representatives of the several groups. Accounts such as these are much wanted, and the opportunity for providing them was an exceptionally favourable one. The criticism, however, loses all point as directed against this second edition, for Mr. Jackson, regarding his task as a trust, has rightly refrained from interfering with the scheme of arrangement of this, perhaps the most characteristic section of the book.

He has, however, subjected the whole to very careful revision. The descriptions are admirably clear and concise, and the additional paragraphs have given Mr. Jackson opportunity for introducing references to allied forms which are always important, and in many cases of very high value indeed.

The second part of the book, containing the plates with their descriptions, is less satisfactory. Of the twelve plates of the first edition ten have been retained without change, one has been slightly altered, and one cancelled. Three new plates, which had been prepared and completed under Prof. Rolleston's own direction, have been added, illustrating points in the anatomy of the skate, of the oyster, and of certain Arthropoda respectively. We sincerely wish these plates had been omitted. They form no essential part of the book; the subjects are not well chosen; and the drawings themselves are not always correct. The figure of the reproductive organs of the earthworm, for instance, is very misleading; and the nephridia, as shown in the same figure, are entirely wrong. The new plates show no improvement on the old ones: the figure of the oyster is not of sufficient importance to justify its insertion, while the plate supposed to illustrate the anatomy of the skate is one of the very worst we have ever seen. We cannot but feel the highest respect for the conscientious and self-effacing spirit in which Mr. Jackson has carried out a most laborious and delicate task; but we believe most sincerely that he would have done more honour to the memory of his chief by suppressing most if not all of these plates, which are in every way unworthy of the book and of its authors. From the fact that this part of the book has alone undergone compression, we suspect that Mr. Jackson, who has no responsibility in connection with the plates save that of retaining them, agrees with us as to their merits.

About a dozen woodcuts have been inserted in the descriptions of the preparations: these are well chosen and will prove useful, though the absence of descriptions in two or three cases is somewhat exasperating. At the present time accurate and original figures illustrating the anatomy of typical animals are so urgently needed that we cannot but regret that the resources of the Clarendon Press were not drawn on more largely in this respect.

The third and concluding portion of the book contains the systematic descriptions of the groups; and here the changes are very great indeed. Occupying less than two hundred pages in the former edition, it has now increased to six hundred. This part of the book is by far the most important, and is exceedingly well done. Short descriptions of the larger groups are followed by most accurate and comprehensive accounts of the several classes. The further subdivision of the classes into orders and other minor groups is given in all cases; and the most recent researches are referred to, without being given undue prominence.

For this part of the work Mr. Jackson is entirely responsible, and we congratulate him very heartily on the admirable manner in which he has effected it. We have indeed but one complaint to make—namely, that, as in the former edition, the groups are described in descending order, Vertebrates being taken first, and Protozoa last. This is a serious fault, giving the effect of an uncomfortable drop as we pass from group to group, and, furthermore, rendering discussion of the mutual relations of the several groups very difficult, and in many cases futile or impossible.

Apart from this, we have nothing but praise to offer. Limits of space will not allow that we should deal at length with the several classes, but a few points may be noted.

The Enteropneusta are left among the "Worms"; their vertebrate affinities are mentioned, though Mr.

Jackson does not appear to favour their claims to rank among the higher group. The vexed question of the homologies of the Arthropod appendages is treated fully. The antennules of Crustacea are doubtfully classed as true appendages, while the Crustacean antennæ, with the chelicerae of Arachnida are regarded as post-oral appendages which have become pre-oral by shifting forwards. The antennæ of Myriapods and Insects are ruled out, "as being apparently processes of the procephalic lobes;" while the suggestion that the telson represents a region rather than a somite will meet with very general approval.

Brauer's classification of Insects is adopted, with some slight modifications, and is given in considerable detail. The leeches are treated with caution as an isolated group, and no suggestion is made of their possible affinities with Turbellaria.

Among the lower groups the Cœlenterata are dealt with very thoroughly. The possibility of near kinship between the Acraspedote Medusæ and the Anthozoa that has found favour of late with Götte and others is mentioned, but rejected. The Protozoa also receive very liberal and thorough treatment, more than a hundred pages being devoted to them. As regards classification three main divisions are adopted: the Acinetaria, Ciliata and Mastigophora are classed together as Plegepoda, a group equivalent to the Stomatophorous Corticata of Lankester, and for which the old term Infusoria might conveniently be used. The remaining divisions are the Endoparasita or Sporozoa, and the Rhizopoda, the latter group being equivalent to Lankester's Gymnomyxa.

Mr. Jackson is a singularly modest writer, and seldom allows his own hand to be seen; a note on the blood-vessels of the earthworm, in which he questions the existence of the so-called subintestinal vessel, is of considerable interest; and throughout the volume there is abundant evidence of intimate practical acquaintance with the groups he describes so well.

The importance, even for the junior student, of direct reference to original papers was, as we have noticed above, one of the points on which Prof. Rolleston insisted most strongly. In this respect Mr. Jackson has afforded assistance of a singularly efficient character. Possessed of a most unusually accurate and extensive acquaintance with the zoological literature of all countries, Mr. Jackson has given the full benefit of his knowledge to readers of his book. Every page teems with evidence of the most diligent research amongst authorities, and none but a specialist in each group can estimate rightly the enormous amount of labour that its preparation must have cost him. Only less admirable is the restraint which has enabled him to refrain from burdening the book with an undue number of references, while those that are given have been selected with the utmost care, and arranged in such way as to afford the student aid of a kind hitherto denied him. "The method I have adopted," says Mr. Jackson, "is to cite the most important and recent authorities, which, when consulted, will in most cases give the names of all other accounts worth reading, so as to form a really very complete index to the state of present knowledge." It is this "index" which constitutes the characteristic feature of the new edition; and in the care and thoroughness with which he has compiled it, Mr. Jackson has conferred an inestimable boon on zoologists, and has rendered his work indispensable to teachers and students alike.

The earlier edition of "Forms of Animal Life" was marked by a certain singularity, at times almost grotesqueness, of diction, which interfered to some extent with the popularity of the book; we are glad to observe that care has been taken to remove this blemish, though an occasional tendency to reversion may be noticed in such statements as that "the anterior prostate is divaricable into two lobes," or that a given figure is "one-half less than natural size."

It would be better, too, if zoologists could completely emancipate themselves from the traditions of human anatomy, and cease to speak of the anterior part of a rabbit as the "upper half," or to use such terms as "vena cava descendens." "Uro-genital," too, which threatens to establish itself permanently, should not be used for urino-genital; and the term "pseud-hæmal" is objectionable, and, as applied to the vascular system of an earthworm, meaningless.

However, these are but small points; and in concluding we acknowledge in the fullest degree the singularly painstaking and conscientious manner in which Mr. Jackson has fulfilled his task, and the signal service he has thereby rendered to zoologists. "Forms of Animal Life" is a unique book; none but Prof. Rolleston could have written it; and probably there is no one who could have retained and developed more successfully than Mr. Jackson has done the exactness and thoroughness to which Prof. Huxley long ago alluded as its special charm.

A. M. M.

THE CARDINAL NUMBERS.

The Cardinal Numbers, with an Introductory Chapter on Numbers Generally. By Manley Hopkins. London: Sampson Low, 1887.)

UNLIKE Hudibras, who could, as we are told, "extract numbers out of matter," Mr. Hopkins proposes in the essay before us to extract matter from numbers, or, as he says in the preface, "to show that every-day things—numbers being one of them—possess in themselves materials worth investigation, and connections with other subjects of thought and study." Our author does not attempt any systematic investigation of the properties of numbers: to do so would far transcend the modest limits to which he confines himself. He prefers to consider numbers in their relation to such subjects as religion, music, poetry, mythology, and superstition. Some purely numerical facts are, however, given, which either are, or else ought to be, found in every text-book of arithmetic—for instance, the rules (given on p. 75, at the beginning of the appendix) for determining when a number is divisible by any of the first twelve numbers, 7 only excepted. The cardinal numbers from 1 to 10 inclusive are treated separately in ten distinct chapters. These, with the introductory chapter and an appendix, the principal portion of which is taken up with magic squares, form the whole of the work.

The nature of our author's remarks will be best seen by making a few quotations. Thus in the chapter on Number One, after speaking of the unity of the Godhead and the oneness of self, he goes on to say:—

"Geography and natural history abound in words which express the separateness of an object, its isolation, its *one-liness*. Similar to the number 1, and to the pronoun I, there are found in different languages and dialects referring to local separation, the words *i*, *hi*, *ey*, *eye*, *egg* (and here think of the Latin *ego* and the Greek ἐγὼ), *eyot*, *ait*, *inch*, *innis*, *île*, *isle*, *inver*, *insula*, *isola*, *isla*; and connote some of these with the animal *eye* and *egg*, having a similar separation as an island in geography. All the latter have the same meaning, and express a portion of land segregated, cut off from other land and surrounded by water—oneness."

With the above we may compare Shakespeare's use of the word *eye* in the passage—"The ground, indeed, is tawny. With an eye of green in 't" ("Tempest," Act II., sc. 1).

Respecting the celebrated *twos* in profane myth and history, we read in the next chapter:—

"Prominent among these are Romulus and Remus; Brutus and Cassius; and in Irish legend Eber and Airem; concerning whom we are informed that Eber was slain by his brother Airem. He was the hero of the Ivernians, the ancient non-Celtic inhabitants of Ireland. Airem was the ancestor of the Celts who conquered the country."

The Hibbert Lecture, May 1886, is referred to in a foot-note as the source from which this Irish version of the story of Romulus and Remus was taken. It is new to us, and will probably be so to most of our readers.

In the chapter on Number Three we are told the origin of the heraldic *fleur de lys*:—

"It was the device of *three* fishes tied together with a ribbon, which formed the *fleur de luce—luce* being the name of the fish; but which was afterwards transfigured into the more elegant emblem of the *fleur de lys*, the flower of the iris, taking the place of the fish, its *three* petals still presenting a trine."

It will be remembered that Justice Shallow, in the opening scene of the "Merry Wives of Windsor," speaking of "the dozen white luces" in his coat, remarks that "the luce is the fresh fish."

To the noble army of circle-squarers we leave the task of refuting the following argument; merely remarking that it may with equal facility be used to disprove the quadrature of the parabola, which has been believed in by all orthodox mathematicians since the time of Archimedes:—

"In a quadrangle, the space may be divided into the minutest squares, leaving no space undivided; but in a circle, every square applied to its periphery will always leave an angular space; and however far the process of smaller angles may be carried, an ultimate undivided space will remain."

Apparently our author is not quite satisfied with this; for in the next paragraph (on p. 47) he proves, in another manner, that the circle cannot be squared. In both proofs, for the words "a circle" we may substitute "any curve, including the parabola," without thereby affecting the argument.

We have never heard of Montrecla, to whom we are referred for an account of attempts to square the circle; but possibly Montucla is meant, who in 1754 published a "History of Researches relating to the Quadrature of the Circle," a second edition of which (by Lacroix) appeared in 1831. This conjecture is strengthened by the fact that our author's list of the principal calculators of π ends with Vega (born in 1754 and murdered in 1802), who obtained its value to 140 decimal places, making no mention of Rutherford and Shanks, who in more recent times pushed on the calculation to 500 and 707 places respectively.

From Chapter VII., which treats of a variety of subjects, including among them "the number of the beast" and the fine distinction between *six* and *half-a-dozen*, we select for comment the following sentence:—

"Six, also, is the least number of the *points of fixature*; so that a body cannot under all circumstances be immovable unless secured (or resisted) at six points."

Having only common-sense to guide us, and being unable to divine what train of reasoning could have led the author to the above conclusion, we should imagine that whenever any two points, A, B, of a body are fixed every other point in the straight line AB is also fixed, so that the body can only rotate round the line AB. Consequently if any third point (not in the straight line AB) is also fixed the body is immovable. Do the words "under all circumstances" imply that the body is immovable even when all *six* of our author's "points of fixature" are in the same straight line? If not, we are at a loss to know what they mean.

The appendix contains among other things a method of filling up magic squares which is said to have been communicated by a Russian mathematician to Prof. Sylvester and by him to a friend of the author. As some portions of the Russian Empire are not very far distant geographically from the land of the Chaldæans, this tradition may have had its origin among the magicians, astrologers, Chaldæans, and soothsayers of the Court of Nebuchadnezzar, to whom magic squares were doubtless well known. We hope Mr. Hopkins will be able to trace it to its source, even though it would take some time to do so, and the appearance of a second edition of "The Cardinal Numbers" might thereby be delayed. The public need not be impatient, for they can in the meantime allay their curiosity concerning the properties of magic squares by a perusal of the "Mathematical Recreations" of Ozanam and a host of more modern writers.

OUR BOOK SHELF.

The Romance of Mathematics. Being the Original Researches of a Lady Professor of Girtham College in Polemical Science, with some Account of the Social Properties of a Conic; Equations to Brain-Waves; Social Forces; and the Laws of Political Motion. By P. Hampson, M.A., Oriel College, Oxford. (London: Elliot Stock, 1886.)

OUR first acquaintance with the title, which we have copied in full, was limited to its four opening words. These suggested various ways in which the subject might be treated; we had no idea that the task before us was to examine and report upon a somewhat mild *jeu d'esprit*.

The editor, who poses as a Cambridge student and quondam pupil of the Girtham Professor, and subsequently as her husband, discovers, in a well-worn desk, certain lectures, essays, and other matter. In his introduction he says it is not his intention to disclose how he came into possession of the papers; in the closing pages he is caught in his work of reading and transcribing, and "at length we gained our point, and obtained the full sanction of the late Lady Professor of Girtham College to publish her papers." "Thus her obedient pupil is enabled to repay his late instructress for all her kindness to him," and also to remove from the mind of the reader the unpleasant feeling he has all along had whilst perusing the papers, that he was a party to a mean action in so doing.

The earliest essay, in an unfinished form, written whilst *in statu pupillari*, is entitled "Some Remarks of a Girtham girl on Female Education," and combats those "male sycophants" who "would prevent us from competing with you; you would separate yourselves on your island of knowledge, and sink the punt which would bear us over to your privileged shore. Of all the twaddle—forgive me, male sycophants!—that the world has ever heard, I think the greatest is that which you have talked about female education."

The second paper is a "Lecture on the Theory of Brain-Waves, and the Transmigration and Potentiality of Mental Forces." She takes the usual equation

$$y = \frac{a}{r} \sin \frac{2\pi}{\lambda} (vt - r),$$

and determines λ by the method of mesmerism. "We find the ratio of brain to brain—the relative strength which one bears to another; and then, by an application of our formula, we can actually determine the wave of thought, and read the minds of our fellow-creatures. An unbounded field for reflection and speculation is here suggested. Like all great discoveries, the elements of the problem have unconsciously been utilized by many who are unable to account for their method of procedure. . . . The development of this theory of brain-waves may be of great practical utility to the world. It shows that great care ought to be exercised in the domain of thought, as well as that of speech." Some verses follow, and then we have Papers iii. and iv., which are, in our opinion, the best part of the book, viz. a "Lecture on the Social Properties of a Conic Section," and the "Theory of Polemical Mathematics." Paper v. contains a "Lecture upon Social Forces, with some Account of Polemical Kinematics," and Paper vi. carries on the preceding into "Polemical Statics and Dynamics"; Paper vii. expounds the "Laws of Political Motion," and Paper viii. closes the book with a lecture "On the Principle of Polemical Cohesion." We ought to apologize for going into such detail, but our account will show our readers that the present work does not deal with mathematical discoveries. It is a "skit," with the perusal of which a reader acquainted with mathematics may while away, not unpleasantly, an odd half-hour or two.

Antipodean Notes. By "Wanderer." (London: Sampson Low, 1888.)

Lights and Shadows of Melbourne Life. By John Freeman. (Same publishers.)

The "notes" in the first of these two books do not embody the results of a very wide experience. They simply record some observations made by the author in the course of a nine months' tour round the world. "Wanderer" does not, however, pretend to offer an exhaustive account of any of the subjects on which he touches. He has an easy, pleasant style, and gives with some vividness his first impressions of the scenes he describes. The greater part of the book relates to New Zealand, the practical, commercial, and social aspects of which he had, he thinks, more and better opportunities of studying than are obtainable by the majority of "globe-trotters." There is a short but interesting chapter on the Maoris, of whose qualities, as they have been affected by contact with civilization, "Wanderer" has no very exalted opinion. He admits, however, that there are exceptions to what he calls "the average of uselessness." One of the native members of the House of Representatives is, he says, "highly educated, intelligent, and even eloquent." The question whether women should be admitted to the House was lately discussed, and the speech of this deputy on the subject was "by far the most brilliant and entertaining of a debate in which many colonial legislators soared above the ordinary level of dull mediocrity."

The second book consists of a series of papers, some of which were originally contributed to Melbourne newspapers. They are written in rather too "smart" a style, but contain much information which it would be hard for Englishmen who may be interested in Melbourne to find elsewhere. The book will no doubt be welcomed by many visitors who will go this year to Melbourne to see the Centennial International Exhibition.

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 Salt Industry in the United States.

