THURSDAY, NOVEMBER 13, 1890.

THE CURE OF CONSUMPTION.

WHEN we read the announcement of some fresh scientific discovery, the first impulse, perhaps, is to ask, "Who has made it?" and the second, to say, "Does it sound right?"

The amazing declaration that Prof. Koch had discovered the sure means of arresting the growth of the bacillus of tuberculosis, *i.e.* of "consumption" without further imperilling the lives of its countless victims, must have made many ask themselves these questions, and in all cases probably with unanimously satisfactory replies.

The man who has made this discovery has been known for more than the last decade as the foremost technologist in bacteriology. The discoveries and really infinitely wide generalizations of M. Pasteur had cleared the way and pointed out the broad path of investigation in this branch of pathology. When Dr. Koch began his remarkable research into the life-history of the bacillus of anthrax or splenic fever, the completeness and perspicuity of that work obtained for him the opportunity of devoting his whole energies and time to this department of pure science, and now not only its votaries, but the whole mass of mankind, will applaud the magnificence of what has been achieved by patient toil in a laboratory.

Many of us doubtless remember the eloquent account given by Prof. Tyndall in the *Times*, some eight years ago, of Koch's discovery of the direct cause or virus of consumption, viz. the *Bacillus tuberculosis*, and, possibly, some may remember the ignorant contempt with which this announcement was received by the enemies of science and truth—the anti-vivisectionists. In 1884, Koch published, in his customarily complete manner, the whole chain of his investigations into this, the most general of specific diseases, and it was in this paper that he set at rest, by final judgment and demonstration of the infective character of the disease, a debate of 40 years. On looking back to that time, it is easy to see (in answer to the first question) that the character of the man's work insured, if his health permitted, the accomplishment of a gigantic step forward, such as that which is now announced on the most trustworthy authority. Were we not in eager anticipation of the publication of Dr. Koch's experimental facts, it would be out of place to ask the second question. But, as is well known, the bearing which the general drift of bacteriological research possesses at the present time is, in this connection, of the utmost interest.

Already we have learnt that, as of course seemed necessarily the case, Koch early abandoned the search for an antidote among pharmacopœial remedies, and looked for the means of arresting the functional activity of the bacillus among the biological waste-products of the organism. Pasteur's fundamental discoveries in fermentation had established the law that every micro-organism produces, from the substances which it katalyzes as a result of its biological activity (and especially multiplication), a material or materials, which, on accumulation, inhibit its growth, and finally, indeed, arrest its vitality. The actual discovery that this principle is applicable in its entirety to micro-organisms which are pathogenic, *i.e.* causative of disease, is probably due to M. Charrin, whose investigations into the properties and growth of the *Bacillus pyocyaneus* have shed much light on this difficult area of investigation. But M. Pasteur's teaching has been productive of similar results in other terribly common diseases, notably in diphtheria, at the hands of Drs. Roux and Yersin. In all cases albuminous substances have been found, which, while toxic in certain doses, are nevertheless capable of giving immunity to animals from the disease which produced them. Such albumins, as was first shown by Wooldridge, are not only to be obtained as a result of the specific katalysis of artificial cultures by the pathogenic microbe, but exist already formed in some animal tissues. According to the latest investigations of Hankin in this direction, and according to the observations of Reichert and Weir Mitchell and Wolfenden on snake poisons, and of Martin on anthrax, &c., these toxic, and yet protective albumins seem to belong almost exclusively to the class known as globulins.

Should these generalizations prove to be true, one most important step alone will be gained, viz. a definite advance into the unknown desert of biological chemistry. But, to return to the arrest *intra vitam* of an infective virus, there is another factor in the successful extinction of a parasitic poison, such as the tubercular microbe, and that is the specific resistance of the tissues to their invasion by bacilli, which has been so strikingly elucidated by Metschnikoff and others.

This factor has a specially important bearing in tuberculosis, since the bacillus, as is well known, grows with vastly different rapidity in various individuals, and even in the same patients exhibits great differences of vigour according to the tissue it has attacked. This makes the practical application of Prof. Koch's discovery so much the more striking as well as important. Already it is stated that the most chronic forms of tuberculosis, viz. caries of bones and joints and lupus, yield most readily and rapidly to the preventive treatment, whereas a greater difficulty is experienced in dealing with advanced lung disease.

There are many instructive parallels which might be drawn between this last fruit of experimental science (absurdly called vivisection) and the direct application by M. Pasteur of his labours to the prevention of a far more horrible, if fortunately relatively much rarer, disease—hydrophobia; but the storm of incredulity and abuse with which Pasteur's single-minded labours were received are replaced in the present instance by respectful appreciation and admiration.

It may be that this is a sign of the wider public knowledge of the scientific facts concerning infectious disease, or it may be that the irresistible effect of the truth of M. Pasteur's labours is clearing away the obstruction of ignorance and folly. In either case it is a happy augury of the future. But we fear much of the very different feeling with which this last gift of pure science has been received is a sad testimony to the frightfully wide extent to which this distinctive disease, tuberculosis, prevails, and that really there is no family but feels what a priceless result Prof. Koch has attained if an extended trial should confirm his early successes.

Whatever be the explanation, we earnestly hope that the public interest which is thus awakened in a practical exposition of the extreme importance of supporting scientific research, although its objects may not be at first sight apparent, will receive no disappointment or check, but develop into a true appreciation of the great principles which underlie human happiness, health, and wealth.

CLERK MAXWELL'S PAPERS.

The Scientific Papers of James Clerk Maxwell. 2 Vols. Edited by W. D. Niven, Director of Studies at the Royal Naval College, Greenwich. (London: Cambridge University Press, 1890.)