I can sympathize to a great extent with your correspondent George P. Merrill on the question of salt statistics. For a number of years I have been accumulating information on the whole subject of salt, and have found the greatest difficulty in obtaining much of a trustworthy character. The most extensive salt literature is in Germany: even there the statistical part of the subject is not dealt with so extensively as the geological, geographical, chemical, and manufacturing. Perhaps the most complete salt literature is that of India, which is issued yearly by the Government; but it deals almost exclusively with Indian salt.

I am not much surprised that the information in our Encyclopædias respecting the salt industry of the United States should be so scanty. Most of the information derivable respecting it has to be obtained from public newspapers, trade pamphlets, or papers in scientific journals. It is true that, so far as the deposit of Petit Anse, in Louisiana, is concerned, the United States Government published an account of it shortly after the termination of the great war. Dr. Sterry Hunt, whom I had the pleasure of meeting at Manchester at the British Association, has written probably more than anyone else on American salts; but it must be borne in mind that it is only within the last twenty years that the great salt discoveries in Western New York and Michigan have been made. I have a complete or nearly complete list of all the Michigan works, which was issued in the *Chicago Tribune* of January 24, 1888. I have also before me a copy of the *Saginaw Courier* of December 18, 1887. This gives some valuable tables respecting the Michigan salt. In Michigan, in 1887, 3,944,309 barrels of salt were inspected by the salt inspector. In 1869, only 561,288 barrels were made; and in 1880, 2,676,588. There was more salt made in Michigan in 1887 than had been made previously to 1869 in that State. The growth of the salt manufacture has been exceedingly rapid in the States; hence the reason why so little is known of it outside the persons interested in the trade.

Within the last five or six years there has grown up a most extensive salt manufacture in the Wyoming Valley in Western New York. Already this new district bids fair to cut out entirely the old Syracuse or Onondaga district. The make of American salt has much more than doubled itself in the last ten years. I am sure that personally I shall be much pleased if Mr. Merrill will, either through your columns or direct to me, give any information more accurate than is obtainable from our Encyclopædias. I am striving to establish at Northwich, the centre of the Cheshire salt trade, a Salt Museum, and although I have been for a long time accumulating specimens of salt from all parts, and have, thanks to the East Indian Government, and through the kind exertions of Mr. J. T. Brunner, M.P., our Parliamentary representative, who is most handsomely furnishing the Museum, a complete set of specimens of Indian salt, yet I find great difficulty in obtaining works treating on salt, also maps, plans, and diagrams. I trust, by degrees, to have a Museum perfectly unique, I believe.

When I say that until the last two or three years our English salt statistics have not been trustworthy, and that it is only by the indefatigable exertions of Mr. Joseph Dickinson, H.M. Inspector of Mines, assisted by myself and one or two other gentlemen connected with our salt trade, that they are now very nearly complete, Mr. Merrill must not be surprised at the difficulty of getting trustworthy information. For some seventeen years I have kept a complete list of all salt exports from the Mersey ports, and this list, I think, is the only complete one published, though the Salt Chamber of Commerce here professes to have a list, which it does not issue for public use. Indeed, I regret to say that it is almost impossible to get any assistance or information from this body.

The French Government issues at times a list of salt manufactured or raised from mines. The last I received, viz. 1879, gave, as the production for that year, 283,000 tons of sea salt and 293,000 tons of rock salt.

I shall be glad to give any information I possess to Mr. Merrill, and should be glad if any of your readers could give any information or assistance that would enable me to make as complete as possible the Salt Museum we are here forming.

Northwich, Cheshire. THOMAS WARD.

Prof. Rosenbusch's Work on Petrology.

PROF. BONNEY'S letter (NATURE, vol. xxxvii. p. 556) makes me venture once more to ask permission for space for a few remarks. One of the objects I had in view in writing to you at first is partly attained by the appearance of Prof. Bonney's "friendly protest"; and his remark that but for my letter he should have refrained "for a season" leads me to hope that in due course this object may be still further realized.

Prof. Bonney sees great objections to Rosenbusch's system of classification, and demurs to some of his groups altogether, both as to those admitted and those omitted. Naturally, then, he desires that this system shall not, by students of petrology, be too readily accepted nor too blindly followed. I do not think there is much danger of this, nor do I think that the "viaduct" was too much complimented either by Dr. Hatch or myself, the defective foundation of the piers in question being quite sufficiently alluded to for the time being.

The position, however, seems to be this. The number of earnest students of petrology is larger now than formerly, and is on the increase. They feel that no satisfactory system of classification had yet been offered to them, and indeed are rather bewildered by the fact that opinions as to what is the best system have been almost as many in number as the teachers who could by any means claim to be authorities entitled to instruct in this matter. Also, it is now a long time since any detailed system of classification, covering the whole ground, has been attempted.

Now we have such an attempt offered to us by Rosenbusch, and there is no doubt that to many it will be very welcome and will be largely used, in spite of the defects undoubtedly seen in it.

Prof. Bonney objects to the viaduct because of the weakness of some of its piers, and still more strongly objects to it, I think, because he considers that when a student has crossed it he will arrive at a point from which he will obtain a view of the surrounding country which will not be a good or correct view, and which will in some respects confuse the knowledge of that country already obtained and still to be sought for.

Would not this be just exactly the best time for some authority of great experience to come forward and point out to us younger workers wherein the viaduct is defective, and wherein we shall see wrongly from the ground on the further side of it; and to tell us his opinions as to a better viaduct, so placed as to lead us to a better point of outlook?

May we hope that Prof. Bonney will himself give us such a detailed criticism of the subject? It would be received with great attention and gratitude by many who, like myself, are looking for "light and leading" in this branch of study.

A. B.

History of the Contraction Theory of Mountain Formation.

IN his "Physical Geology," second edition, p. 674, Prof. Green says: "The notion that the earth's contraction has been the cause of the displacement of the rocks and the elevations of the surface seems to have occurred first to Descartes (éd. française, 1668, p. 322)."

It does not seem to be generally known that, a few years later, the same idea occurred to Newton. In a letter to Dr. Thomas Burnet he refers to that writer's "Sacred Theory of the Earth," the Latin edition of which was published in 1681, and considers the creation of the earth in connection with the Mosaic account. After suggesting illustrations of the "generation of hills," Newton concludes thus: "I forbear to describe other causes of mountains, as the breaking out of vapours from below before the earth was well hardened,—*the settling and shrinking of the whole globe after the upper regions or surface began to be hard;*" though he adds, "I have not set down anything I have well considered, or will undertake to defend."

The letter, which is written in reply to one of Burnet's, dated January 13, 1680–81, is given in full in Brewster's "Memoirs of Sir Isaac Newton," vol. ii. Appendix 4. The manuscript from which it is printed is a copy of the letter, without date or signature; but, according to Brewster, "the whole is distinctly written in Sir Isaac's hand." CHARLES DAVISON.

Birmingham, April 23.

Lightning and Milk.

EMIN PASHA (NATURE, vol. xxxvii. p. 583) mentions the African superstition "that fire kindled by a flash of lightning cannot be extinguished until a small quantity of milk has been poured over it." This idea is embodied in a Russian proverb, and has also existed in parts of Germany (Boyes, *Lacon*, p. 157). Emin Pasha adds that, in tempering swords made from meteoric iron (*vulgo*, thunderbolts), the blacksmith uses not water, but milk. Are other instances of this custom known? Has any explanation been offered? Indian folk-lore furnishes two ideas which may illustrate it: one, that the fall of a meteor is a bad omen (*Indian Notes and Queries*, July 1887, 674); the other, that evil spirits are very fond of fresh milk (*ib.*, December 1886, 198). Meteorites and lightning are connected in the minds of ignorant people, particularly, as Emin Pasha tells us, in the present instance. The milk, therefore, whether applied by smith or fire-man, may be rather intended as a propitiation than used for its intrinsic power of tempering steel or extinguishing flame. F. A. BATHER.

20 Campden Hill Road, Kensington, W., April 29.

The Duplex Pendulum Seismograph.

As the accuracy of the duplex pendulum seismograph has been impugned by a writer in NATURE, vol. xxxvii. p. 571, who at the same time adopts the instrument (with modifications which are, in my opinion, the reverse of improvements) I forward to you comparison diagrams. They show side by side the record given by the seismograph itself, and the real motion of the base of the instrument when that was artificially shaken in a manner that closely imitated an earthquake. The real motion was recorded by means of a multiplying lever hinged by a universal joint in a bracket fixed to a separate support. In both records the motion is magnified about six times. The agreement of the two demonstrates the accuracy of the instrument as an earthquake recorder, alike for large and for small motions. These are examples of tests which I have been in the habit of applying to seismographs since 1880 (see Proc. R. S., vol. xxxi. p. 440). In the present case the test was made with one of the duplex pendulum seismographs made and sold by the Cambridge Scientific Instrument Company, and described by me in NATURE, vol. xxxiv. p. 343. J. A. EWING.

University College, Dundee, April 20.

Self-Induction.

I HAVE to apologize for erroneously attributing to Dr. Lodge a suggestion with reference to the self-induction of wires for high-tension electric discharges. I do not, however, consider, as Prof. Lodge appears to do, that for such discharges it is "on the face of it absurd" to suppose that the self-induction of iron wires is less than that of copper wires of the same dimensions. Prof. Ewing has suggested that for very small values of the magnetizing force, H, iron may possibly behave as a diamagnetic body, and the corresponding values of the magnetic susceptibility, k, may be negative. The values of the magnetic induction, B, which are given by the equation—

$$B = (1 + 4\pi k)H,$$

will be less than H, because k is negative. The rate of increase of B with H will be less than unity for iron if this supposition is true, and will be equal to unity for copper, for which we may suppose that the value of k is negligible. The coefficient of self-induction, which will be proportional to the rate of increase of B with regard to H for wires of the same dimensions will accordingly be less for the iron than for the copper.

City and Guilds Institute, May 2. W. E. SUMPNER.

SUGGESTIONS ON THE CLASSIFICATION OF THE VARIOUS SPECIES OF HEAVENLY BODIES.[1]

IV.

IV.—ON THE SPECTRA OF STARS OF GROUP II.

IN the previous part of this memoir I have attempted to give a general idea of that grouping of celestial bodies which in my opinion best accords with our present knowledge, and which has been based upon the assumed meteoric origin of all of them.

I now proceed to test the hypothesis further by showing how it bears the strain put upon it when, in addition to general grouping, it is used to show us how specific differences are arrived at.

I. General Discussion of Dunér's Observations.

In the paper communicated to the Royal Society on November 17 I pointed out that the so-called "stars"

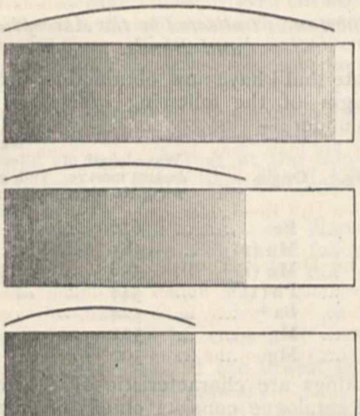


Fig. 6.—Diagram showing how an absorption fluting varies in width according to the quantity of absorbing substance present.

of Class III.*a* were not masses of vapour like our sun, but swarms of meteorites; the spectrum being a compound one, due to the radiation of vapour in the interspaces and to the absorption of the light of the red- or white-hot meteorites by vapours volatilized out of them by the heat produced by collisions.

I also showed that the radiation was that of carbon vapour, and that some of the absorption was produced by the chief flutings of Mn and Zn.

Dunér in his map gives eleven absorption bands, chiefly flutings, in Class III *a*, but in the case of the tenth and eleventh bands there is some discrepancy between his map and the text, to which reference will be made subsequently. His measurements are of the darker portions of the flutings, speaking generally.

[1] The Bakerian Lecture, delivered at the Royal Society on April 12, by J. Norman Lockyer, F.R.S. Continued from p. 11.

It will be clear at once that in the case of the *dark* flutings the dark bands should agree with the true *absorption* of the vapours, and that when the amount of absorption varies, only that wave-length away from the maximum of the flutings will vary. Thus, the same fluting may be represented as in Fig. 6, according to the quantity of the absorbing substance present.

In the case of the *bright* flutings, however, the dark bands on either side may *in some cases* be produced partly by contrast only, and the brighter and wider the bright flutings are the more they will appear to vary, and in two ways: first, they will dim by contrast when the bright fluting is dimmer than ordinary; and secondly, the one on the side towards which the bright fluting expands from its most decided edge will diminish as the bright fluting expands (see Fig. 7).

There is also another important matter to be borne in mind. As these spectra are in the main produced by the integration of the continuous spectra of the meteorites, the bright flutings of carbon, and the dark flutings produced by the absorption of the continuous spectra by the

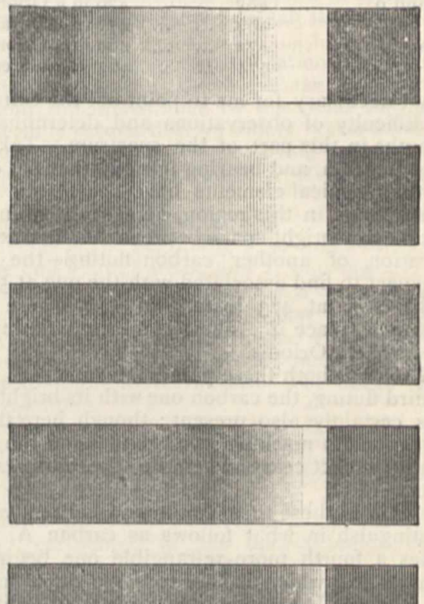


Fig. 7.—Diagram showing the variation in width of a bright fluting, and the consequent variation in width of the contrast band at the fainter edge.

vapour surrounding each meteorite; the proportion of bright fluting area to dark fluting area will vary with the reduction of the spacing between the meteorites.

If any bright or dark flutings occur in the same region of the spectra when the spaces are greatest, the radiation effect will be stronger, and the absorption fluting will be "masked;" where they are least the radiation itself will be masked. This reasoning not only applies to flutings but to lines also.

The Radiation Flutings.

We will first deal with the radiation flutings—those of carbon. The brightest less refrangible edge of the chief one is at wave-length 517, where it sharply cuts off the tail end of the absorption of the magnesium fluting the darkest edge of which begins at 520, as the carbon light from the interspace pales the absorption. The same thing happens at the more refrangible edge of the other absorption of Mg at 500, as Dunér's figures show.

	Less refrangible edge.	More refrangible sharp edge.
Band 8 (absorption of Mg)	502	496 in α Herculis.
	501	496 in ρ Persei.
	503	496 in R Leonis Min.
	505	496 in β Pegasi.

If this explanation of the rigidity of the less refrangible edge may be accepted, it is suggested that the rigidity of the end of band 8 at 496, near the nebula line 495, seems to indicate that we may have that line as the bright, less refrangible, boundary of another radiation fluting.

The fluting at 517 is the chief radiation fluting of carbon. The next more refrangible one, which would be most easily seen, as the continuous spectrum would be less bright in the blue, has its less refrangible and brightest edge at 474.

This in all probability has been seen by Dunér, though, as before stated, there is here a discrepancy between his maps and his text. It lies between his dark bands 9 and 10, the measurements of which are as follow:—

	Less refrangible edge.	More refrangible edge.
Band 9	482	476 in α Orionis.
	484	477 in β Pegasi.
Band 10	472	460 in α Orionis.
	474	462 in α Herculis.

It is not necessary for me to point out the extreme and special difficulty of observations and determinations of wave-lengths in this part of the spectrum. Taking this into consideration, and bearing in mind that my observations of the chemical elements have shown me no other bands or flutings in this region, I feel justified in looking upon the narrow bright space between bands 9 and 10 as an indication of another carbon fluting—the one we should expect to find associated with the one at 517, with its bright edge at 473 instead of 476, where Dunér's measurements place it. There is a bright fluting in this position in Nova Orionis.

I shall refer to both these points later on.

The third fluting, the carbon one with its brightest edge at 564, is certainly also present; though here the proof depends upon its masking effect, and upon the manner in which this effect ceases when the other flutings narrow and become faint.

In addition to these three flutings of carbon, which we shall distinguish in what follows as carbon A, there is sometimes a fourth more refrangible one beginning at wave-length 461, which is due to some other molecular form of carbon. It extends from wave-length 461 to 451, and, as we shall presently see, it is this which gives rise to the apparent absorption band No. 10 in the blue; this we shall distinguish as carbon B.

It is very probable also that in some cases there is, in addition to carbon A and carbon B, the hydrocarbon fluting which begins at wave-length 431, the evidence of this being Dunér's apparent absorption band 11. It may be remarked here, that although most of the luminosity of this fluting is on the more refrangible side of 431, there is also a considerable amount on the less refrangible side.

With regard to bands 9, 10, and 11, then, there is little doubt that they are merely dark spaces between the bright blue flutings of carbon, and that whether they are seen or not depends upon the relative brightnesses of the carbon flutings and the continuous spectrum from the incandescent meteorites. When the continuous spectrum is faint, it will not extend far into the blue, and the resulting dark space between the bright carbon A fluting at 474 and the end of the continuous spectrum is the origin of the apparent absorption band 9. When the continuous spectrum gets very bright, band 9 should, and does, disappear. On reference to the maps of the spectra of the "stars" with bright lines, it will be seen that the broad apparent absorption band in the blue agrees exactly in position with band 9, and it undoubtedly has the same origin in both cases. This band may therefore be regarded as the connecting link between the bodies belonging to Group I. and those belonging to the group under consideration.