THE gratitude with which we receive these fine volumes is not unmingled with complaint. During the eleven years which have elapsed since the master left us, the disciples have not been idle, but their work has been deprived, to all appearance unnecessarily, of the assistance which would have been afforded by this collection of his works. However, it behoves us to look forward rather than backward; and no one can doubt that for many years to come earnest students at home and abroad will derive inspiration from Maxwell's writings, and will feel thankful to Mr. Niven and the committee of friends and admirers for the convenient and handsome form in which they are here presented.

Under the modest title of preface, the editor contributes a sketch of Maxwell's life, which will be valued even by those who are acquainted with the larger work of Profs. Lewis Campbell and W. Garnett; and while abstaining from entering at length into a discussion of the relation which Maxwell's work bears historically to that of his predecessors, or attempting to estimate the effect which it had upon the scientific thought of the present day, he points out under the various heads what were the leading advances made.

In the body of the work the editor's additions reduce themselves to a few useful footnotes, placed in square brackets. Doubtless there is some difficulty in knowing where to stop, but the number of these footnotes might, I think, have been increased. For example, the last term in the differential equation of a stream-function symmetrical about an axis is allowed to stand with a wrong sign (vol. i. p. 591), and on the following page the fifth term in the expression for the self-induction of a coil should be $-\frac{1}{8}\pi \operatorname{cosec} 2\theta$, and not $-\frac{1}{8}\pi \cos 2\theta$.

To a large and enterprising group of physicists, Maxwell's name at once suggests electricity, and some, familiar with the great treatise, may be tempted to suppose that this book can contain little that is new to them. It was De Morgan, I think, who remarked that a great work often overshadows too much lesser writings of an author upon the same subject. In the present case it is true that much of the "Dynamical Theory of the Electro-magnetic Field" was subsequently embodied in the separate treatise. Nevertheless, there were important exceptions Among these may be noticed the experimental method of determining the self-induction of a coil of wire in the Wheatstone's balance. By adjustment of resistances, the steady current through the galvanometer in the bridge is reduced to zero; but at the moment of making or breaking battery contact, an instantaneous current passes. From the magnitude of the throw thus observed in comparison with the effect of upsetting the resistance-balance to a known extent, the self-induction can be calculated. The letter to Sir W. Grove, entitled "Experiment in Magneto-electric Induction" (ii. p. 121), will also be read with interest by electricians. It gives the complete theory of what is sometimes called "electric resonance."

There can be little doubt but that posterity will regard as Maxwell's highest achievement in this field his electromagnetic theory of light, whereby optics becomes a department of electrics. The clearest statement of his views will be found in the note appended to the "Direct Comparison of Electro-static with Electro-magnetic Force" (vol. ii. p. 125). Several of the points which were then obscure have been cleared up by recent researches.

Scarcely, if at all, less important than his electrical work was the part taken by Maxwell in the development of the Dynamical Theory of Gases. Even now the difficulties which meet us here are not entirely overcome; but in the whole range of science there is no more beautiful or telling discovery than that gaseous viscosity is the same at all densities. Maxwell anticipated from theory, and afterwards verified experimentally, that the retarding effect of the air upon a body vibrating in a confined space is the same at atmospheric pressure and in the best vacuum of an ordinary air-pump.

Besides the more formal writings, these volumes include several reviews, contributed to NATURE, as well as various lectures and addresses, all abounding in valuable suggestions, and enlivened by humorous touches. Among the most noticeable of these are the address to Section A of the British Association, the lectures on colour vision, on molecules, and on action at a distance, and, one of his last efforts, the Rede Lecture on the telephone. Many of the articles from the "Encyclopædia Britannica" are also of great importance, and become here for the first time readily accessible to foreigners. Under "Constitution of Bodies," ideas are put forward respecting the breaking up of but feebly stable groups of molecules, which, in the hands of Prof. Ewing, seem likely to find important application in the theory of magnetism.

A characteristic of much of Maxwell's writing is his dissatisfaction with purely analytical processes, and the endeavour to find physical interpretations for his formulæ. Sometimes the use of physical ideas is pushed further than strict logic can approve;[1] but those of us who are unable to follow a Sylvester in his analytical flights will be disposed to regard the error with leniency. The truth is that the limitation of human faculties often imposes upon us, as a condition of advance, temporary departure from the standard of strict method. The work of the discoverer may thus precede that of the systematizer; and the division of labour will have its advantage here as well as in other fields.

The reader of these volumes, not already familiarly

[1] "With all possible respect for Prof. Maxwell's great ability, I must own that to deduce purely analytical properties of spherical harmonics, as he has done, from 'Green's theorem' and the 'principle of potential energy,' seems to me a proceeding at variance with sound method, and of the same kind and as reasonable as if one should set about to deduce the binomial theorem from the laws of virtual velocities or make the rule for the extraction of the square root flow as a consequence from Archimedes's law of floating bodies."—Sylvester, *Phil. Mag.*, ii. p. 306, 1876.

acquainted with Maxwell's work, will be astonished at its variety and importance. Would that another ten years' teaching had been allowed us! The premature death of our great physicist was a loss to science that can never be repaired. RAYLEIGH.

SAP.

Sap: Does it rise from the Roots? By J. A. Reeves. (London: G. Kenning, 1890.)

THE object of this book is clearly stated in the following words from the introduction (p. 4):—

"Facts will be advanced to show there is no evidence to support any of the following theories, viz.:—That the sap in trees rises at any time; that inorganic matter rises from the soil; that the soil is exhausted by the growth of vegetation; that sap is elaborated in the leaves," &c.;

and the style is exemplified in the following quotations from the conclusion (p. 82):—

"Instead of water ascending and gases descending; the facts (which are open to the observation of any person disposed to give unbiassed attention to the subject) go to prove that the water *descends* to the roots, and the gases *ascend* to the leaves, both actions being in strict conformity with the Laws of Gravitation."

"Let the reader witness a monster forest tree during a Summer shower, after a long drought, and then calmly consider—Whether the CREATOR IN HIS INFINITE WISDOM ordained that the thirsty leaves should be refreshed and invigorated by drinking in the genial rain falling upon them. Or,—Whether each leaf was designed to *resist such moisture*, but, at the same time, to draw the water it needs from the soil, which is often hundreds of feet below, and as DRY AS DUST."

The italics and large and small capitals are the author's, and we have now to examine how he proceeds to justify the extraordinary statements quoted.

Starting with a number of extracts from Sachs's "Text-book of Botany," which refer to several different things, and are in part misquoted or mutilated, and of which the most remarkable is as follows,[1] "It is not known how water reaches the tops of trees, but probably by the *formation of dew*," the author concludes that much difference of opinion exists. This conclusion is not without warrant, but the nature of the diverging opinions is by no means illustrated by his statements, and is not to be understood without an acquaintance with much more modern literature than he seems to have any knowledge of. At any rate, he might have obtained even more conflicting statements by judicious culling from the writings of Böhm, Elfving, Westermaier, Vesque, and other modern authorities. Granted, however, that much difference of opinion has been expressed on the subject, let us see how the author proceeds to clear up the matter. He suggests as an alternative theory that the leaves of plants obtain their water and mineral substances from the air.

"It is suggested that the foliage of plants by absorbing the moisture in the air also absorbs the impalpable dust which it contains."

"It seems quite possible that, in dry weather, a portion of the dust alluded to, which comes in contact with the leaves of plants, may, with the dews of night, pass through the leaf-cells into the downward flow of sap. If so, such inorganic matter becomes a constituent of the sap, to be chemically acted upon in the formation of new cells effecting the mysterious operations called growth."

This kind of thing is sufficiently startling, and what its effect may be on the minds of those insufficiently acquainted with the elements of botany need not be discussed. For the information of those who expect to find such views supported by new and adequate evidence, however, the following illustrations may suffice:—

"The oil which rises through the cotton wick of a lamp to support the flame is constantly referred to as an apt illustration of the transpiration theory."

"The leaves of the weed anacharis contain a large proportion of silica, although the plant has no root, and it grows whilst flowing with the stream."

"Seeds sown in flannel, moistened with distilled water, will grow (although not to maturity) and produce as rich green foliage as if grown in alluvial soil. [N.B.—Iron cannot be supplied from flannel.]"

If it were not that the book contains internal evidence of the deadly earnestness of the writer, we should have regarded these (and other paragraphs, adduced to show that the roots do not absorb the water and minerals of the transpiration current) as quaint jokes of the Max O'Rell or Mark Twain type. Moreover, the work teems with such funny statements. Speaking of trees (p. 40),

"If the pendent ends of the branches be embedded in the soil, the descending sap will be *drawn out* and and [*sic*] roots will be formed of the discharged sap."

Although the superfluous "and" might suggest that even the pen of the author gasped and stammered, as it were, at this monstrous statement, we fear it must be regarded as an innocent misprint, for the idea that tissues and roots can be formed by the mere hardening of sap is gravely expressed in several places, *e.g.* pp. 37, 48, and 54.

Other notions of sixteenth century value are to be found serving as the foundation stones for the curious superstructure which the author dignifies as a theory. Thus, on p. 32:—

"The germination and growth of a seed seem to be controlled by the same law of gravitation as the growth of a mature plant. Water *descending*, gas *ascending*. . . . When, however, the seed is placed in moist warm soil, water is absorbed, and a kind of fermentation or decomposition commences, the contents are expanded, the gas is necessarily evolved. This expansive operation continues until the skin of the seed is broken. The heavy watery parts exude first, and cell to cell of atomic matter becomes united with the embryo-radicle, and gravitates downwards, forming the root; while the gases or vapours, which result from the fermentation in the seeds, press upwards and cause the plumule to form."

We could not resist quoting this rather lengthy joke, for the sake of the climax: it may be doubted whether the days of a belief in levitation could have produced a statement to equal the last sentence.

This must suffice to show the tenor of the production before us, and we can only conclude by expressing our wonder that any writer could be found to invent the text and any publisher to produce it.

[1] At p. 684 of Sachs's "Text-book," second edition (English translation), this statement runs: "It is not known how this water has reached the higher parts of the trees, though it is possibly by the formation of dew," &c., and it bears a very different signification from that given.

INDOOR GAMES.

The Hand-book of Games. Vol. I. Table Games. (London: Bell and Sons, 1890.)

THIS work was originally published in the year 1850. In spite of the antiquity of the information, there is a steady demand for the old edition, and the publishers, having resolved to reissue the book, decided that it should be thoroughly revised, and many of the articles entirely re-written. In consequence of the recent development of old games and the invention of new ones, the present edition will fill two volumes of about 500 pages each, while the first edition consisted of only one volume of 600 pages.

The games included in the first volume are known as table games. The first one treated of is billiards, and is written by the noted amateur Major-General A. W. Drayson; the well-known professional Mr. W. J. Peall has read through the proof-sheets, and, in his own words, "endorsed, in nearly every case, the author's advice, both theoretical and practical." Billiards is one of the many games that have made remarkable progress in the last fifty years. Of its origin very little is known: some consider that the French invented it; others that the Germans originated the idea, the French only improving on them. Bouillet gives the English as the originators of it. "Billiards," he says in his first work, "appears to be derived from the game of bowls. It was anciently known in England, where perhaps it was invented. It was brought into France by Louis XIV., whose physician recommended this exercise." In his other work we read, "It would seem that the game was invented in England." Whatever may have been the origin of the game, it was originally played on the floor or on a table, and consisted in trying to send a ball through a ring which revolved on a pin or stick fixed firmly on the floor or table. A few years before 1674, billiards must have been well known, especially in England, for in a work published in that year, where it is described as a "most gentle, cleanly, and ingenious game," the author says that in England there were few towns of note "which had not a public billiard table, neither are they wanting in many noble and private families in the country." From those days up to the present time the game has gradually been raised from the "disreputable to the highly respectable," and it is now ranked among the first-class ones.