Band 10 is the dark space between the bright carbon A fluting at 474 and the carbon B at 461, and can only exist as long as the carbon flutings are brighter than the continuous spectrum. Dunér's mean values for the band are 461–473, and on comparing these with the wave-lengths of the carbon flutings (see Fig. 10, which will be given in the next instalment) it will be seen that the coincidence is almost perfect.

There is a little uncertainty about band 11, which Dunér was only able to measure in one star, but it very probably has its origin in the dark space between the bright carbon B fluting and the hydrocarbon fluting at 431 (see Fig. 10). This would give a band somewhat broader and more refrangible than that shown in Dunér's map; but, as already pointed out, great accuracy in this part of the spectrum cannot be expected.

Chemical Substances indicated by the Absorption Flutings and Bands.

I may state that I have now obtained evidence to show that the origin of the following *absorption* flutings is probably as under:—

No. of Fluting.	Origin.	Wave-length of darkest most refrangible edge.	Wave-length of less refrangible end, given by Dunér as measured in α Orionis.
2	Fe	616	628
3	Mn (2) ...	585	595
4	Mn (1) [1] ...	558	564
5	Pb (1) [2] ...	544	550
6	Ba [3]	524	526
7	Mg	521	517
8	Mg	500	495

These flutings are characteristic of the whole class, and Dunér's catalogue consists chiefly of a statement of their presence or absence, or their varying intensities, in the different stars.

He gives other bands and wide lines which he has measured specially in α Orionis. I have also discovered the origin of the majority of these. They are as follows:—

			Wave-length.
	I.	Fluting of Cr (1)	581
	II.	?	570–577
	III.	Fluting of Pb (2)	567
	IV.	?	543
	V.	Line of Mn seen in bunsen ...	538–540
	VI.	Band of Ba	532–534
Lines	1.	Fluting of Cr (2)...	559 [4]
	2.	,, ,, (3)...	536
	3.	Line of Cr seen in bunsen	520
	4.	Ba band	514 [5]
	5.	1st, 2nd, and 3rd Ba flutings ...	601
	6.		634
	7.		649

Band 1, which extends from wave-length 649·5 to 663·8, has not yet been allocated.

Tests at our Disposal.

In order to prove that my explanation of the nature of these celestial bodies is sufficient, a discussion of the individual observations of them, seeing that differences in

[1] Means strongest fluting.

[2] The second Pb band has been seen in α Scorpii and α Orionis. Owing to an error in the map in the former paper, this fluting was ascribed to zinc.

[3] This is the second brightest band, wave-length 525. The first, at wave-length 515, is masked by the radiation fluting at 516.

[4] This is not given by Dunér. It would be masked by the Mn fluting in the star. I have inserted it to show that we could not be dealing with the 3rd fluting of Cr at 536 if we could not explain the apparent absence of the 2nd.

[5] In the early stages this band is masked by the vivid light coming from the carbon in the interspaces.

the spectra are known to exist, should show that all the differences can be accounted for in the main by differences in the amount of interspace; that is to say, by a difference between the relative areas of space and meteorite in a section of the swarm at right angles to the line of sight. I say in the main, because subsequent inquiry may indicate that we should expect to find minor differences brought about by the beginnings of condensation in large as opposed to small swarms, and also by the actual or apparent magnitudes of the swarms varying their brilliancy, thus enabling a more minute study to be made of the same stage of heat in one swarm than in another.

How minor differences may arise will be at once seen when we consider the conditions of observation.

The apparent point of light generally seen is on my view produced not by a mass of vapour of more or less regular outline and structure, but by a swarm of meteorites perhaps with more than one point of condensation.

An equal amount of light received from the body may be produced by any stage, or number of nuclei, of condensation; and with any differences of area between the more luminous centre and the outliers of the swarm.

All these conditions producing light of very different qualities are integrated in the image on the slit of the spectroscope.

I have said "generally seen," because it has been long known that many of the objects I am now discussing are variable, as well as red, and that at the minimum they are not always seen as sharp points of light[1] but have been described as hazy.

The severe nature of the tests at our disposal will be recognized when we inquire what must follow from the variation of the spacing. Thus, as the spacing is reduced—

I. The temperature must increase.

- *α*. Vapours produced at the lowest temperatures will be the first to appear.
- *β*. The spectrum of each substance must vary with the quantity of vapour produced as the temperature increases, and the new absorptions produced must be the same *and must follow in the same order* as those observed in laboratory experiments.

II. The carbon spectrum must first get more intense and then diminish afterwards as the spaces, now smaller, are occupied by vapours of other substances.

- *α*. The longest spectrum will be that produced by mean spacing.
- *β*. The masking of the dark bands by the bright ones must vary, and must be reduced as the mean spacing is reduced.

III. The continuous spectrum of the meteorites must increase.

- *α*. There will be a gradually-increasing dimming of the absorption-bands from this cause.
- *β*. This dimming will be entirely independent of the width of the band.

IV. The spectrum must gradually get richer in absorption-bands.

- *α*. Those produced at the lowest temperatures will be relatively widest first.
- *β*. Those produced at the highest temperatures will be relatively widest last.
- *γ*. They must all finally thin.

These necessary conditions, then, having to be fulfilled, I now proceed to discuss M. Dunér's individual observations. I shall show subsequently that there are, in all probability, other bodies besides those he has observed which really belong to this group.

[1] Hind first noticed this in 1851. Quoted by Arago, "Astronomie Populaire."

II. Discussion of Dunér's Individual Observations.

Consideration of the Extreme Conditions of Spacing.

Cœteris paribus, when the interspaces are largest we should have a *preponderance* of the radiation of carbon, so far as quantity goes. The bands will be wide and pale, the complete radiation will not yet be developed; a minimum of metallic absorption phenomena—that is, only the flutings of magnesium (8 and 7), the first fluting of manganese (3), and the first fluting of iron (2); but the great width of the bright band at 517 will mask band 8.

When the interspaces are least, the radiation of carbon should give place to the absorption phenomena due to the presence of those metallic vapours produced at the highest temperature at which a swarm can exist as such; the bright flutings of carbon should be diminished, and the true absorption flutings of Mg, Fe, Mn, Pb, and the band of Ba, should be enhanced in intensity.

There will be an *inversion* between the radiation and absorption.

The highest intensity of the absorption phenomena will be indicated by the strengthening of the bands 2, 3, 4, 5, and 6; and the appearance of the other flutings and bands specially recorded in *α* Orionis. The bands 7 and 8 will disappear as they are special to a low temperature, and will give way to the absorption of manganese, iron, *b*, &c.

This inversion, to deal with it in its broadest aspect should give us at the beginning 7 strong, and 2, 3 weak, and at the end 7 and 8 weak, and 2, 3 strong.

The first stage, representing almost a cometic condition of the swarm before condensation has begun, has been observed in Nos. 3,[1] 23, 24, 25, 36, 68, 72, 81, 118, 247, 249. There is a very large number of similar instances to be found in the observations. The above are only given as examples.

The *last* stage, before all the bands fade away entirely, has been observed in Nos. 1, 2, 26, 32, 33, 38, 40, 61, 64, 69, 71, 75, 77, 82, 96, 101, 116. As before, these are only given as instances.

It is natural that these extreme points along the line of evolution represented in the bodies under consideration should form, as I think they do, the two most contrasted distinctions recorded by Dunér—that is, recorded in the greatest number of cases.

Origin of the Discontinuous Spectrum.

I have already shown that when the meteorites are wide apart, though not at their widest, and there is no very marked condensation, the spectrum will extend farther into the blue, and therefore the flutings in the blue will be quite bright; in fact, under this condition the chief light in this part of the spectrum, almost indeed the only light, will come from the bright carbon. Under this same condition the temperature of the meteorites will not be very high, there will therefore be little continuous spectrum to be absorbed in the red and yellow. Hence we shall have discontinuity from one end of the spectrum to the other. This has also been recorded, and in fact it is the condition which gives us almost the most beautiful examples of the class (196, *α* Herculis, 141, 172, 229).

The *defect* of continuous light *in the blue* in this class, after condensation has commenced and the carbon flutings are beginning to disappear, arises from defect of radiation of the meteorites, and hence in all fully-developed swarms the spectrum is not seen far into the blue for the reason that the vapours round each meteorite are at a tempera-

[1] The references are to the numbers of the stars in Dunér's catalogue.

ture such that fluting absorption mainly takes place, although of course there must be some continuous absorption in the blue. This is perhaps the most highly-developed normal spectrum-giving condition; 44, 45, 55, 60, 65, 86, 92, 278 are examples.

The Paling of the Flutings.

Subsequently, the spectra are in all cases far from being discontinuous, and the flutings, instead of being black, are pale. Thus, while the bands are dark in the stars we have named, they are not so dark in *α* Orionis. Here, in short, we have a great distinction between this star and *α* Herculis, *ο* Ceti, R Lyræ, and *ρ* Persei.

Obviously this arises from the fact that the average distances between the meteorites have been reduced; their temperature being thereby increased as more collisions are possible, the vapours are nearly as brilliant as the meteorites, and radiation from the interspaces cloaks the evidences of absorption. Nor is this all: as the meteorites are nearer together, the area producing the bright flutings of the carbon is relatively reduced, and the bands 10 and 9 will fade for lack of contrast, while 8 and 7 will fade owing to the increased temperature of the system generally carrying the magnesium absorption into the line stage; *b* is now predominant (see 102, 157, 163, 114, 125, 135).

Under these conditions the *outer* absorbing metallic atmosphere round each meteorite will in all probability consist of Mn and Fe vapours, and in this position the masking effect will least apply to them. This is so (114, 116); they remain dark, while the others are pale.

Here we have the indication of one of the penultimate stages already referred to.

Phenomena of Condensation.

Dealing specially with the question of condensation,—I have already referred to possibly the first condition of all, recorded by Dunér in the observations now discussed—I may say that the first real and obvious approach to it perhaps is observed when all, or nearly all, except 9 and 10 of the flutings are *wide* and *dark*. The reasons will be obvious from what has been previously stated. Still more condensation will give all, or nearly all, the bands wide and pale, while the final stage of condensation of the swarm will be reached when all the bands fade and give place to lines. We have then reached Class II. (107, 139, 168, 264); 2 and 3 should be and are perhaps the last to go (203).

The Bands 9 and 10.

With regard specially to the bands 9 and 10, which include between them a bright space which I contend is the second fluting of carbon, I may add that if this view is sound, the absence of 10 should mean a broad carbon band, and this is the condition of non-condensation, though not the initial condition. The red flutings should therefore be well marked—whether broad or not does not matter; but they should be dark and not *pale*. Similarly the absence of band 9 means non-condensation.

Therefore 9 and 10 should vary together, and as a matter of fact we find that their complete absence from the spectrum, while the metallic absorption is strong, is a very common condition (1, 2, 6, 16, 26, 32, 39, 40, 46, 54, 60).

That this explanation is probably the true one is shown by further consideration of what should happen to the red flutings when 9 and 10 are present. As the strong red flutings indicate condensation, according to my view this condensation (see *ante*) should pale the other flutings. This happens (3, 8, 13, 28, 35, 45, 30; and last, not least, among the examples, I give 50, *α* Orionis).

III. Results of the Discussion.

The Line of Evolution.

I have gone over all the individual observations recorded by Dunér, and, dealing with them all to the best of my ability in the light afforded by the allocation of the bands to the various chemical substances, the history of the swarms he has observed seems to be as follows:—

(1) The swarm has arrived at the stage at which, owing to the gradual nearing of the meteorites, the hydrogen lines, which appeared at first in consequence of the great tenuity of the gases in the interspaces, give way to carbon. At first the fluting at 473 appears (as in many bright-line stars), and afterwards the one at 517. This is very nearly, but, as I shall show subsequently, not quite, the real beginning of Class III.*a*, and the radiation is now accompanied by the fluting absorption of Mg, Fe, and Mn—bands 7, 2, 3. This is the absorption produced at the temperature of the oxy-coal gas flame, while the stars above referred to give us the bright line of Mn seen at the temperature of the bunsen.

(2) The bright band of carbon at 517 narrows and unveils the Mg absorption at band 8. We have 8 now as well as 7 (both representing Mg), added to the bands 2 and 3, representing Fe and Mn, and these latter now intensify.

(3) The spacing gets smaller; the carbon, though reduced in relative quantity, gets more intense. The second band at 473 in the blue gets brighter as well as the one at 517. We have now bands 9 and 10 added. This reduced spacing increases the number of collisions, so that Pb and Ba are added to Mg, Fe, and Mn. We have the bands 2, 3, 4, 5, 6, 7, 8, 9, and 10. This is the condition which gives, so to speak, the normal spectrum

(4) This increased action will give us a bright atmosphere round each meteorite, only the light of the meteorite in the line of sight will be absorbed: we shall now have much continuous spectrum from the interspaces as well as the vapour of carbon. *The absorption flutings will pale*, and the Mg flutings will disappear on account of the higher temperature, while new ones will make their appearance.

(5) Greater nearness still will be followed by the further dimming of the bright carbon flutings including the one at 517. The blue end of the spectrum will shorten as the bands fade, narrow, and increase in number. If the star be bright, it will now put on the appearance of *α* Orionis; if dim, only the flutings of Fe and Mn(1), bands 2 and 3, will remain prominent.

(6) All the flutings and bands gradually thin, fade, and disappear. A star of the third group is the result.

In the latter higher-temperature stages we must expect hydrogen to be present, but it need not necessarily be visible, as the bright lines from the interspaces may cancel or mask the absorption in the line of sight of the light of the meteorites; but in case of any violent action, such as that produced by another swarm moving with great velocity, we must expect to see them bright, and they are shown bright in a magnificent photograph of *ο* Ceti, taken for the Draper Memorial, which I owe to the kindness of Prof. Pickering. I shall return to this question.

Stages antecedent to those recorded by Dunér.

So far I have referred to the swarms observed by Dunér. The result of the discussion has been to show that all the phenomena are included in the hypothesis that the final stages we have considered are antecedent to the formation of stars of Group III., bodies which give an almost exclusively line absorption, though these bodies are probably not yet stars, if we use the term star to express complete volatilization, similar to that observed in the case of our sun.

The question then arises, Are all the mixed fluting stages really included among the objects already considered?

It will be remembered that in my former communication I adduced evidence to the effect that the mixed fluting stage was preceded by others in which the swarms were still more dispersed, and at a lower temperature. The first condition gives us bright hydrogen; the last little continuous spectrum to be absorbed, so that the spectrum is one with more bright lines than indications of absorption; and, in fact, the chief difference between the spectra of these swarms and of those still sparser ones which we call nebulæ lies in the fact that there are a few more bright metallic lines or remnants of flutings; those of magnesium, in the one case, being replaced by others of manganese and iron.

If my view be correct—if there are stages preceding those recorded by Dunér in which we get both dark and bright flutings—it is among bodies with spectra very similar to these that they should be found.

The first stage exhibited in the objects observed by Dunér is marked by flutings 7, 3, and 2 (omitting the less refrangible one not yet allocated), representing the flutings Mg, Mn, and Fe visible at the lowest temperatures.

The stars which I look upon as representing a prior stage should have recorded in their spectra the flutings 7 and 3 (without 2), representing Mg and Mn.

(*To be continued.*)

THREE DAYS ON THE SUMMIT OF MONT BLANC.

ALPINE men are already beginning to think of the work of the coming season. We commend to their attention the following notes relating to the experiences of M. Richard, who spent three days during the past summer on the summit of Mont Blanc, with a view to making a series of continuous meteorological and other observations. There are many Alpine men who might, if they pleased, follow his example without much inconvenience to themselves and with considerable advantage to science. The following is a summary of the record which M. Richard has contributed to *La Nature*:—

The summit of Mont Blanc is a station of the utmost importance to meteorology, since it rises to a great height (4810 metres), and overtops the whole Alpine group. But it had not hitherto been considered possible to remain there for any length of time. De Saussure, whose statue is erected at Chamounix, passed some days in 1788, on the Géant hill, at the height of 3510 metres. In 1844 Martins, Bravais, and Le Pileur, pitched their tent at the Grand-Plateau, 4000 metres high, and here they passed several days, and made numerous and important observations. Hitherto no explorer had remained on the summit of the mountain itself for any length of time; tourists making but a very short stay—usually only a few minutes. From these facts we can see the importance of the scientific expedition carried out in the summer of 1887, with great success, by M. Joseph Vallot, one of the most daring and able members of the Alpine Club. Having made, in 1886, a series of physiological observations, during the ascent of some of the highest peaks of the Alps, he determined to establish on Mont Blanc three temporary meteorological observatories, the first at Chamounix, 1050 metres high, the second on the rocks of the Grands-Mulets, 3059 metres high, and the third on the summit of Mont Blanc. He constructed meteorological sheds, and furnished each of them with registering instruments constructed by MM. Richard Brothers—a barometer, a thermometer, and a hygrometer. The instruments placed at Chamounix and the Grands-Mulets were inspected every week, but those at the summit could not be reached for fifteen days, on account of bad weather. To superintend the lower stations he procured the assistance of M. Henri Vallot, a distinguished engineer, on whose competence and carefulness he could rely. At Chamounix, M. Joseph Vallot's plan was considered impracticable. He executed it, however, in company with M. F. M. Richard, one of the makers of the registers. No less than twenty-four guides were necessary, on account of

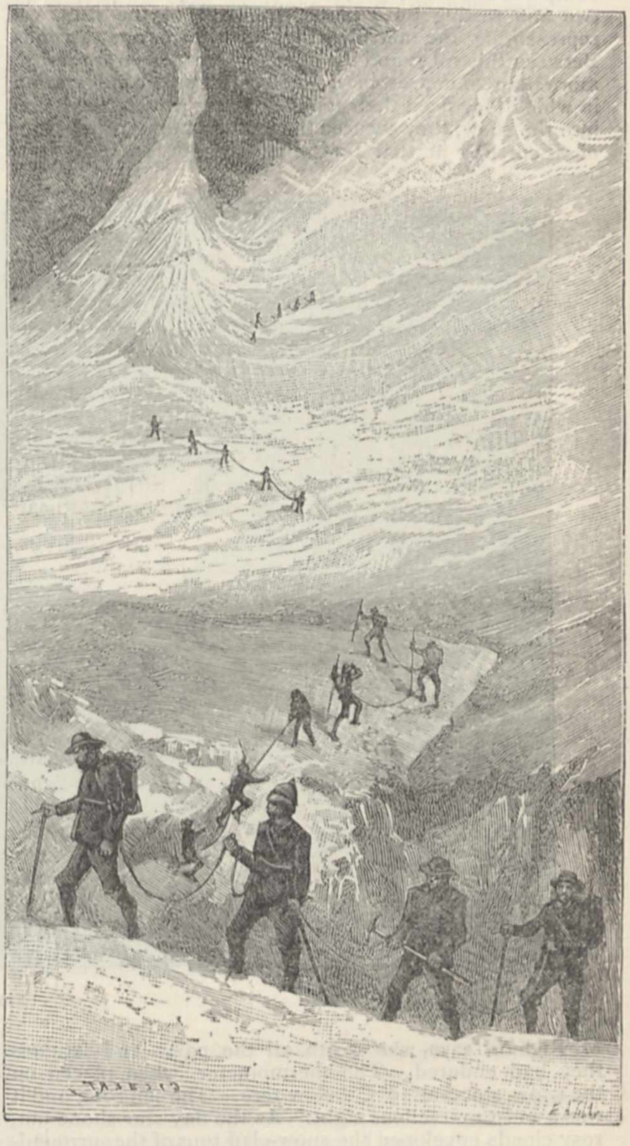


FIG. 1.

the great weight of the baggage (250 kilogrammes). At midday, July 27, 1887, they began the ascent to the Grands-Mulets. On account of the late start, the party, overtaken by night, arrived at the Grands-Mulets at 10 o'clock. Getting to bed at 11 o'clock, the travellers set out again the next morning at 3, after a light meal.

M. Richard then proceeds to tell the story of the journey and of the time spent on the top of Mont Blanc. The ascent from the Grands-Mulets is difficult, but not very dangerous when the snow is good. Crevasses have to be crossed by ladders, and very steep banks of snow must be struggled through. They arrived at the Grand-Plateau at 7 o'clock, and stopped there for refreshment and repose. At the Tournette rock, one of the bearers was forced to stop from fatigue, and to give his load to one of the more robust, and about 3 o'clock in the afternoon they arrived at the summit. All the guides but two deposited their burdens on the snow, and immediately took their departure. When ascending the last hill, MM. Vallot and Richard were attacked by mountain-sickness, and for some hours did not recover. M. Richard compares the shape of the mountain-top to a pear cut in two and resting on a plate, the stalk of the fruit well representing the narrow ridge by which one ascends. Between this ridge and the dome, which measures scarcely more than 20 metres in diameter, is a small indentation, in which they fixed their tent. Having driven the stakes into the snow, they secured the tent by a long rope. None of them had at that time the strength or courage to arrange the baggage. They were compelled to take shelter from the wind, and having refreshed themselves with a little soup, made with melted snow and preserved bouillon, they stretched themselves on the ground, with their heads on the boxes of instruments and the cooking-utensils.

Overcome by his efforts in erecting the tent, M. Richard fell asleep ; but during part of the night M. Vallot made gallant efforts to fix his instruments, but he was at length compelled by the snow to return. After some hours of sleep, the cold woke M. Richard, and, fearing the effects of the carbonic acid gas engendered by the breathing of four persons, with the consent of the others he allowed some air to enter, and, lighting a lantern, placed it on the ground, believing it would be extinguished before there would be any danger of suffocation. However, the wind which raged outside kept the tent well ventilated, and froze them to the marrow. About 4 o'clock they all went out of the tent and watched the sun rise—a sight which,

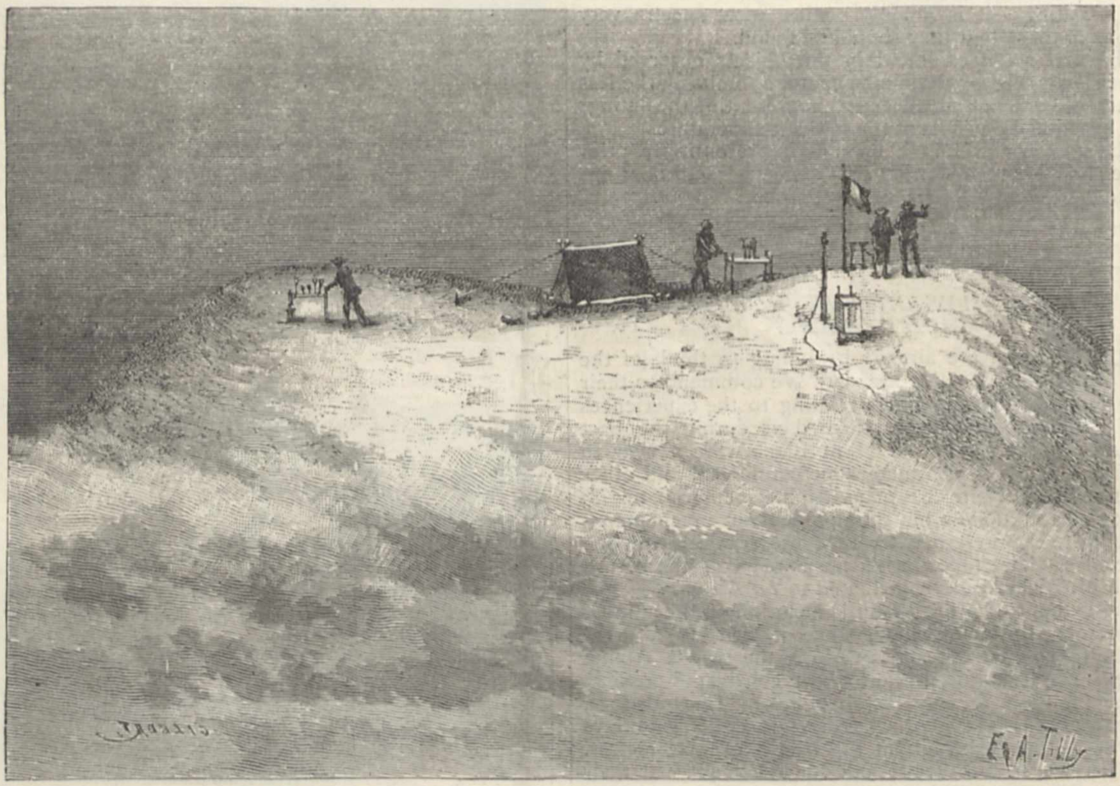


FIG. 2.

M. Richard says, was worth all the pains and fatigues they had endured. The thermometer, when placed on the snow, stood at 19° C. below zero. The sun rose, and it was a most marvellous sight. As the day-star shone out, rosy clouds enveloped the snow-clad tops of the surrounding mountains ; little by little, the shadows in which the rocky peaks emerging from the snow were clothed disappeared, leaving the peaks covered with the richest tints. The clouds below sometimes appeared like a rough sea, with its waves dashing against a rocky shore, and sometimes like a thick veil thrown over valleys by the night. Then these clouds dissolved into air under the influence of the sun's rays, seeming to disappear as if by magic, leaving no other trace of their existence than a light mist clinging to the sides of the mountains.

They now began to put their instruments into position. The large actinometer, made by M. Violle, was placed on a small table ; and the others—the actinometers of Arago and M. Violle, the thermometers, and the Fontin barometer—being fixed (Fig. 2), M. Vallot at once commenced his observations. Then they made their tent more comfortable with a floor of double-tarred cloth, and, above this, a mattress, hard, no doubt, but to them a very welcome addition. The tent was 4 metres square, and 1·50 metre high. The health of the party was not very good : M. Richard and one of the guides suffered from severe headaches, with feverish symptoms. The least effort, even ordinary movement, caused such fatigue that they were compelled to lie down during a great part of the day. They had a visitor the first day, in the person of Baron Munch, coming from Courmayeur, in Italy, into Chamounix, who was amazed to find sojourners on the top of Mont Blanc. The second night was not so trying as the first : they had pillows, which were softer than the pots and pans, and they thus had a most refreshing sleep. The tent was very picturesque. M. Vallot had brought for the party gutta-percha snow-boots, which they put on over fur-lined boots. Thanks to this precaution their feet were kept free from frost-bite. Their leather shoes were of no use; they had been dried in the sun and hung on a string stretched aloft across the tent. On this string at night were also hung the glasses which are always necessary to protect the eyes from ophthalmia in those regions. M. Vallot had also brought coverings for the ears and neck, and linen masks to preserve the skin of the face. Equipped in this manner the aspect of the travellers was curious and even terrifying (Fig. 4). The tent with the various articles hung up, with the boxes of provisions, the blazing stove, and the boiling soup, had a most picturesque appearance (Fig. 3).

The second day was spent in making observations. The provisions were almost neglected; they never had an appetite during their stay. The different preserved meats, though very tempting, did not entice their benumbed stomachs, and twice each day they took nothing but a little preserved bouillon, in which a small piece of cheese had been broken. Their drink was warm coffee; on the first day tea had made them ill, and they never could take it again during their three days' sojourn: the guides, however, drank a little of it.

On July 30, the observations began at sunrise. Towards 10 o'clock the little colony received a second visitor, an Englishman, who, on his departure, wished to take away with him some letters dated from the top of Mont Blanc. A yellow-beaked crow settled herself time after time near the observers. The guides declared that her presence was a sign of good weather; but it did not prove so. Towards 2 o'clock enormous clouds began to form on the side of Mont Pelvoux; then their colour changed; the gloom turned to darkness; and while the weather remained fine over Chamounix, the valley of Aosta and the Savoy Alps were soon hidden by a terrible thunderstorm. A furious wind drove the observers into the tent. It was 4 o'clock, and they had almost made up their

FIG. 4. FIG. 3.

minds to descend, but as there was not time to put all their instruments in safety, they decided to remain and weather the storm. They held the ropes of the tent, and piled snow all around it to keep it steady. Towards 9 o'clock, M. Vallot having gone out, found himself surrounded by electrical clouds, which played around his clothes and his head, but he escaped any actual shock. During the hours that they thus anxiously passed in the tent they were compelled to close the last opening to prevent the snow from getting in. But the time was not spent without profit. M. Vallot made some physiological diagrams. The beatings of the pulse, of the carotid, &c., were to have so much the more interest because they would differ from those which would be obtained when but a short stay is made, the travellers now having been two days at the summit. These observations made them forget their troubles. At last, about 2 o'clock in the morning, the tempest passed away, and, although the wind continued to blow violently, they got a refreshing sleep.

They decided on the following day, July 31, to continue their observations till 9 o'clock, then to bring everything into the tent, and to redescend to Chamounix. The guide Payot was suffering from a violent head-ache, with a high fever, and was compelled to keep his bed, but about 11 o'clock he bravely offered to descend at once, and even desired to carry his knapsack. M. Vallot had not given orders for help to be sent to take their baggage away; they therefore left the greater portion behind them in the tent; still there were many things that could not be left. These were divided into bundles, and, with a last glance at the magnificent view, they began the descent. The guide Michel had warned them that this would be very difficult, since last night's storm would have obliterated all traces of the usual paths. And so it was found to be. After the Grand-Plateau, the journey was most dangerous. At this height it had rained, and the snow had become so soft that they often sank to the waist in it. In the rapid slopes, where they were forced to descend zigzag, the snow slipped from under their feet, but, after much care and fatigue, they arrived at the Grands-Mulets. A good meal, a denser air, and a milder temperature, soon restored them to their usual health. Towards 7 o'clock they came to Chamounix, where they received an enthusiastic welcome.

It had thus been proved that it was quite possible to live and make observations at those high altitudes. The greatest danger is in the violent storms that burst almost without notice, and which may become terrible tempests against which any temporary observatory would not stand. M. Richard says that the results of the observations will be published when the papers have been inspected and classified.

THE PHOTOGRAPHIC CHART OF THE HEAVENS.

WE reprint from the *Observatory* for May the following article by the editors:—

The "Bureau du Comité international permanent pour l'exécution photographique de la Carte du Ciel" has published, amongst other more technical papers relating to this subject, one by Dr. Gill, of a very remarkable character, to which we wish to draw attention. Most of those who attended the Conference understood that the work in contemplation was to make a photographic chart of the heavens, to take pictures of the stars by photography, showing, with the greatest care, the appearance of the heavens as they are at the present time, in order that at a future time these pictures might be used, by comparison with other pictures taken under similar conditions or directly with the sky, to determine the many questions that could be dealt with in this way—to enable, in fact, the astronomer of the future to have the sky of his past and his present to deal with. That this was so will be seen from a consideration of the three following resolutions which were agreed to unanimously by the Conference:—

"1. The progress made in astronomical photography demands that the astronomers of the present day should unite in undertaking a description of the heavens by photographic means.

"2. This work should be carried out at selected stations, and with instruments which should be identical in their essential parts.

"3. The principal objects are (*a*) to prepare a general photographic chart of the heavens for the present epoch, and to obtain data which will enable us to determine with the greatest possible accuracy the positions and the brightness of all the stars down to a given magnitude (the magnitude being understood in a photographic sense to be defined); (β) to provide for the best means of utilizing both at the present day and in the future the results of the data obtained by photographic means."

These were the fundamental resolutions; others, recommended by the two sections into which the Conference divided, were adopted as explanatory of the first. Amongst these was one in which it was decided to take "a second series of plates down to the 11th magnitude, in order to insure greater precision in the micrometric measurement of the reference-stars, and render possible the construction of a catalogue." We have stated these fundamental resolutions at length as bearing on the question of a catalogue of stars, for the paper by Dr. Gill contains the astounding proposition of cataloguing no less than 2,000,000 stars; that is to say, Dr. Gill gravely and seriously proposes the establishment of a Central Bureau, consisting of chief, assistants, secretaries, and a staff of measurers and computers, to take the photographs and *measure* them, and make a catalogue, the work to go on for twenty-five years at a cost of 250,000 francs, or £10,000, per annnm, or for fifty years at 150,000 francs.

It is quite true that this is only a proposition that Dr. Gill makes; but if such a proposition is possible in face of these direct resolutions of the Conference, it is quite time that everyone interested in the success of the work the Conference met to consider (that is, the photographic chart of the heavens) should bestir himself and see that the proposed work is not endangered by such astounding proposals.

To tack on to a work such as that sanctioned by the Conference—a work eminently practical, that has the support of all astronomers, and that has already been taken up by many of the Governments who were expected to join—a gigantic work such as Dr. Gill proposes, a work beside which that proposed by the Conference sinks into insignificance, would neither be fair to the Conference nor just to those Governments who have joined in the undertaking. The feature of the international scheme that makes it possible to obtain the assent of Government is that the work is proved to be practicable by experiment, and that it can be done at a moderate cost in something like five years, while the results are good for as long as the plates will last. To increase this work by extending it to, at the lowest computation of time, twenty-five and possibly fifty years, and to add enormously to the cost, would be to jeopardize the whole scheme.

Dr. Gill states that the actual state of astronomical science demands a catalogue of stars to the 11th magnitude. He thus raises the question on its merits; and we would here state that it is more than possible that not only is there no need of such a catalogue, but that the use of such catalogues as he proposes has for ever ceased. The minds of some astronomers move in grooves, and it will, no doubt, never be conceded by them that catalogues can be superseded; they will die as they have lived, in the strong belief that the only way to use the stars is to catalogue them.

Till recently the knowledge we had of the stars was only to be gained from a written description of their brightness and position with regard to each other; hence the catalogue was an absolute necessity if we needed to know the number or brightness of certain stars in any part of the sky at any previous time; and we could only find this out if we had a catalogue of that time. Our catalogues of stars are all we have to show what has been observed up to the present time; but when we have a photographic chart of the heavens, we have for our record not a catalogue, but a representation. That catalogues of stars such as are used for fundamental places will be always used goes without saying; the photographic plates themselves, and the four or five stars on each required as the fiducial points and for identification, will of course be catalogued; but, beyond this, to catalogue the stars on each plate, to measure them for the purpose only of getting their places written down, would be the most utter waste of time, labour, and money that it could enter the mind of man to conceive.