The game as described in this article is for amateur players only, and, as stated by Mr. Peall, "there are few amateurs who may not gain some useful hints from a study of this book." Although the author gives some very good explanations of the various strokes, describing the best ways of making them and *the effects* produced on the impact of balls, yet in some cases it would be advantageous to the reader to know the reasonings from which the results are drawn. On pp. 34 and 35, in discussing the effect produced by "side" on the striker's ball, the example he gives serves to illustrate our point.

Following these explanations, the games of pool, black pool (commonly known as "shell out"), pyramids, and snooker are described, the last of which is an extension of the game of pyramids, but not as yet generally known.

We now come to the game of chess, by Mr. R. F. Green, who gives a condensed but capital account of it as it is played to-day. Of all games chess is the most difficult, and in consequence of the riddance of the element of chance, great skill is required to play it well. In the study of this game a great expenditure of time is necessary—in fact, "no knowledge or proficiency, easily acquired, could be held in such high and general esteem; and the time involved may, especially in the case of young students, be looked upon as well spent. It constitutes a mental training of the greatest possible value, and promotes a taste which can only be elevating." Lovers of this game will find much in this article that will interest them, and the hints, technical terms, rules, moves, &c., should form a good foundation for beginners.

The remaining games include draughts, backgammon, dominoes, solitaire, reversi, go-bang, rouge et noir, roulette, E. O., hazard, and faro, all of which are thoroughly explained and illustrated by "Berkeley."

In conclusion, a work of this sort becomes a necessity to those who wish to understand the scientific principles which form the bases of many of our games, while for those who play occasionally it will serve as a most handy book for reference. It is thoroughly to be recommended.

W.

OUR BOOK SHELF.

Elementary Algebra. With numerous Examples. By W. A. Potts, B.A., and W. L. Sargant, B.A. (London: Longmans, Green, and Co., 1890.)

IN this book the principles of algebra as far as quadratic equations only are dealt with. The authors have explained them in plain and simple language, and have worked out numerous examples in order to illustrate the methods adopted. In an elementary treatise like this, intended for those who are preparing for public school entrance examinations, great importance must be attached to the working out, briefly and neatly, of examples, and here we have a good and copious collection, together with some papers set at former entrance examinations.

Heat and Light Problems. By R. Wallace Stewart. University Correspondence College Tutorial Series. (London: W. B. Clive and Co., 1890.)

THIS work forms a supplement to the author's "Elementary Text-book of Heat and Light," and is an expansion of the chapters on calculations in that book. The mathematical sides of both these subjects only being dealt with, the fundamental formulæ in each case are clearly worked out and illustrated by many examples. At the heading of each chapter a short summary is given, for convenience of reference, of the many formulæ that may have been proved in previous chapters, but which are used in the one under consideration. This method causes a saving of time and patience, and facilitates the solving of the problems. Students who find special difficulties with regard to the questions on the quantitative relations of either of these two branches of physical science, cannot do better than study this work. By so doing, they will find themselves very much enlightened, and their difficulties considerably diminished.

Annalen des k.k. naturhistorischen Hofmuseums, Wien, Bd. V., Nr. 2 and 3, 1890.

THE above-named (445 pp. in all) contain six original contributions and notices. Of the former, one, by Dr. Karl Fritsch, is botanical, and deals with the flora of Madagascar; another, by Ludwig Hans Fischer, is devoted to personal adornments among the native Indians and, of the four which remain, three are zoological, the fourth, by Dr. Felix Koerber, being meteorological. Dr. Fritsch's communication, *apropos* of collections made by Dr. Paulay on the voyage of the "*Saida*," adds to the genera *Blepharis* and *Walleria* each a new species, while new varieties of *Hibiscus vitifolius* and *Cynorchis fastigiata* are described. Dr. Fischer's paper gives an account of his journeys and collections made on behalf of the Vienna Museum. It is a most interesting and carefully executed work of 30 pp., with six plates and 51 admirable woodcuts. The author's notes on ear ornaments are especially commendable, but when all is done as by him it becomes difficult to particularize. This monograph bears the same stamp of excellence as those of Dr. Otto Finsch and Prof. Hein which have preceded it (cf. NATURE, vol. xlii. p. 157), and ethnologists owe the authorities of the Vienna Museum a debt of gratitude for the manner in which they have enriched the literature of their subject. Of the zoological treatises, one (by Dr. Gottlieb Marktanner-Turneretscher) is a Report upon the Hydroids in the Museum collection. The *Gymnoblastea* and *Calyptoblastea* are chiefly dealt with; several new forms are described, localities and donors' names are sufficiently recorded, and a Report upon the *Hydrocorallines* is promised. The two remaining contributions are entomological. One, by Dr. J. Kreichbaumer (13 pp.), is a continuation of the author's previous Report on the *Ichneumonidæ* in the Museum; new genera and species are described. The other is a lengthy monograph of the Linnean genus *Sphex* (266 pp., with 5 plates) by Franz Friedr. Kohl. The author acknowledges his indebtedness to the collections of other Museums and of private individuals, from many of which types have been lent him, and he makes a point of excepting "the material in the London Museum, which contains the greatest number of types." This is greatly to be regretted, in consideration of the pretentious nature of his work, which purports to be a revisionary monograph of the genus; he promises a companion treatise on the allied genera *Ammophila* and *Sceliphron*, and we sincerely hope that, in preparing this, arrangements may be made whereby he shall consult our national cabinet.

Exercises in Practical Chemistry. By A. D. Hall, M.A. (London: Rivingtons, 1890.)

THE author states in his preface that an opinion has been growing latterly that chemistry, as usually taught, is a subject lacking in educational value, and that this is especially the case in practical chemistry. These exercises are suitable for boys beginning practical work, and they are intended "to exemplify the exact nature of chemical reactions, and to illustrate some of the great principles and fundamental laws of the science." Consequently many of the exercises are quantitative. The first experiment is a verification of Boyle's law by means of a straight barometer tube and mercury. The second is a determination of the coefficient of expansion of air. After a few such preliminary exercises, the more usual chemical experiments follow. The author has not attempted to give "details of craftmanship," as he states that they can be better obtained from the teacher.