The proposition brought forward by Dr. Gill should be settled decisively so far as the proposition concerns the work proposed by the Conference. There can be no question that such a thing was never intended; had such a thing been thought of, we should have had a "Conference for discussing the best way of making a Catalogue of Stars by photography."

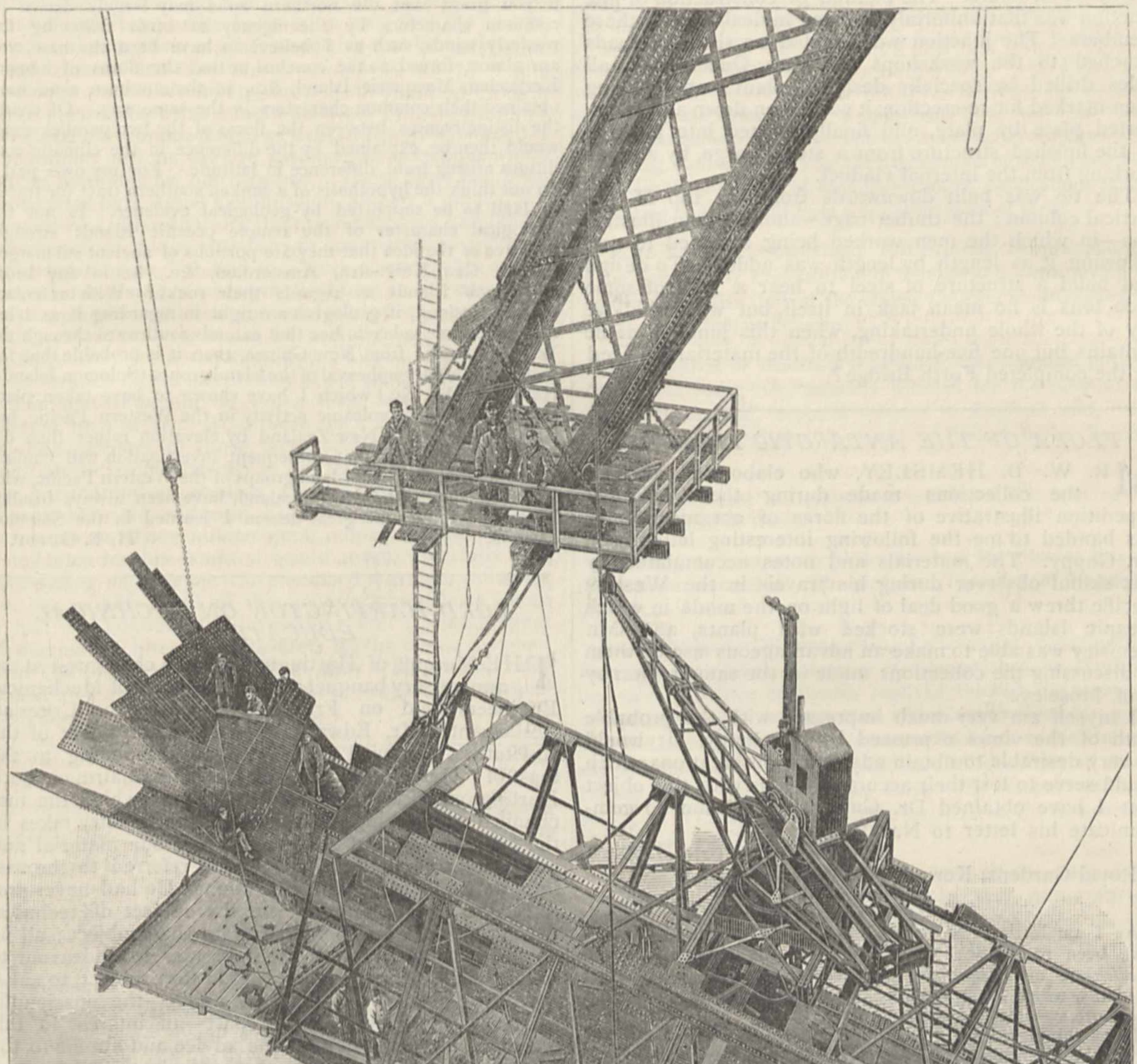
As this was not done, it can be done now; and if there is the great need of a catalogue of stars to the 11th magnitude felt by so many astronomers, as stated by Dr. Gill, it is a thing of so much greater importance as far as cost and time are concerned, that it should be considered and dealt with entirely apart from the other work. A new Congress might discuss it; the one which met in 1887 is not in any way committed to such a scheme.

THE FORTH BRIDGE.

WE have been enabled, through the kindness of Mr. Baker, to reproduce one of the photographs of the Forth Bridge, showing what is known as the "junction" at the end of bay 1, between tie 1, strut 2, and the bottom member.

A general account of the Forth Bridge has been so recently placed before the readers of NATURE (vol. xxxvi. p. 79), in the lecture by Mr. Baker, on May 20, 1887, before the Royal Institution, that it is unnecessary to cover the same ground again. The progress made in erection since that date is indicated by our engraving, showing the successful completion of the lower portion of the first bay.

The junction we have illustrated is nothing more nor



less than the connection of the web of a lattice girder with one of its booms, but here the junction alone weighs as much as an ordinary iron railway bridge of 100 feet span. This mass of steel work is suspended 80 feet above high water, and projects 180 feet beyond the masonry piers. Considerable forces are sometimes needed to bring the tubes into their correct position; and as in the case of the Britannia Bridge, which on a hot day moves 3 inches horizontally and $2\frac{1}{4}$ inches vertically between sunrise and sunset, so here considerable movement takes place during the day, and by careful watching the great tubes can sometimes be caught and retained in proper position, without the intervention of hydraulic or other power.

The weight of steel employed in the junction now under consideration is about 90 tons. The attachments to the strut and tie are made by means of strong gusset plates, the bottom member itself being strengthened internally at the junction by suitable diaphragms.

The importance of this junction will be readily understood, when it is stated that a load of some 6000 tons—the weight of an American liner—will be transmitted through it, in the finished structure, on its way to the masonry pier. Some 16,000 rivets are required for the junction; and large as this number may appear, it bears but a small ratio to the eight million rivets used in the whole structure. The method of construction of the junction was that uniformly adopted in dealing with these members. The junction was erected on the drill roads attached to the workshops at South Queensferry, all holes drilled by specially designed plant; and, having been marked for re-erection, it was taken down and transported plate by plate, and finally hoisted into position in the finished structure from a steam barge, by a crane working from the internal viaduct.

The tie was built downwards from the top of the vertical column; the timber cage—shown in our illustration—in which the men worked being attached to and following it as length by length was added. To design and build a structure of steel to bear a load of some 6000 tons is no mean task in itself, but what shall we say of the whole undertaking, when this junction alone contains but one five-hundredth of the material required for the completed Forth Bridge?

FLORA OF THE ANTARCTIC ISLANDS.

MR. W. B. HEMSLEY, who elaborated at Kew the collections made during the *Challenger* expedition illustrative of the floras of oceanic islands, has handed to me the following interesting letter from Dr. Guppy. The materials and notes accumulated by this skilful observer during his travels in the Western Pacific threw a good deal of light on the mode in which oceanic islands were stocked with plants, and Mr. Hemsley was able to make an advantageous use of them in discussing the collections made in the same region by Prof. Moseley.

I myself am very much impressed with the probable truth of the views expressed by Dr. Guppy. It would be very desirable to obtain additional observations which would serve to test their accuracy. It is with this object that I have obtained Dr. Guppy's permission to communicate his letter to NATURE.

W. T. THISELTON DYER.

Royal Gardens, Kew, April 28.

17 *Woodlane, Falmouth, April* 8, 1888.

As I am likely to be proceeding soon to the South Seas, I have been re-perusing your volume of the "Botany of the *Challenger*," more especially the remarks concerning the dispersal of plants, which I hope to take the opportunity of following up in a more systematic way than before.

I was thinking that if you thought it worth while you might direct the attention of masters of ships going round the Horn and the Cape of Good Hope to the chance of finding seeds in the crops of the oceanic birds that follow the ships in the regions of the westerly winds. I am inclined to believe that important results would be obtained. Judging from my experience, about one bird in twenty-five would contain a seed in its crop.

I am still inclined, if you will pardon my saying so, to the belief that the agency of birds like the Cape pigeons may explain some of the difficulties in the floras of the islands in the Southern Ocean. To return to the instance of my seed, I have since found an account where a Cape pigeon, around the neck of which a ribbon had been tied, followed a ship on its way home from Australia for no less than 5000 miles (Coppinger's "Cruise of the *Alert*," 1885, p. 18); and on consulting other voyages I find that the Cape pigeon appears to perform the circuit of the globe in the region of the Westerlies, so that my seed might readily have been transferred from Tristan d'Acunha to Amsterdam.

A remarkable point has occurred to me whilst reading your remarks (doubtless you have already thought of it). In a botanical sense, and also in a geographical sense, the Antarctic Islands seem to be arranged in two parallel zones. Tristan d'Acunha, Amsterdam, and St. Paul's, lying between the parallels of 37° to 40° S. lat., have similar floras. Further south is the second zone, between 47° and 55° (*circa*), in which the land and islands (Fuegia, Crozets, Kerguelen, Macquarie, &c.) are characterized by their common floras. Now, how are these two parallel botanical zones to be explained? It seems to me that if you grant that the northern zone may largely derive its common characters by the agency of birds following the westerly winds, such as I believe to have been the case, you are almost forced to the conclusion that the floras of Fuegia, Kerguelen, Macquarie Island, &c., in the southern zone have obtained their common characters in the same way. Of course the distinctiveness between the floras of the two parallel zones would then be explained by the difference in the climatic conditions arising from difference in latitude. For my own part I do not think the hypothesis of a sunken southern tract (or tracts) of land to be supported by geological evidence. Is not the geological character of the remote oceanic islands strongly negative of the idea that they are portions of ancient submerged tracts? Can Kerguelen, Amsterdam, &c., be in any sense *continental* islands as regards their rocks? With reference to New Zealand, if geologists are right in regarding it as lying along the same volcanic line that extends southward through the Western Pacific from New Guinea, then it is probable that the vast post-Tertiary upheaval of the island groups (Solomon Islands, New Hebrides, &c.) which I have shown to have taken place along this line of volcanic activity in the Western Pacific, has been represented in New Zealand by elevation rather than depression. I believe that subsequent investigation will confirm my belief that the great island groups of the Western Pacific, with New Caledonia and New Zealand, have been always insular. This is, I think, the great lesson I learned in the Solomon Islands.

H. B. GUPPY.

LORD HARTINGTON ON TECHNICAL EDUCATION.

THE Marquis of Hartington was the chief guest at the anniversary banquet of the Institution of Mechanical Engineers held on Friday, May 4, at the Criterion Restaurant. Mr. Edward H. Carbutt, President of the Institution, occupied the chair. In responding to the toast of "Our Guest," proposed by the Chairman, Lord Hartington, after speaking of the part which the mechanical engineering profession of this country takes in the maintenance and the extension of our material and industrial supremacy in the world, referred to the vast importance of technical education. He had never professed to be an authority on the subject of technical education—he was no authority on that subject; all he could do in the position he held was to endeavour to arouse such interest as he could in that subject, to enlist in the minds of the ordinary public—the unscientific public of whom he formed a part—an interest in this question, and to listen to the advice and attend to the counsel which were given to the public by those who were authorities on the subject, and to whose advice he held it was most important that attention should be paid. He had been greatly struck by the fact that in every country in Europe which competed with us in industrial or commercial pursuits greater attention had recently been paid to giving a practical direction to the national education than had hitherto been considered necessary in England. We had, like other countries—perhaps somewhat in arrear of them—established a national and tolerably complete instruction; but they, earlier than we, had embraced the idea of making that national instruction not only a literary instruction, but a technical and commercial education. But he could not help thinking that in that respect they had gained some considerable advantages over ourselves. He did not think there was any occasion for us to take a desponding or a pessimistic view of the situation. He had great confidence in the energy, the skill, and the intelligence of our people. But he believed there were facts which it would be madness on our part to ignore. If a new process, a new invention, were discovered in any other country—if a new process of manufacture were discovered greatly superior to that which was in existence among ourselves—we should at once admit that it was necessary for us either to improve that invention or else to resign ourselves to being defeated in the competition for the production of that article. But if it were true, as he believed it was, that the system of national education in other countries was being devoted to purposes which made the manual labour of the working population more intelligent, more skilled, and therefore more valuable, that was a fact which was just as important and which had consequences of exactly the same character as if foreign nations were to discover an invention which was not available for our own use. These facts had been investigated by a Royal Commission, and by a great number of private individuals for their own purposes; and there was no sort of doubt that foreign countries had not only attempted to give, but had to a very considerable extent succeeded in giving, a more practical turn to the education of their people in all branches of industry and commerce where science and art could be usefully and successfully applied. If it were the fact that we had fallen behind in this branch of the instruction of our people, it appeared to him that it would be worse than idle, it would be criminal, on our part if we were for a moment to ignore the consequences of those facts, and the consequences which might result not only to our temporary commercial and manufacturing position in the world, but to the future industrial position of England. He was sure there were none to whose advice great employers and leaders of industry in this country would more cheerfully and more willing listen, none who exercised a greater influence over the public mind of this country, than those whom he had the honour of addressing; and it was a great satisfaction to him to be assured by the words that had fallen from their Chairman that they were giving their earnest and anxious attention to the subject of technical education.

NOTES.

A Royal Commission has been appointed to inquire "whether any and what kind of new University or powers is or are required for the advancement of higher education in London." The Commissioners are Lord Selborne, Chairman; Sir James Hannen, Sir William Thomson, Dr. J. T. Ball, Mr. G. C. Brodrick, the Rev. J. E. C. Welldon, and Prof. Stokes, P.R.S. Mr. J. L. Goddard is appointed Secretary to the Commission.

Much trouble was taken to secure the success of the annual *conversazione* of the Royal Society held last night. We shall give some account of it next week.

The Emperor Frederick has marked the opening of his reign by conferring personal honours on some eminent Germans. Dr. Werner Siemens, the electrician, is one of those who have been ennobled or dignified with the prefix "Von."

The Donders Memorial Fund, to which we called attention some time ago, now amounts to about £2000, of which £250 has been subscribed in England. Prof. Donders' seventieth birthday falls on Sunday, the 27th inst.; but it has been decided that the celebration in his honour shall take place on the following day. The subscription list, so far as this country is concerned, will be closed on the 14th inst.

At the general monthly meeting of the Royal Institution, on Monday last, Dr. Tyndall was elected Honorary Professor, and Lord Rayleigh Professor, of Natural Philosophy.

A preliminary meeting, called by invitation of the Council of the Yorkshire Philosophical Society, to consider the desirability of forming a Museum Association, was held in York on May 3. Among the Museums represented at the meeting were those of Liverpool, Manchester, York, Sheffield, Nottingham, Bolton, Bradford, Sunderland, and Warrington. It was unanimously decided that a Museum Association should be formed, and that it should consist of curators or those engaged in the active work of Museums, and also of representatives of the Committees or Councils of Management of Museums. The Association will consider (1) whether it may not be possible to secure a compendious index of the contents of all provincial museums and collections; (2) the most effectual methods of facilitating the interchange of specimens and books between various museums; (3) the best plans for arranging museums and classifying their contents; (4) the organization of some concerted action for the obtaining of such Government publications as are interesting or important from a scientific point of view.

Prof. Arthur Schuster, F.R.S., has been appointed to the Langworthy Professorship of Physics and Directorship of the Physical Laboratory at the Owens College, in succession to the late Prof. Balfour Stewart.

The Gaekwar of Baroda is reported to have decided to send a number of young men, carefully selected for the purpose, to study scientific and technical subjects in England, under the supervision of Mr. Gajjar, Professor of Biology in the Baroda College.

The Government of Ceylon have sanctioned the opening of a Forest School at Kandy.

We regret to have to record the death of Sir Charles Bright, the eminent electrician. He died last Thursday, at the age of fifty-six.

Dr. Sigismond Wróblewski, Professor of Experimental Physics at the Polish University of Cracow, died on April 16 last, in consequence of injuries received through the explosion of some petroleum lamps. Prof. Wróblewski lived for some time in London, and was afterwards a Professor at the University of Strasburg. He also worked in the laboratory of Prof. Debray in the École Normale, Paris. He accepted the appointment at Cracow in 1882. His researches on the liquefaction of gases are well known.

The sodium salt of a new sulphur acid, of the composition $H_2S_4O_8$, has been prepared by M. Villiers (*Bull. de Soc. Chim.*, 1888, 671). It was obtained by the action of sulphur dioxide upon a strong solution of sodium thiosulphate, and is tolerably stable, crystallizing in well-developed prisms. A quantity of crystalline sodium thiosulphate contained in a flask was treated with an amount of water insufficient for complete solution; the flask was immersed in iced water, and a current of sulphur dioxide passed, with constant agitation, until the solution was saturated and all or nearly all the thiosulphate had dissolved. If any of the latter crystals remained undissolved, a little more water was added, and the solution again saturated with the gas, repeating this treatment until all had passed into solution. After leaving the liquid thus obtained at the ordinary temperature for two or three days, it was found to be capable of taking up a further considerable volume of sulphur dioxide, the former quantity having evidently entered into chemical combination in some way or other. It was therefore again saturated, and left for another day or two, after which the solution was evaporated *in vacuo* over sulphuric acid. It was then found that a precipitate of sulphur was gradually deposited upon the base of the containing dish, while fine white prisms of brilliant lustre were formed at the surface. On analysis they were found to be anhydrous, and yielded numbers corresponding to the formula $Na_2S_4O_8$ or NaS_2O_4. They dissolved in water with formation of a neutral solution. On again evaporating this solution under the receiver of the air-pump, crystals of a hydrate, $Na_2S_4O_8 + 2H_2O$, separated out. From the remarkable similarity in properties between oxygen and sulphur, it is probable that this new acid by no means exhausts all the possible combinations, for it appears as if one is capable of replacing the other to any extent, forming compounds which may perhaps be considered as oxygen substitution derivatives of polysulphides. M. Villiers has not yet completed his investigation of the properties and constitution of the new acid, further details of which will be awaited with considerable interest.

ON April 2 a severe shock of earthquake was felt at Kalleli, in the Lysefjord. It occurred simultaneously with one at Gjæsdal, also on the west coast of Norway. In the former place three distinct shocks were felt, causing the windows to rattle, clocks to stop, &c. A loud subterranean rumbling was heard. On the other side of the narrow fjord no shock was felt, but a deep rumbling detonation was heard.

ON the morning of April 18 a severe shock of earthquake was felt at Vexiö, in the south of Sweden. It lasted fully two minutes, and was followed by subterranean detonations. This is the third earthquake observed in this district during the last six months.

THE Calcutta Correspondent of the *Times* telegraphs that India has been visited by a series of what he calls "phenomenal" storms, partaking very much of the character of the Dacca tornado. At Moradabad, 150 deaths are reported, caused chiefly by hailstones. Many of the houses were unroofed, trees were uprooted, and masses of frozen hail remained lying about long after the cessation of the storm. At Delhi there was an extraordinary hailstorm lasting about two minutes, which was virtually a shower of lumps of ice. One of the hailstones picked up in the hospital garden weighed 1½ lb.; another, secured near the Telegraph Office, was of the size of a melon, and turned the scale at 2 lbs. At another place the Government House suffered severely, 200 panes of glass being broken by hail. In Lower Bengal, at Rayebati, 2000 huts were destroyed, while twenty persons are reported to have been killed and 200 severely injured. Chudressur, close to Serampore, was almost completely wrecked. The storm lasted only three minutes, its course extending for a mile and a half, and its path being 300 yards wide. Its advent was preceded by a loud booming noise. Large boats were lifted out of the river, and in one case a small boat was blown up into a tree.

ACCORDING to an official report, the substance of which has been given by the Calcutta Correspondent of the *Times*, an immense amount of injury was done by the Dacca tornado. No fewer than 118 persons were killed, excluding those drowned, and 1200 wounded had to be treated. The amount of the damage to property is estimated at Rs.6,78,428. Three hundred and fifty-eight houses were completely destroyed, 121 boats were wrecked, and 148 brick-built houses were partially, and 9 were completely, destroyed. Shortly after the Dacca tornado, another visited part of the Murchagunje subdivision, and 66 deaths and 128 cases of injury are reported. All the houses struck were completely destroyed. The Dacca tornado travelled altogether 3¼ miles. Its rate of speed varied from 12 to 20 miles, and its greatest width was 20 yards. It was accompanied by a rumbling hissing sound, the clouds over it were illuminated, and liquid mud was deposited along its track, and was ingrained in the wounds of the injured.

WE are glad to be able to report, on the authority of Captain de Brito Capello, Director of the Lisbon Observatory, that the Government of Brazil has established a Meteorological Service there, by decree dated April 4 last. The Director is Senhor A. Pinheiro, who has visited this country on several occasions.

AT the meeting of the French Meteorological Society, on the 3rd of April, M. Vaussenat presented and analyzed a long series of photographs of clouds taken at the Observatory of the Pic-du-Midi, from 1880 to 1887, under all conditions of the atmosphere. He drew special attention to the importance of the systematic observation of clouds, at that mountain observatory, and stated that by the aid of such observations he had been able to issue local predictions of weather which had acquired great accuracy. M. Grad gave particulars respecting the present meteorological organization in Alsace and Lorraine. In 1870, the Meteorological Commission presided over by M. Hirn established a complete network of stations, but this service was interrupted by the war which broke out soon after. At present there are twenty stations in the two provinces. One of these, viz. Strasburg, possesses an unbroken series of observations since 1801. It has been decided to establish a service there for the issue of weather forecasts for the benefit of agriculture.

MR. T. WILSON, of the Smithsonian Institution, gives in the *American Naturalist* an interesting account of some recent discoveries made by Mr. Frank Cushing, who has not only been adopted by the tribe of Zuñis, but initiated into the order of their priesthood. While at Tempe, in Arizona, in the spring of 1887, Mr. Cushing heard of a large truncated mound in the desert 6 or 7 miles to the south-east. He visited it, and declared it to be of artificial formation. Workmen were brought from Tempe, and in a short time they came upon the ruins of an immense building. Mr. Cushing at once arrived at the conclusion that this building had been used as an Indian temple. He observed many things which corresponded in a remarkable degree with the Zuñi religion, and which he was able to recognize in consequence of the experience he had gained as a priest. Continuing his explorations, he found the remains of a city 3 miles long and at some places 1 mile wide. This city was somewhat irregularly laid out, consisting principally of large squares or blocks of houses surrounded by a high wall, apparently for protection. The state of the buildings clearly indicated that the city had been ruined by an earthquake. Many bodies crushed by fallen roofs and walls were found. Mr. Cushing also discovered a number of graves, believed to be the graves of priests. The symbols and decorations on the pottery found in these graves resemble the symbols and decorations on modern Zuñi pottery. About 10 or 15 miles from this ruined city, which Mr. Cushing calls Los Muertos, the City of the Dead, he has lately found the remains of another prehistoric town, in connection with which there are many traces of extensive works for irrigation.

THE Boston Society of Natural History proposes to establish a Zoological Garden in that city. The enterprise will be thoroughly educational. The chief object will be to show specimens of American animals, especially those of New England.

ACCORDING to a telegram from Sydney, the Conference upon the means of dealing with the rabbit-pest in Australia has resulted in the selection of an island where M. Pasteur's and other methods of extirpation will be thoroughly tried. The liability of other animals and birds to infection by the same means will also be tested.

DURING the month of July the following courses, for technical teachers and others, will be given in the new buildings of the City and Guilds of London Institute:—Elementary Principles of Machine-Designing, by Prof. W. C. Unwin, F.R.S.; Practical Lessons in Organic Chemistry, intended mainly for teachers of technological subjects, by Prof. Armstrong, F.R.S.; the Construction and Use of Electrical Measuring Instruments, by Prof.

Ayrton, F.R.S.; Experimental Mechanics, by Prof. Henrici F.R.S.; the Principles of Bread-making, by William Iago; Photography, by Capt. Abney, F.R.S.; Mathematical and Surveying Instruments, by Arthur Thomas Walmisley; Gas Manufacture, by Lewis T. Wright; the Application of Modern Geometry to the Cutting of Solids for Masonry and other Technical Arts, by Lawrence Harvey; and the Craft of the Carpenter, by John Slater.

THE additions to the Zoological Society's Gardens during the past week include two Long-eared Bats (*Plecotus auritus*), from Cornwall, presented by Mr. F. A. Allchin; a —— Roe (*Capreolus* —— ♀), from Corea, presented by Mr. F. Harston Eagles; two Burrowing Owls (*Speotyto cunicularia*), from Buenos Ayres, presented by Mr. J. Clark Hawkshaw; a Blue and Yellow Macaw (*Ara ararauna*), from Para, presented by Mrs. Yarrow; two Crested Ducks (*Anas cristatus*), from the Falkland Islands, presented by Mr. F. E. Cobb, C.M.Z.S.; an Asp Viper (*Vipera aspis*), from Italy, presented by Messrs. Paul and Co.; a Common Viper (*Vipera berus*), from Burnham Beeches, presented by Mr. F. M. Oldham; two Japanese Deer (*Cervus sika* ♂ ♂), from Japan; a Macaque Monkey (*Macacus cynomolgus* ♂), from India, a Vulpine Phalanger (*Phalangista vulpina* ♂), from Australia, two Burrowing Owls (*Speotyto cunicularia*), from Buenos Ayres, deposited; a Spotted Cavy (*Cœlogenys paca*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

NEW MINOR PLANETS.—Herr Palisa, at Vienna, discovered a new minor planet, No. 276, on April 17, and M. Charlois, at Nice, discovered a second, No. 277, on May 3, the sixty-fourth and third discoveries respectively of the two astronomers. No. 273 has been named Atropos.

COMET 1888 *a* (SAWERTHAL).—The following ephemeris (*Dun Echt Circular*, No. 155) is in continuation of that given in NATURE, vol. xxxvii. p. 520:—

For Greenwich Midnight.

1888.	R.A. h. m. s.	Decl. ° ′	Log Δ.	Log *r*.	Brightness.
May 10	23 45 45	31 39·8 N.	0·2242	0·1003	0·14
12	23 50 0	32 33·7			
14	23 54 9	33 25·8	0·2360	0·1198	0·12
16	23 58 12	34 16·1			
18	0 2 8	35 4·7	0·2470	0·1386	0·11
20	0 5 58	35 51·7			
22	0 9 42	36 37·2	0·2572	0·1566	0·09
24	0 13 20	37 21·2			
26	0 16 51	38 3·9	0·2666	0·1738	0·08
28	0 20 16	38 45·3			
30	0 23 35	39 25·6	0·2752	0·1904	0·07

The brightness at discovery is taken as unity.

CINCINNATI ZONE CATALOGUE.—No. 9 of the Publications of the Cincinnati Observatory contains a zone catalogue of 4050 stars observed during 1885, 1886, and the early part of 1887 with the 3-inch transit instrument of the Observatory, made by Buff and Berger. The region covered by the zones is from S. Decl. 18° 50′ to S. Decl. 22° 20′, most of the stars down to mag. 8·5 having been observed, besides a considerable number of fainter ones. A low power was employed, so as to give a field of 50′ in breadth, and as the zones were taken 15′ apart, each star was thus usually observed in three zones. The R.A.'s were deduced from transits, recorded on a chronograph, over a system of five vertical wires; the declinations, from bisections by a micrometer wire, two readings being taken for each star whenever practicable. The probable error of a single observation was found to be R.A. ± 0·123s., Decl. ± 1″·84, the observations being a little rougher than could have been desired, in consequence of the low magnifying power used. An important portion of the work has been the comparison of the resulting places with those for the same stars in earlier catalogues, and a considerable number of errata in Lalande's, Lamont's, and other catalogues have been detected. A list of seventy-five proper motions, nearly all of them new, is likewise added.

PUBLICATIONS OF LICK OBSERVATORY.—The first volume of the Publications of the Lick Observatory has been received. It is chiefly occupied with the details of the progress of the institution from the date of Mr. Lick's first deed of trust, 1874, and with the description of the smaller instruments, the great refractor being reserved for a future volume. Meteorological observations taken on Mount Hamilton from 1880 to 1885, and reduction tables for the Observatory occupy a large part of the volume. Amongst the most interesting reports are those of Prof. Newcomb, on the glass for the great objective; of Mr. Burnham, on Mount Hamilton as an observing station; and of Prof. Todd, on the transit of Venus, 1882. A report on the structure of the mountain is also given by Profs. Irving and Jackson.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 *MAY* 13–19.

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

At Greenwich on May 13

Sun rises, 4h. 12m.; souths, 11h. 56m. 9·7s.; sets, 19h. 40m.: right asc. on meridian, 3h. 22·8m.; decl. 18° 34′ N. Sidereal Time at Sunset, 11h. 8m.

Moon (at First Quarter May 18, 23h.) rises, 5h. 58m.; souths, 13h. 54m.; sets, 21h. 57m.: right asc. on meridian, 5h. 21·2m.; decl. 19° 46′ N.

Planet.	Rises. h. m.	Souths. h. m.	Sets. h. m.	Right asc. on meridian. h. m.	Declination on meridian. ° ′
Mercury..	4 16 ...	12 8 ...	20 0 ...	3 34·8 ...	19 50 N.
Venus.....	3 45 ...	10 54 ...	18 3 ...	2 20·6 ...	12 38 N.
Mars......	15 36 ...	21 19 ...	3 2* ...	12 46·9 ...	4 6 S.
Jupiter....	20 21* ...	0 38 ...	4 55 ...	16 3·2 ...	19 43 S.
Saturn....	8 51 ...	16 47 ...	0 43* ...	8 14·5 ...	20 29 N.
Uranus...	15 44 ...	21 23 ...	3 2* ...	12 51·5 ...	4 47 S.
Neptune..	4 41 ...	12 24 ..	20 7 ...	3 50·7 ...	18 28 N.

* Indicates that the rising is that of the preceding evening and the setting that of the following morning.

Occultations of Stars by the Moon (visible at Greenwich).

May.	Star.	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image. ° °
15 ...	61 Geminorum ..	6 ...	21 48	near approach	212 —
16 ...	*d′* Cancri	6 ...	23 5 ...	23 45 ...	74 337

May.	h.	
15 ...	0 ...	Mercury at least distance from the Sun.
16 ...	22 ...	Saturn in conjunction with and 0° 42′ north of the Moon.

Variable Stars.

Star.	R.A. h. m.	Decl. ° ′		h. m	
U Cephei	0 52·4 ...	81 16 N. ...	May 17,	1 38	*m*
ζ Geminorum ...	6 57·5 ...	20 44 N. ...	,, 15,	0 0	*M*
U Hydræ	10 32·0 ...	12 48 S. ...	,, 15,		*m*
W Virginis	13 20·3 ...	2 48 S. ...	,, 17,	1 0	*M*
R Draconis	16 32·4 ...	67 0 N. ...	,, 14,		*m*
U Ophiuchi	17 10·9 ...	1 20 N. ...	,, 18,	0 36	*m*
W Sagittarii ...	17 57·9 ...	29 35 S. ...	,, 17,	3 0	*m*
β Lyræ...	18 46·0 ...	33 14 N. ...	,, 17,	23 0	*M*
R Lyræ	18 51·9 ...	43 48 N. ...	,, 18,		*m*
η Aquilæ	19 46·8 ...	0 43 N. ...	,, 19,	23 0	*m*
W Cygni	21 31·8 ...	44 53 N. ...	,, 18,		*M*
δ Cephei	22 25·0 ...	57 51 N. ...	,, 15,	23 0	*M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A. °	Decl. °	
Near η Aquilæ ...	... 295 ...	0	... May 15. Very swift.
From Delphinus ...	... 314 ...	15 N.	... May 13–18. Very swift. Streaks.

THE PYGMY RACES OF MEN.[1]

I.

IT is well known that there existed among the nations of antiquity a wide-spread belief in the existence of a race or races of human beings of exceedingly diminutive stature, who dwelt in some of the remote and unexplored regions of the earth. These were called *Pygmies*, a word said to be derived from πυγμή, which means a fist, and also a measure of length, the distance from the elbow to the knuckles of an ordinary-sized man, or rather more than 13 inches.

In the opening of the third book of the *Iliad*, the Trojan hosts are described as coming on with noise and shouting, "like the cranes which flee from the coming of winter and sudden rain, and fly with clamour towards the streams of ocean, bearing slaughter and fate to the Pygmy men, and in early morn offer cruel battle," or, as Pope has it—

> "So when inclement winters vex the plain,
> With piercing frosts, or thick descending rain,
> To warmer seas the cranes embodied fly,
> With noise and order through the midway sky,
> To Pygmy nations wounds and death they bring,
> And all the war descends upon the wing."