An Elementary Geography of India, Burma, and Ceylon. By Henry F. Blanford, F.R.S. Macmillan's Geographical Series. (London: Macmillan and Co., 1890.)

DR. GEIKIE, the editor of Macmillan's Geographical Series, could not have entrusted the subject of the present volume to a more thoroughly competent writer than Mr. Blanford. In the course of a long service in India, as Mr. Blanford himself notes in the preface, he had occasion to visit most parts of the Empire, so that his knowledge of the geography of India is incomparably more exact, extensive, and vivid than if it had been derived merely from books. Traces of this fact are to be found in every section of his excellent manual. In the preparation of a volume of this kind one of the chief difficulties of the writer is to decide how much shall be omitted; and this question Mr. Blanford seems to us to have settled with admirable tact and judgment. Nothing he introduces would, if properly understood, tend simply to burden the memory. The facts he has selected are both important and interesting; and they are presented in so simple and clear a style, while their relations to one another are so distinctly brought out, that they cannot fail to arrest the attention of young learners, and to foster the growth of individual intelligence. The illustrations—for the most part taken from photographs—are in every way worthy of the text.

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.*]

Araucaria Cones.

I AM happy to say that I can inform the Duke of Argyll of at least two instances within my own personal observation of the fruiting of Araucaria. The cones were seen, and one of them handled, by myself and many members of the Geologists' Association five years ago, when we were entertained at luncheon by our excellent Rural Dean, the Rev. J. T. Brown, Rector of St. Paul's, Wokingham. The fact will be found recorded in the Proc. Geol. Assoc., vol. ix. p. 223. The other instance was a few years earlier, and the tree which bore the cones is, I believe, still standing on the lawn of Sandhurst Rectory. My attention was drawn to them, as to something somewhat rare, by the present Bishop Suffragan of Reading, who was Rector of Sandhurst at that time. A year or so later, a geologist, who has written much on palæobotany, when on a visit to this neighbourhood for the purpose of making the acquaintance of the London Bagshots, had the assurance to inform me that the Araucaria never blossomed or fruited in this country, because it was a diœcious tree! In order to convince him of his error on so fundamental a matter, I took him to Sandhurst Rectory and pointed out the tree to him; but I cannot recollect if any fruit-cones were on it then.

I may add that the fruit is large and the bract-scales very succulent. It resembles most nearly the fruit of the Alpine cedar (*Pinus Cembra*), but the fruit is three or four times as large.

Wellington College, Berks, Nov. 7. A. IRVING.

IT is quite a common occurrence for the Araucaria to bear cones in this country, when the tree is healthy and of fair size. Very possibly it may be necessary that some check to its development shall have taken place before a large number of cones are formed, as I have never seen more than three or four upon a single tree.

Not only are the cones formed, but seed is ripened, and I have now in my possession some plants about three years old, which I have reared from English-grown seeds picked up under a fruited Araucaria. Apparently about a year elapses between the appearance of the cone and the shedding of the seed, and no doubt towards the end of the summer of 1891 the tree belonging to the Duke of Argyll will yield many thousands of fertile seeds. These do not seem to keep well through the winter, but are best sown in the autumn without delay. Artificial heat is not necessary to their germination. JOHN I. PLUMMER.

8 Constitution Hill, Ipswich, November 11.

IN reply to the Duke of Argyll's inquiries (NATURE, November 6, p. 8), we have an Araucaria in our garden, now about 20 feet high, which bore barren cones first in the summer of 1889. We have also a seedling Araucaria, one of several grown from seeds from large seed-bearing cones gathered from the avenue of Araucarias in the late Lady Rolle's grounds at Bicton Park, near Budleigh Salterton, in 1878, at which time they were abundant on the splendid trees forming the avenue.

Further Barton, Cirencester, Nov. 9. E. BROWN.

Squeaking Sand *versus* Musical Sand.

ALLOW me to use your columns to thank Mr. Henry C. Hyndman for the reference in NATURE of October 2 (vol. xlii. p. 554) to a locality of sonorous sand in the interior of South Africa. Its occurrence in the interior is new to me, though it has been reported from the west coast at Liberia, and at Cape Ledo, from which latter place my friend, Mr. L. Harold Jacoby, a member of the American Eclipse Expedition, recently brought me specimens.

Dr. Alexis A. Julien and myself quite agree with Mr. Carus-Wilson in his remarks (NATURE, October 9, vol. xlii. p. 568) that there is no scarcity of sonorous sand, and only observers are lacking. This we established in 1884, when we announced at once seventy-four localities on the Atlantic coast of the United States, although at the time we began our researches its occurrence at Manchester, Massachusetts, was thought to be unique in America. The localities were in part reported by the keepers of life-saving stations to whom we had sent circulars.

The old theory adopted by Mr. Carus-Wilson, that the sounds are produced by "rubbing together of millions of clean sand grains very uniform in size," is, we think, insufficient to explain *musical* sand, but well adapted to explain *squeaking* sand. Two distinct classes of sounds are produced by disturbing sand, both undoubtedly due to vibrations; the more common sound is caused by attrition of the particles, and has a well-known harsh character by no means musical; this in rare cases becomes a loud squeak. The second is caused, we believe, by oscillations of the particles themselves protected from actual contact by elastic air-cushions, and this is decidedly musical in tone. Musical sand yields notes by friction only when *dry*; squeaking sand yields a harsh, shrill squeak (reminding one of the cry of a guinea-fowl), best when *moist*. This latter variety is very rare; we have collected by correspondence and in person over 500 samples of sand from around the world, and musical sand seems to be comparatively common, but only two localities of squeaking sand are known to us, both in so-called boiling springs—one in Maine, and the other in Kansas. A very small quantity of squeaking sand pressed between the thumb and forefinger produces, when wet, a peculiar shrill squeak—a phenomenon which we think well explained by the attrition theory. The magnificent acoustic displays which I have witnessed in the desert of Sinai (NATURE, vol. xxxix. p. 607) and on the coast of Kauai (NATURE, vol. xlii. p. 389) are, however, manifestly due to greater freedom of oscillatory motion than is possible if the particles merely scrape against each other.

Dr. Julien and I await with interest the second edition of Mr. Carus-Wilson's paper, and shall be very much obliged to him for giving a large circulation to the results we have obtained by extended travel and years of study, though we had planned to present the results to the scientific public in our own way.

H. CARRINGTON BOLTON.

University Club, New York City, October 27.

Honeycomb Appearance of Water.

THIS afternoon, while ascending a mountain pathway adown which water was trickling, after the torrents of rain that fell in the morning had ceased, I observed an appearance of the surface of running water so exactly like the hexagons of the bees' cells that I looked at it carefully for some time. Little air-bells of water seemed to issue from under the withered leaves lying in the tract, which rushed towards the hexagons, occupying an irregular space about four inches by five. As soon as these air-bells arrived at the hexagons, they arranged themselves into new cells, making up, apparently, for the loss occasioned by the continual bursting here and there of the cell-walls. No sooner had these cell-walls burst, than others closed in and took their places. The worst-formed hexagons were those at the under or lower side of the surface—the part of the surface farthest down the hill; here they were larger, and more like circles. By an ingenious mechanical theory, Darwin accounts for the hexagonal structures of the cells of the hive-bee so as to supersede the necessity of supposing that the hive-bee constructed its comb as if it were a mathematician. But here the blind forces of Nature, under peculiar conditions, had presented an appearance, on running water less than half an inch in depth, so entirely like the surface of a honeycomb, that it would be a startling result could it be reproduced in a laboratory.

J. SHAW.

Tynron, November 7.

On the Soaring of Birds.

MR. GUTHRIE has suggested (November 6, p. 8) one more *vera causa* of soaring. Like all its predecessors, this seems to the last degree unlikely to occur to an extent adequate to the explanation of soaring in the sense in which the term is commonly used, viz. floating at a constant height without motion of the wings.

May not the true cause be that birds do not soar at all in this sense, but only seem to soar because the movement of the wings is too rapid for our imperfect eyes to detect? Is it not possible that birds which to our eyes seem to soar would betray themselves to the camera? Is it not also possible that in some cases the motion may be too rapid to be discovered even by photography?

Whether this be the whole truth or not, I venture to protest against such statements as that a bird followed a ship for 11 minutes "without flapping a wing." If Mr. Guthrie had said, "without any flapping which my eyes could perceive," I should not have had a word of criticism to offer. But that would be an entirely different statement. What would be thought of one who should say that he had seen a conjurer with hands a yard apart take a card with the right hand out of the left without any movement of either hand? Yet many people have seen or seemed to see this common trick.

G. W. H.

A Bright Green Meteor.

AN exceedingly bright green meteor was seen here on the 8th inst. at 5.30 p.m. It passed from north to south under α and β Aries, which would give it an altitude of 19°. The path was parallel to the above stars and about 5° in length. This indication may serve to determine the height of the meteor if it was seen from elsewhere.

J. P. MACLEAR.

Cranleigh, Guildford.

Weighing by a Ternary Series of Weights.

IT has been shown in NATURE (vol. xlii. p. 568) that any number of pounds may be weighed with weights, the numbers of pounds in which form a geometrical progression with 1 for first term and 3 for common ratio. The following method of treating the same problem may serve to illustrate some remarks made by the President of the Mathematical Section of the British Association at the recent meeting in Leeds. One of these remarks had reference to the fascinating interest attaching to such inquiries into the properties of series of numbers, another showed that the adoption of special systems of notation for different problems was often of great service, and a third remark alluded to the attainment of one and the same result by diverse methods of procedure. In the present case the interest attaching to the subject may be left to speak for itself; the notation suitable for the problem requires elucidation. It is well known that by means of only two figures, 1 and 0, any number may be expressed if we agree that the value of the 1 shall be doubled every time it is removed one place further to the left, so that, for example, 11111 would denote the number 1+2+4+8+16, and that any number not greater than 31 would be denoted by means of five figures or less. It follows that if we had five weights of corresponding value to the above five numbers we could weigh any number of units of weight from 1 to 31. Now, the present problem only differs from this in two respects—namely, in that the 1 increases threefold in value on being removed one place to the left, and that the value denoted by it may in any position, except the place on the extreme left, be taken negatively. Let us agree to denote the negative value by using a different type, and we may then indicate all values from 1 to 40 as follows:—

1	1	111	5	1111	14	1011	23	1111	32
11	2	110	6	1110	15	1010	24	1110	33
10	3	111	7	1111	16	1011	25	1111	34
11	4	101	8	1101	17	1001	26	1101	35
		100	9	1100	18	1000	27	1100	36
		101	10	1101	19	1001	28	1101	37
		111	11	1111	20	1011	29	1111	38
		110	12	1110	21	1010	30	1110	39
		111	13	1111	22	1011	31	1111	40

In the extreme right-hand column of this table, where 1 denotes a single unit, the figures 1, **1**, 0 are written each once and then repeated in the same order, and so on to the end. In the second column, where 1 denotes three units, each figure is repeated three times, and then again three times, and so on to the end, but this column begins at the value $\frac{3+1}{2}$. The third column, where 1 denotes nine units, begins at the value $\frac{9+1}{2}$, and the figures are repeated nine times. The fourth column, in which 1 stands for 27, begins at the value $\frac{27+1}{2}$, and contains only the figure 1, twenty-seven times repeated. Hence it will be found that, in order to weigh all the pounds from one to forty, we shall have to make use of *each* weight twenty-seven times.