The combats between the pygmies and the cranes are often alluded to by late classical writers, and are not unfrequently depicted upon Greek vases. In one of these in the Hope collection at Deepdene, in which the figures are represented with great spirit, the pygmies are dwarfish-looking men with large heads, negro features, and close woolly or frizzly hair. They are armed with lances. Notices of a less poetical and apparently more scientific character of the occurrence of very small races of human beings are met with in Aristotle, Herodotus, Ctesias, Pliny, Pomponius Melo, and others. Aristotle places his pygmies in Africa, near the sources of the Nile, while Ctesias describes a race of dwarfs in the interior of India. The account in Herodotus is so circumstantial, and has such an air of truthfulness about it, especially in connection with recent discoveries, that it is worth quoting in full.[2]

"I did hear, indeed, what I will now relate, from certain natives of Cyrênê. Once upon a time, they said, they were on a visit to the oracular shrine of Ammon, when it chanced that, in the course of conversation with Etearchus, the Ammonian king, the talk fell upon the Nile, how that its sources were unknown to all men. Etearchus upon this mentioned that some Nasamonians had once come to his Court, and when asked if they could give any information concerning the uninhabited parts of Libya, had told the following tale. The Nasamonians are a Libyan race who occupy the Syrtes, and a tract of no great size towards the east. They said there had grown up among them some wild young men, the sons of certain chiefs, who, when they came to man's estate, indulged in all manner of extravagancies, and among other things drew lots for five of their number to go and explore the desert parts of Libya, and try if they could not penetrate further than any had done previously. The young men therefore dispatched on this errand by their comrades with a plentiful supply of water and provisions, travelled at first through the inhabited region, passing which they came to the wild beast tract, whence they finally entered upon the desert, which they proceeded to cross in a direction from east to west. After journeying for many days over a wide extent of sand, they came at last to a plain where they observed trees growing: approaching them, and seeing fruit on them, they proceeded to gather it. While they were thus engaged, there came upon them some dwarfish men, under the middle height, who seized them and carried them off. The Nasamonians could not understand a word of their language, nor had they any acquaintance with the language of the Nasamonians. They were led across extensive marshes, and finally came to a town, where all the men were of the height of their conductors, and black-complexioned. A great river flowed by the town, running from west to east, and containing crocodiles."

It is satisfactory to know that the narrative concludes by saying that these pioneers of African exploration, forerunners of Bruce and Park, of Barth, Livingstone, Speke, Grant, Schweinfurth, Stanley, and the rest, "got safe back to their country."

Extension of knowledge of the natural products of the earth, and a more critical spirit on the part of authors, led to attempts of explanation of this belief, and the discovery of races of monkeys—of the doings of which, it must be said, more or less fabulous stories were often reported by travellers—generally sufficed the commentators and naturalists of the last century to explain the origin of the stories of the pygmies. To this view the great authority of Buffon was extended.

Still more recently-acquired information as to the actual condition of the human population of the globe has, however, led to a revision of the ideas upon the subject, and to more careful and critical researches into the ancient documents. M. de Quatrefages, the eminent and veteran Professor of Anthropology at the Muséum d'Histoire Naturelle of Paris, has especially carefully examined and collated all the evidence bearing upon the question, and devoted much ingenuity of argument to prove that the two localities in which the ancient authors appear to place their pygmies, the interior of Africa near the sources of the Nile, and the southernmost parts of Asia, and the characters they assign to them, indicate an actual knowledge of the existence of the two groups of small people which still inhabit these regions, the history of which will form the subject of this lecture. The evidence which has convinced M. de Quatrefages, and which, I have no doubt, will suffice for those who take pleasure in discovering an underlying truth in all such legends and myths, or in the more grateful task of rehabilitating the veracity of the fathers of literature and history, will be found collected in a very readable form in a little book published last year in the "Bibliothèque scientifique contemporaine," called "Les Pygmées," to which I refer my readers for fuller information upon the subject of this discourse, and especially for numerous references to the literature of the subject, which, as the book is accessible to all who wish to pursue it further, I need not give here.

It is still, however, to my mind, an open question whether these old stories may not be classed with innumerable others, the offspring of the fertile invention of the human brain, the potency of which as an origin of myths has, I think, sometimes been too much underrated. I shall therefore now take leave of them, and confine myself to giving you, as far as the brief space of time at my disposal admits, an account of our actual knowledge of the smallest races of men either existing or, as far as we know, ever having existed on earth, and which may therefore, taking the word in its current though not literal sense, be called the "pygmies" of the species.

Among the various characters by which the different races of men are distinguished from one another, *size* is undoubtedly one of considerable importance. Not but what in each race there is much individual variation, some persons being taller, and some shorter; yet these variations are, especially in the purer or less mixed races, restricted within certain limits, and there is a general average, both for men and women, which can be ascertained when a sufficient number of accurate measurements have been recorded. That the prevailing size of a race is a really deeply-seated, inherited characteristic, and depends but little on outward conditions, as abundance of food, climate, &c., is proved by well-known facts. The tallest and the shortest races in Europe are respectively the Norwegians and the Lapps, living in almost the same region. In Africa, also, the diminutive Bushmen and the tallest race of the country, the Kaffirs, are close neighbours. The natives of the Andaman Islands and those of many islands of the equatorial region of the Pacific, in which the conditions are similar, or if anything more favourable to the former, are at opposite ends of the scale of height. Those not accustomed to the difficulties both of making and recording such measurements will scarcely be prepared, however, to learn how meagre, unsatisfactory and unreliable our knowledge of the stature of most of the races of mankind is at present, although unquestionably it has been considerably increased within recent years. We must, however, make use of such material as we possess, and trust to the future correction of errors when better opportunities occur.

It is convenient to divide men, according to their height, into three groups—tall, medium, and short; in Topinard's system, the first being those the average height (of the men) of which is above 1·700 metres (5 feet 7 inches), the latter those below 1·500 metres (4 feet 11 inches), and the middle division those between the two. In the last division are included certain of the Mongolian or yellow races of Asia, as the Samoyedes, the Ostiaks, the Japanese, the Siamese, and the Annamites; also the Veddahs of Ceylon and certain of the wild hill-tribes of Southern India. These all range between 1·525 and 1·600 metres—say between 5 feet and 5 feet 3 inches.

[1] A Lecture delivered at the Royal Institution on Friday evening, April 13, 1888, by Prof. Flower, C.B., LL.D., F.R.S., Director of the Natural History Departments of the British Museum.

[2] Herodotus, Book II. 32, Rawlinson's translation, p. 47.

It is of none of these people of whom I am going to speak to-day. My pygmies are all on a still smaller scale, the average height of the men being in all cases below 5 feet, in some cases, as we shall see, considerably below.

Besides their diminutive size, I may note at the outset that they all have in a strongly-marked degree the character of the hair distinguished as frizzly—*i.e.* growing in very fine, close curls, and flattened or elliptical in section, and therefore, whatever other structural differences they present, they all belong to the same primary branch of the human species as the African Negro and the Melanesian of the Western Pacific.

I will first direct your attention to a group of islands in the Indian Ocean—the Andamans—where we shall find a race in many respects of the greatest possible interest to the anthropologist.

These islands are situated in the Bay of Bengal, between the 10th and 14th parallels of north latitude, and near the meridian 93° east of Greenwich, and consist of the Great and Little Andamans. The former is about 140 miles long, and has a breadth nowhere exceeding 20 miles. It is divided by narrow channels into three, called respectively North, Middle, and South Andaman, and there are also various smaller islands belonging to the group. Little Andaman is a detached island lying about 28 miles to the south of the main group, about 27 miles in length and 10 to 18 in breadth.

Although these islands have been inhabited for a very great length of time by people whose state of culture and customs have undergone little or no change, as proved by the examination of the contents of the old kitchen-middens, or refuse heaps, found in many places in them, and although they lie so near the track of civilization and commerce, the islands and their inhabitants were practically unknown to the world until so recently as the year 1858. It is true that their existence is mentioned by Arabic writers of the ninth century, and again by Marco Polo, and that in 1788 an attempt was made to establish a penal colony upon them by the East India Company, which was abandoned a few years after; but the bad reputation the inhabitants had acquired for ferocious and inhospitable treatment of strangers brought by accident to their shores caused them to be carefully avoided, and no permanent settlement or relations of anything like a friendly character, or likely to afford any useful information as to the character of the islands or the inhabitants, were established. It is fair to mention that this hostility to foreigners, which for long was one of the chief characteristics by which the Andamanese were known to the outer world, found much justification in the cruel experiences they suffered from the malpractices, especially kidnapping for slavery, of the Chinese and Malay traders who visited the islands in search of *bêche de mer* and edible birds'-nests. It is also to this characteristic that the inhabitants owe so much of their interest to us from a scientific point of view, for we have here the rare case of a population, confined to a very limited space, and isolated for hundreds, perhaps thousands, of years from all contact with external influence, their physical characters unmixed by crossing, and their culture, their beliefs, their language entirely their own.

In 1857, when the Sepoy mutiny called the attention of the Indian Government to the necessity of a habitation for their numerous convict prisoners, the Andaman Islands were again thought of for the purpose. A Commission, consisting of Dr. F. J. Mouat, Dr. G. Playfair, and Lieut. J. A. Heathcote was sent to the islands to report upon their capabilities for such a purpose; and, acting upon its recommendations, early in the following year the islands were taken possession of in the name of the East India Company by Captain (now General) H. Man, and the British flag hoisted at Port Blair, near the southern end of Great Andaman, which thenceforth became the nucleus of the settlement of invaders, now numbering about 15,000 persons, of whom more than three-fourths are convict prisoners, the rest soldiers, police, and the usual accompaniments of a military station.

The effect of this inroad upon the unsophisticated native population, who, though spread over the whole area of the islands, were far less numerous, may easily be imagined. It is simply deterioration of character, moral and physical decay, and finally extinction. The newly-introduced habits of life, vices, and diseases, are spreading at a fearful rate, and with deadly effect. In this sad history there are, however, two redeeming features which distinguish our occupation of the Andamans from that of Tasmania, where a similar tragedy was played out during the present century. In the first place, the British Governors and residents appear from the first to have used every effort to obtain for the natives the most careful and considerate treatment, and to alleviate as much as possible the evils which they have unintentionally been the means of inflicting on them. Secondly, most careful records have been preserved of the physical characters, the social customs, the arts, manufactures, traditions, and language of the people while still in their primitive condition. For this most important work, a work which, if not done, would have left a blank in the history of the world which could never have been replaced, we are indebted almost entirely to the scientific enthusiasm of one individual, Mr. Edward Horace Man, who most fortunately happened to be in a position (as Assistant Superintendent of the Islands, and specially in charge of the natives) which enabled him to obtain the required information with facilities which probably no one else could have had, and whose observations "On the Aboriginal Inhabitants of the Andaman Islands," published by the Anthropological Institute of Great Britain and Ireland, are most valuable, not only for the information they contain, but as correcting the numerous erroneous and misleading statements circulated regarding these people by previous and less well informed or less critical authors.

The Arab writer of the ninth century previously alluded to states that "their complexion is frightful, their hair frizzled, their countenance and eyes frightful, their feet very large, and almost a cubit in length, and they go quite naked," while Marco Polo (about 1285) says that "the people are no better than wild beasts, and I assure you all the men of this island of Angamanain have heads like dogs, and teeth and eyes likewise; in fact, in the face they are just like big mastiff dogs." These specimens of mediæval anthropology are almost rivalled by the descriptions of the customs and moral character of the same people published as recently as 1862, based chiefly on information obtained from one of the runaway sepoy convicts, and which represent them as among the lowest and most degraded of human beings.

The natives of the Andamans are divided into nine distinct tribes, each inhabiting its own district. Eight of these live upon the Great Andaman Islands, and one upon the hitherto almost unexplored Little Andaman. Although each of these tribes possesses a distinct dialect, these are all traceable to the same source, and are all in the same stage of development. The observations that have been made hitherto relate mostly to the tribe inhabiting the south island, but it does not appear that there is any great variation either in physical characters or manners, customs, and culture among them.

With regard to the important character of size, we have more abundant and more accurate information than of most other races. Mr. Man gives the measurements of forty-eight men and forty-one women, making the average of the former 4 feet $10\frac{3}{4}$ inches, that of the latter 4 feet $7\frac{1}{4}$ inches, a difference therefore of $3\frac{1}{2}$ inches between the sexes. The tallest man was 5 feet $4\frac{1}{4}$ inches; the shortest 4 feet 6 inches. The tallest woman 4 feet $11\frac{1}{2}$ inches; the shortest 4 feet 4 inches. Measurements made upon the living subject are always liable to errors, but it is possible that in so large a series these will compensate each other, and that therefore the averages may be relied upon. My own observations, based upon the measurements of the bones alone of as many as twenty-nine skeletons, give smaller averages, viz. 4 feet $8\frac{1}{2}$ inches for the men, and 4 feet $6\frac{1}{2}$ inches for the women; but these, it must be recollected, are calculated from the length of the femur, upon a ratio which, though usually correct for Europeans, may not hold good in the case of other races.[1] The hair is fine, and very closely curled; woolly, as it is generally called, or, rather, frizzly, and elliptical in section, as in the Negroes. The colour of the skin is very dark, although not absolutely black. The head is of roundish (brachycephalic) form, the cephalic index of the skull being about 82. The other cranial characters are fully described in the papers just referred to. The teeth are large, but the jaws are only slightly prognathous. The features possess little of the Negro type; at all events, little of the most marked and coarser peculiarities of that type. The projecting jaws, the prominent thick lips, the broad and flattened nose of the genuine Negro are so softened down in the Andamanese as scarcely to be recognized, and yet in

[1] See "On the Osteology and Affinities of the Natives of the Andaman Islands" (Journal Anthropological Institute, vol. ix. p. 108, 1879); and "Additional Observations on the Osteology of the Natives of the Andaman Islands" (*ibid.*, vol. xiv. p. 115, 1884).

the relative proportions of the limb-bones, especially in the shortness of the humerus compared with the fore-arm, and in the form of the pelvis, Negro affinities are most strongly indicated.

In speaking of the culture of the Andamanese, of course I only refer to their condition before the introduction of European civilization into the islands. They live in small villages or encampments, in dwellings of simple and rude construction, built only of branches and leaves of trees. They are entirely ignorant of agriculture, and keep no poultry or domestic animals. They make rude pots of clay, sun-dried, or partially baked in the fire, but these are hand-made, as they are ignorant of the use of the potter's wheel. Their clothing is of the scantiest description, and what little they have chiefly serves for decorative or ornamental purposes, and not for keeping the body warm. They make no use of the skins of animals. They have fairly well-made dug-out canoes and outriggers, but only fit for navigating the numerous creeks and straits between the islands, and not for voyages in the open sea. They are expert swimmers and divers. Though constantly using fire, they are quite ignorant of the art of producing it, and have to expend much care and labour in keeping up a constant supply of burning or smouldering wood. They are ignorant of all metals; but for domestic purposes make great use of shells, especially a species of *Cyrene* found abundantly on the shores of the islands, also quartz chips and flakes, and bamboo knives. They have stone anvils and hammers, and they make good string from vegetable fibres, as well as baskets, fishing-nets, sleeping-mats, &c. Their principal weapons are the bow and arrow, in the use of which they are particularly skilful. They have harpoons for killing turtle and fish, but no kind of shield or breastplate for defence when fighting. The natural fertility of the island supplies them with abundance and a great variety of food all the year round, the purveying of which affords occupation and amusement for the greater part of the male population. This consists of pigs (*Sus andamanensis*), which are numerous on the islands, paradoxurus, dugong, and occasionally porpoise, iguanas, turtles, turtles' eggs, many kinds of fish, prawns, mollusks, larvæ of large wood-boring and burrowing beetles, honey, and numerous roots (as yams), fruits, and seeds. The food is invariably cooked before eating, and generally taken when extremely hot. They were ignorant of all stimulants or intoxicating drinks—in fact, water was their only beverage; and tobacco, or any substitute for it, was quite unknown till introduced by Europeans.

(*To be continued.*)

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE Institution of Mechanical Engineers held its annual meeting at the house of the Institution of Civil Engineers in Great George Street, Westminster, on the 3rd and 4th inst., under the presidency of Mr. E. H. Carbutt.

The papers brought forward for reading and discussion were: the Third Report of the Research Committee of the Institution on Friction; "Description of the Emery Testing Machine," by Mr. Henry R. Towne, of Stamford, Connecticut, U.S.A.; and "Supplementary Paper on the Use of Petroleum Refuse as Fuel in Locomotive Engines," by Mr. Thomas Urquhart, Locomotive Superintendent, Grazi and Tsaritsin Railway, South-East Russia; the third of which was deferred till the next meeting of the Institute.

The third report of the Friction Committee is on experiments on the friction of a collar-bearing. The general conclusions of the Committee are that this kind of bearing is inferior to a cylindrical journal in weight-carrying power. The coefficient of friction is also much higher than for a cylindrical bearing, and the friction follows the law of the friction of solids more nearly than that of liquids, due doubtless to the less perfect lubrication applicable to this form of bearing compared with a cylindrical one. The coefficient of friction appears to be independent of the speed, but to diminish somewhat as the load is increased, and may be stated approximately at $\frac{1}{20}$ at 15 lbs. per square inch, diminishing to $\frac{1}{30}$ at 75 lbs. per square inch.

In the broad principles of construction on which the Emery system of testing and weighing machinery rests are included two radically new and highly important elements—namely, an arrangement of hydraulic chambers and diaphragms capable of receiving without injury pressures and shocks of great intensity, and of transmitting them simultaneously, without loss from friction, to a convenient point for the purpose of measuring and recording them, and capable also of reducing them to such lower term of degree as may be desirable; and a means for flexibly uniting a vibrating scale-beam either to a fixed abutment or to another beam of the same system, in such a manner as absolutely to eliminate friction, and to preserve indefinitely the fulcrum intervals or distances precisely as first adjusted, and to resist and transmit all the pressures and shocks to which the fulcrums are subjected, without in the slightest degree impairing their sensitiveness or durability.