If, instead of four, seven weights were used, we might, by using each weight $3^6 = 729$ times, weigh any number of pounds from 1 to $729 + \frac{729-1}{2} = 1093$[1] pounds.

Further, we may, for any given number of weights, construct tables, one for each weight, showing the numbers of pounds for which it will be used positively, and also indicating by different type the numbers for which it has to be subtracted. Thus, with five weights we should have for the first four the following tables, whilst the fifth would contain the 81 consecutive numbers beginning with 41 and ending with 121, all to be used positively.

1	4	7	10	13	16	19	22	25
28	31	34	37	40	43	46	49	52
55	58	61	64	67	70	73	76	79
82	85	88	91	94	97	100	103	106
109	112	115	118	121	**2**	**5**	**8**	**11**
14	**17**	**20**	**23**	**26**	**29**	**32**	**35**	**38**
41	**44**	**47**	**50**	**53**	**56**	**59**	**62**	**65**
68	**71**	**74**	**77**	**80**	**83**	**86**	**89**	**92**
95	**98**	**101**	**104**	**107**	**110**	**113**	**116**	**119**

2	3	4	11	12	13	20	21	22
29	30	31	38	39	40	47	48	49
56	57	58	65	66	67	74	75	76
83	84	85	92	93	94	101	102	103
110	111	112	119	120	121	**5**	**6**	**7**
14	**15**	**16**	**23**	**24**	**25**	**32**	**33**	**34**
41	**42**	**43**	**50**	**51**	**52**	**59**	**60**	**61**
68	**69**	**70**	**77**	**78**	**79**	**86**	**87**	**88**
95	**96**	**97**	**104**	**105**	**106**	**113**	**114**	**115**

5	6	7	8	9	10	11	12	13
32	33	34	35	36	37	38	39	40
59	60	61	62	63	64	65	66	67
86	87	88	89	90	91	92	93	94
113	114	115	116	117	118	119	120	121
14	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**
68	**69**	**70**	**71**	**72**	**73**	**74**	**75**	**76**
95	**96**	**97**	**93**	**99**	**100**	**101**	**102**	**103**

14	15	16	17	18	19	20	21	22
23	24	25	26	27	28	29	30	31
32	33	34	35	26	37	38	39	40
95	96	97	98	99	100	101	102	103
104	105	106	107	108	109	110	111	112
113	114	115	116	117	118	119	120	121
41	**42**	**43**	**44**	**45**	**46**	**47**	**48**	**49**
50	**51**	**52**	**53**	**54**	**55**	**56**	**57**	**58**
59	**60**	**61**	**62**	**63**	**64**	**65**	**66**	**67**

Supposing, now, we wished to determine how any number of pounds, less than 122, may be weighed by means of the weights 1, 3, 9, 27, 81, we seek the number in question, say, for example, 115, first in the upper part of each of the first four tables, as well as in the fifth, and find in this way that we shall require to place all the weights except the weight 3 on one side of the balance; and as the same number is found in thick type in the second table, we see that the weight 3 must be placed in the opposite scale of the balance, and we have $1 + 9 + 27 + 81 - 3 = 115$. In like manner $70 = 1 + 81 - (3 + 9)$ and $38 = 3 + 9 + 27 - 1$. It is manifest that these tables, like the similar tables founded on the binary series, 1, 2, 4, &c., may be used to discover what number up to a certain limit a person has thought of, on being informed first in which of the tables the number occurs in the upper part of the table, and then in which, if any, of the remaining tables it is found in the lower part. For this purpose it is only necessary to add together, not the lowest numbers at the head of the tables, as for the binary series, but to take in each table a number one less than the double of the lowest number, both in the positive and in the negative group, and then to subtract the second sum from the first.

Many facts respecting such tables as the above may be ascertained from the following rows of numbers, which are formed, a column at a time, beginning on the left with 1, 0, 1, and adding the last number to each of the former two, which gives 2, 1 and their sum, 3, for the second column; from these 3 + 2, 3 + 1, and their sum, for the third, and so on.

1 .	2 .	5 .	14 .	41 .	122 .	365 .	1094
0 .	1 .	4 .	13 .	40 .	121 .	364 .	1093
1 .	3 .	9 .	27 .	81 .	243 .	729 .	2187

The upper row contains the lowest numbers in the several tables; the middle number in any column shows the highest number of units that can be weighed with the weights shown in the last row as far as the preceding column. The first two rows, moreover, show, in reverse order, how many times each weight will be used positively or negatively. The *highest* of the weights, for example, will be used only positively, as shown by the numbers 1, 0 in the *first* column, the weight next to the highest will be used twice as often positively as negatively, as shown by the numbers 2, 1 in the *second* column, and so on. Thus, for five weights we should have in the *first* table, as shown by the *fifth* column, 41 numbers in the upper part of the table, 40 in the lower part; in the second table the corresponding numbers are 3 × 14 and 3 × 13; in the third 9 × 5 and 9 × 4, and in the fourth 2 × 27 and 27, as we have already found above.

J. WILLIS.

Bradford, October 22.

[1] The coincidence of this number with the number of NATURE in which this subject was introduced is, of course, purely fortuitous.

THE CELL THEORY, PAST AND PRESENT.[1]

II.

THE continued investigations into the structure of cells, both in plants and animals, led to modifications in the conception of their morphology. Hugo von Mohl announced that he had discovered (*Botanische Zeitung*, translated by A. Henfrey in Taylor's "Scientific Memoirs," vol. iv., 1846) in the vegetable cell, after being acted on by alcohol and iodine, a thin nitrogenous membrane distinct from and applied to the inner surface of the cellulose wall of the cell, which he named the *primordial utricle*. He regarded it as forming a vesicle within the cell wall, and containing the contents and the nucleus. By subsequent observers it has been shown that the primordial utricle is nothing more than a thin layer of protoplasm lying close to the cellulose wall, and inclosing the sap cavity of the cell.