The hydraulic construction is such that through it the strain on the specimen is transmitted without loss to a hydraulic chamber containing a thin film of liquid, which is again transmitted through a small copper tube, without loss from friction or otherwise, to a much smaller chamber containing a similar thin film of liquid. The acting area of the liquid in the smaller chamber is less than that in the larger in the proportion in which the load on the specimen is desired to be reduced before it is received upon the beams in the scale-case where it is measured. In the scale-case containing the weighing mechanism, the pressure transmitted from the smaller chamber is received at one end of a system of levers, and measured by means of devices which are shown in detail in the figures which accompanied the paper.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Among the courses of lectures announced for this Term we may notice the following:—

In Physics, Prof. Clifton is lecturing on Optical Properties of Crystals, and Mr. Selby on Absolute Electrical Units, at the Clarendon Laboratory. At Christ Church, Mr. Baynes lectures on Thermo-dynamics, and on the Transfer of Energy in an Electro-magnetic Field.

The University has made a grant to Mr. Smith, in aid of the Millard Engineering Laboratory, and practical work on the physical basis of engineering is regularly carried on there.

In Chemistry, besides the usual courses, Mr. Veley is lecturing on Thermo-chemistry, and Mr. Marsh on Recent Organic Research.

The work of the Geological Chair is at present being done by Mr. W. W. Watts (M.A. Camb.), who is lecturing for a term in order that Prof. Green may complete his session at the Yorkshire College.

Owing to Prof. Moseley's continued illness, Dr. Hickson is still acting as Deputy Linacre Professor, and is lecturing on the Morphology of the Chordata. Mr. Bourne, who is to assume his post as Superintendent of the Plymouth Marine Station in a month, is lecturing on Embryology, and Prof. Westwood on the Winged Arthropoda.

Dr. Burdon-Sanderson lectures this Term on Nutrition, and Dr. Gilbert on the Rotation of Crops.

In the absence of any Professor of Botany, Mr. J. B. Farmer is conducting the necessary elementary courses.

CAMBRIDGE.—Prof. Adams is appointed one of the four representatives of Cambridge at the 800th anniversary of the foundation of the University of Bologna, in June next.

An additional class-room for students of Mineralogy is to be formed.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, April 19.—"The Radio-Micrometer." By C. V. Boys.

The author gave the result of a mathematical investigation made with a view to arrive at the best possible construction of the radio-micrometer already described by him. At the conclusion of the meeting he showed in action an instrument which he had made, having the best proportions, which was both simpler in construction and far more sensitive than the one he exhibited on a previous occasion.

"On the Compounds of Ammonia with Selenium Dioxide." By Sir Charles A. Cameron, M.D., F.R.C.S.I., and John Macallan, F.I.C.

On passing dry ammonia into a solution of selenium dioxide in absolute alcohol, a compound is formed to which the authors have assigned the name ammonium selenosamate, and the formula NH_4,SeO_2NH_2. It is the ammonium salt of a new acid; namely, H,SeO_2NH_2. It is unstable, continuously evolving ammonia, and ultimately becoming a stable acid salt, $NH_4,H,(SeO_2NH_2)_2$. The neutral salt forms hexagonal prisms and pyramids, and the acid forms prismatic crystals. The neutral salt dissolves in 116 parts of alcoholic ammonia, but is decomposed by absolute alcohol or by water.

April 26.—"On the Modifications of the First and Second Visceral Arches, with especial Reference to the Homologies of the Auditory Ossicles." By Hans Gadow, Ph.D., M.A., Strickland Curator and Lecturer on Comparative Anatomy in the University of Cambridge. Communicated by Prof. M. Foster, Sec. R.S.

The phylogenetic development of the first two visceral arches shows us some most interesting changes of function, which we can follow upwards from the lower Selachians to the highest Mammals.

Originally entirely devoted to respiration as gill-bearing structures, the whole hyoidean arch becomes soon a factor in the alimentary system. Its proximal half forms the hinge of the masticatory apparatus, its distal half remains henceforth connected with the process of deglutition. Then this suspensorial arrangement is superseded by a new modification; the hyomandibula is set free and would disappear (it does nearly do so in Dipnoi and certain Urodela), unless it were made use of for a new function; with its having entered the service of the conduction of sound, it has entered upon a new departure, and it is saved from degeneration. The whole system of the one to four elements of the middle ear, which all have the same function as conductors of sound, is to be looked upon as *one* organ of *one* common origin,—namely, as a modification of the hyomandibula, the primitive proximal paramere of the second visceral arch.

Successive Modifications of the Mandibular and Hyoidean Visceral Arches.

I. Primitive condition (Notidanidæ). The palato quadrate bar alone carries the mandible. The second arch is indifferent. Hyomandibula and quadrate (the palatine part is an outgrowth) are both attached to the cranium.

II. The hyomandibula gains a fibro cartilaginous connection with the mandible, the masticatory apparatus becomes amphistylic and occasionally hyostylic (Rajidæ, most Selachians).

The hyoid gains a cranial attachment (many Rajidæ).

III. The quadrate or autostylic suspensorium becomes preponderant; the hyomandibula is, as in Teleosteans, divided into a proximal and into a distal (symplectic) element. The proximal part is received into a fenestra of the otic capsule, and is converted into a stapes, whilst the distal half either remains (*Proteus, Siren, Menopoma*) or is lost (other Urodela). The whole hyomandibula would have been lost owing to its excalation from suspensorial functions, unless it had entered the auditory service.

IV. The autostylic arrangement prevails. The whole hyomandibula remains, gains an attachment on the "tympanum" and differentiates itself into several conjointed pieces, notably stapes or columella proper, and extra-columella or malleus.

The extra-columella gains connection with the parotic cartilage; this connection frequently remains, but in *Anura* alone it conatins a special element of probably parotic origin.

The quadrate forms an important part of the tympanic frame.

IV*a*. Collateral departure of the *Anura*. The connection between the tympanal part of the hyomandibula with the mandible is lost.

V. The quadrate still forms the principal suspensorial part of the mandible. The extra-columella, or malleus, retains for a long time its previously acquired connection with Meckel's cartilage (*Amniota*).

V*a*. The top end of the hyoid is attached to the cranium (*Geckos, Mammalia*), and is occasionally fused with the extra-columella (*Hatteria*).

V*b*. Or, the proximal portion of the hyoid is removed from the skull and remains otherwise well developed (*most Lizards*); or its proximal portion becomes reduced and lost (*Chelonia, Crocodilia, Ophidia, Aves*).

V*c*. The extra-columella gains an attachment to the quadrate, squamosal, or pterygoid, whilst its connections with the mandible (*Ophidia, Chamæleon*), and the tympanum, are lost.

VI. The quadrate gradually loses its articulation with the mandible; the latter gains a new outer articulation with the squamosal; the quadrate acts almost entirely as a tympanic frame. Incus and malleus fuse sometimes with each other, and lean on to the parotic region. The masticatory joint is doubly concave-convex (*Monotremata*).

VII. The quadrate is converted into the principal part of the tympanic frame, viz. annulus tympanicus. The mandible has lost its articulation with the quadrate, and the masticatory joint is a single concave-convex one, the convexity belonging to the mandible (*Monodelphia*).

EDINBURGH.

Royal Society, April 2.—Rev. Prof. Flint, Vice-President, in the chair.—Prof. Crum Brown communicated a paper by Dr. Prafulla Chandra Rây on the conjugated sulphates of the copper-magnesium group.—Dr. John Murray read a paper by Mr. A. Dickie on the chemical analysis of water from the Clyde area.—Sir W. Turner read a paper by Prof. His on the principles of animal morphology.—Prof. Tait communicated two mathematical notes.

April 16.—Prof. Chrystal, Vice-President, in the chair.—Dr. Buchan gave an analysis of the *Challenger* meteorological observations, pointing out various important meteorological conditions the existence of which had been revealed by the work of the *Challenger* Expedition.—Dr. John Murray read a description of the rocks of the Island of Malta, comparing them with deep-sea deposits.—Prof. Chrystal described an electrical method of reversing deep-sea thermometers.—Dr. Thomas Muir read a paper on a class of alternants expressible in terms of simple alternants.—Prof. Tait communicated a quaternion note.

PARIS.

Academy of Sciences, April 30.—M. Janssen, President, in the chair.—On the consequences of the equality assumed to exist between the true and the mean value of a polynome, by M. J. Bertrand. The author shows by a rigorous demonstration that the rule is not justified which gives *a posteriori* the precise value of a system of observations, although this rule is frequently applied with complete confidence in its accuracy.—On the theory of the figure of the earth, by M. Maurice Lévy. The point here mainly discussed is the difficulty of establishing a satisfactory agreement between the theory of fluidity and that of precession in connection with Clairaut's differential equation and the subsequent researches of Lipschitz inserted in vol. lxii. of the *Journal de Crelle*.—Remarks in connection with Père Dechevrens' recent note on the ascending movement of the air in cyclones, by M. H. Faye. In order to solve by direct observation the question of the ascending or descending movement of the atmosphere in cyclones, Père Dechevrens has devised a special anemometer for his observatory of Zi-Ka-Wei in China. But he suggests that more trustworthy results might perhaps be obtained by fitting up a similar apparatus at a greater elevation from the ground; for instance, on the top of Eiffel's Tower, 300 metres high, now being erected in Paris. M. Faye accepts this suggestion, confident that, if carried out, it cannot fail to confirm his own views on the movement of the atmospheric currents in cyclones.—An elementary proof of Dirichlet's theorem on arithmetical progressions in cases where the ratio is 8 or 12, by Prof. Sylvester. In this demonstration the author starts from the following principle: To show that the number of prime numbers of a given form is infinite, let an infinite progression be constructed of integers relatively prime to each other, and each containing a prime number at least of the given form.—Distribution in latitude of the solar phenomena recorded during the year 1887, by M. P. Tacchini. A table is given of the spots, eruptions, faculæ, protuberances, as observed in each zone of 10° in the two solar hemispheres. The hydrogenic protuberances occur in all the zones, whereas the other phenomena were almost entirely restricted to the central region between 0° and ± 40°, as in the previous year. The spots, faculæ, and metallic eruptions present an agreement in the respective zones of maximum frequency between 0° and ± 20°; a maximum for each of the three orders of phenomena corresponds to the zone 0°–10° exactly as in 1886. The spots were confined to the equatorial zone (+30°–20°); the eruptions and the faculæ occurred at much higher latitudes, in fact as far as +50° and −60°. Hence there are zones with faculæ and eruptions, but without spots, while on a great part of the solar surface hydrogenic protuberances are observed in the total absence of spots.—In a second communication, M. Tacchini gives a summary of the solar observations made at Rome during the first quarter of the year

1888. From this summary it appears that the phenomena of spots and faculæ still continue to decrease, while the protuberances have increased. This confirms the remark already made that there is no close relation between these two orders of phenomena.—Determination of the heats of combustion of the isomerous acids corresponding to the formulas $C_4H_4O_4$ and $C_5H_6O_4$, by M. W. Louguinine. The constituent formulas of the fumaric and pyromalic, as well as of the mesaconic, citraconic, and itaconic acids have been the subject of frequent discussions amongst chemists. In order to throw some light on these obscure questions, the author here determines the heats of combustion of the acids in question. He concludes generally that fumaric differs greatly from pyromalic acid, the former being the lower homologue of one of the three acids with formula $C_5H_6O_4$. The formulas corresponding to these three acids are evidently closely related, the difference here being of quite another order from that which exists between the formulas corresponding to the fumaric and pyromalic acids.—On the slow combustion of certain organic substances, by M. Th. Schlœsing. The author's experiments with tobacco seem to show that the combustion arising in heaps of foliage, hay, and the like is in the first instance due to the action of micro-organisms, but with the increase of temperature it gradually assumes a purely chemical character. The influence of living organisms appears to cease between 40° and 50° C., after which the chemical action rapidly increases.

Berlin.

Meteorological Society, April 10.—Dr. Vettin, President, in the chair.—Dr. Zenker communicated the second part of his research on the distribution of heat over the earth's surface. In the first part, of which he had spoken at the last meeting of the Society, he had shown that the distribution of heat depends not only upon the radiation from the sun and absorption by the atmosphere, but additionally upon the nature of the earth's surface, whether it is land or water. In previous researches on the distribution of heat, the mean values were determined from and based upon empirical observations; Dr. Zenker, on the other hand, has calculated the distribution of heat over the surface of the sea with the help of Hann's isothermal charts, starting with the temperature of a point on its surface which was quite uninfluenced by the neighbouring continents, and was consequently equally unaffected by any warm or cold currents. Using this factor, and the formulæ deduced in the theoretical part of his paper, he has calculated the distribution of heat from the pole to the equator for each successive parallel, and compared it with the distribution of solar radiation. As a basis for the distribution of heat over the surface of the land, it was first necessary to determine the conditions under which the influence of the neighbouring sea is either nothing or minimal in amount. The starting-point for this was the fact that the temperatures on continents exhibit very great variations, and from these was determined for each area, as a percentage, the relative influences of the sea and continent upon its temperature. The region where the influence of the sea was proved to be nil (or where, as the speaker said, the "continentality" was 100 per cent.) was in the neighbourhood of the east coast of Asia, whereas all other points were found to be affected by the neighbouring sea to a greater extent; the observed temperature on the land was therefore only partly dependent upon the position of the place on any given parallel, other influences making themselves more or less felt. Hence it was possible to calculate for each parallel the real and "accessory" temperature. The amount of heat radiated down from the sun was compared with these temperatures, and was found to be about the same for each 10° C. of difference in temperature; from 0°–10° C., however, quite considerable differences of radiation were necessary. In conclusion, Dr. Zenker compared the temperatures which really exist on the earth's surface with those which he had deduced, and found that in reality the climate on the sea of the southern hemisphere is colder than it should be according to calculation—a result which must be attributed to the oceanic currents of cold water. The continental climate in the northern hemisphere is slightly too warm, in consequence of the disturbance introduced by the Gulf Stream.—Lieutenant Moedebeck gave an account of a balloon journey which he made on March 31. The marked phenomenon during the same was the influence of rivers; thus, after the balloon had risen to a height of 300–500 metres, and was passing away over Berlin, it sank so rapidly over the Spree that when it was about 50 metres above the earth a large quantity of ballast had to be thrown out. At an elevation of 1200 metres he met with a long narrow rain-cloud, in passing through which the dry-bulb thermometer registered 1°·5 C., the wet-bulb 1° C.; at an elevation of 1300–1400 metres, both thermometers recorded the same temperature of 2°·5 C. At this height, and in circumscribed areas, a few very small semi-soft hailstones were observed. Shortly after this the balloon began to sink, and while still above the cloud, but at a lower level, somewhat larger but similar hailstones were observed for the second time. As soon as the balloon had passed through the cloud, rain fell for a short time, as the result of which the balloon was so weighted that it descended rapidly to the earth. The atmosphere above the cloud was not clear but rather misty.

BOOKS, PAMPHLETS, and SERIALS RECEIVED FOR REVIEW.

Land and Fresh-water Mollusca of India, Parts 1 to 6, and plates: Lieut.-Col. H. H. Godwin Austen (Taylor and Francis).—Botany for Beginners, 4th edition: Rev. Prof. G. Henslow (Stanford).—Botany of the Afghan Delimitation Commission (Linnean Society): J. E. T. Aitchison (Longmans).—Report on the Meteorology of India in 1886: J. Eliot (Calcutta).—Indian Meteorological Memoirs, vol. iv. part 4 (Calcutta).—Memoirs on the Winds and Monsoons of the Arabian Sea and North Indian Ocean: W. L. Dallas (Calcutta).—A Short Text-book of Electricity and Magnetism: T. Dunman (Ward, Lock, and Co.).—A Short Text-book of Sound, Light, and Heat: T. Dunman (Ward, Lock, and Co.).—A Life of Matthew Fontaine Maury: D. F. M. Corbin (Low).—An Illustrated Manual of British Birds, part 2: H. Saunders (Gurney and Jackson).—Bibliothek der Gesellschaft für Erdkunde zu Berlin (Berlin).—Essai de Définition et de Nomenclature; Les Dislocations de l'écorce Terrestre: E. de Margerie and Dr. A. Heim (Zurich).—Nature's Fairy Land: H. W. S. Worsley-Benison (Stock).—Evolution and its Relation to Religious Thought: J. Le Conte (Appleton, New York).—Record of Experiments conducted by the Commissioner of Agriculture in the Manufacture of Sugar from Sorghum and Sugar Canes, 1887–88 (Washington).—The Constants of Nature, 1st Supplement to Part 1: F. W. Clarke (Washington).—The Vegetable Resources of the West Indies: D. Morris (Silver).—Fruit: Dr. Crespi (Heywood).—Journal of the Royal Agricultural Society, April (Murray).—Quarterly Journal of Microscopical Science, April (Churchill).—Geological Magazine, May (Trübner).—Journal of the Society of Telegraph Engineers and Electricians, vol. xvii. No. 72 (Spon).—Schriften der Naturforschenden Gesellschaft in Danzig, Siebenter Band, Erstes Heft (Danzig).—Bulletin of the California Academy of Sciences, vol. ii. No. 8.

CONTENTS.