Prof. Huxley, in an article on the cell theory (*British and Foreign Medico-Chirurgical Review*, October 1853), criticized the views of Schleiden and Schwann, and introduced the terms *endoplast* and *periplast* into histological description. He regarded the primordial utricle as the essential part of the endoplast in the plant, and as homologous with the "nucleus" of the animal cell; whilst the protoplasm and nucleus are simply its subordinate modifications. The periplast, on the other hand, consisted in plants of the cellulose cell wall; whilst in animals the cell wall and matrix of cartilage, the cell walls and intercellular substance of connective tissue, the calcified matrix of bone, and the sarcous elements of muscular fibre, were all examples of periplast which had passed through various forms of chemical and morphological differentiation. Huxley maintained that the periplast was the metamorphic element of the tissues, and by its differentiation every variety of tissue was produced, owing to intimate molecular changes in its own substance. The endoplast again might grow and divide, as in the process of cell multiplication; but it frequently disappeared, and underwent neither chemical nor morphological metamorphosis; and so far from being a centre of vital activity, he held that it exercised no attractive, metamorphic, or metabolic force upon the periplast.

[1] The Inaugural Address delivered to the Scottish Microscopical Society, by Sir William Turner, F.R.SS. L. and E., President of the Society. Continued from p. 15.

But about this time it began to be more distinctly recognized that many anatomical units which were to be regarded as cells, as Schwann had indeed admitted in a few exceptional cases, possessed no cell wall or investing membrane, and that the analogy with a bladder or vesicle could no longer be sustained. Thus in 1856 ("Lehrbuch der Histologie," 1857; preface dated October 1856), Leydig gave as his idea of a cell a more or less soft substance, approaching in its original state to the globular in form, which inclosed a central body, the nucleus. Subsequently, the cell substance might harden into a more or less independent membrane, and the cell would then consist of membrane, contents, and nucleus. Leydig's conception, therefore, of what were the essential parts of a cell closely corresponded with the opinion expressed some years previously by John Simon. Brücke again maintained ("Elementarorganismen," *Wien. Sitzbericht*, 1861) that the constancy of the presence of a nucleus was subject to certain limitations, especially in the cells of cryptogams, and that there was no positive information either respecting the origin or the function of the nucleus. He further showed that the soft contents of the cell were of a highly complicated nature, and that they frequently exhibited spontaneous movements and contractility. In 1861 and also in 1863, Max Schultze published (*Müller's Archiv*, 1861, p. 1; "Das Protoplasma," Leipzig 1863), most important papers on the properties of cells. He adopted the term protoplasm which Von Mohl had employed to designate the contents in vegetable cells which surround the nucleus, and applied it to the substance which had the corresponding position in animal cells. He completely discarded the view that a membrane was essential to a cell, and defined a cell as a nucleated mass of protoplasm. He identified the protoplasm of the animal and vegetable cell as essentially the same substance as the contractile sarcode which forms the freely moving pseudopodia of the Rhizopoda, and he looked upon it as possessing great physiological activity. The conception of the functions and relative importance of the constituent parts of a cell had now undergone a material change. The suggestive ideas of Simon and Leydig had been distinctly formulated by Max Schultze. Instead of the cell membrane being regarded as a necessary part of a cell, and the active element concerned in the formation of the cell contents, as Schwann believed, it now became universally recognized as only a secondary structure formed by a differentiation of the superficial part of the protoplasm. Schultze also maintained that the appearance of the membrane might be looked upon as a sign of commencing loss of activity, for a cell with a membrane can no longer divide as a whole, but the division is restricted to the protoplasm contained within it. A cell with a membrane is, he says, like an encysted Infusorian. Taking the embryonal cell as a type, he believed that both the nucleus and the protoplasm were derived from the corresponding constituents of another cell. The protoplasm was the substance especially endowed with living force; the nucleus, he thought, played an important *rôle*, though its exact function could not be defined. The only structural character which Schultze recognized in the protoplasm was a finely granular appearance throughout the somewhat jelly-like, contractile material in which the granules were embedded. Although the name of protoplasm was now given to this substance, yet it obviously corresponded morphologically with the blastema which both Schleiden and Schwann had recognized within the cell, between the nucleus and the cell wall; though it now assumed in the minds of observers a different physiological import.

The reign of protoplasm had now been inaugurated. Not only was the cell membrane believed to be a product of its differentiation, but the matrix of cartilage and of connective tissues, and the other intercellular substances, were thought to be produced not as a secretion, but by a conversion of the protoplasm of the cells into their respective forms. But, further, Max Schultze ("Organis. der Polythalamien," 1854) described a non-nucleated Amœba; and Haeckel (*Zeitsch. f. wiss. Zool.*, 1865, Bd. xv.) and Cienkowski (Max Schultze, *Archiv*, 1865) other non-nucleated organisms, simple in their structure. These organisms were believed to consist solely of a clump of soft protoplasm, which might either be naked, when they were called *simple cytodes;* or encased in a wall or envelope, and then termed *encased cytodes.* Haeckel named these—the most simple of all organisms—Monera, and referred them to a group on the confines of both the animal and the vegetable kingdoms, which he termed Protistæ. Stricker ("Allgemeines über die Zelle," in "Handbuch der Lehre von den Geweben," Leipzig, 1871) also excluded the nucleus as necessary to our conception of an elementary organism. He went so far as to say that the historic name of cell might be applied to the morphological elements of the higher animals, or to independent living organisms, even if they were only little masses of animal sarcode or protoplasm. He was not, however, disposed to extend the definition to isolated fragments of living protoplasm, unless the whole group of phenomena characteristic of an independent organism could be recognized. Stricker held that protoplasm may be fluid, solid, or gelatinous. It exhibited the phenomena of movement, of nutrition, of growth, and the capability of reproducing its like, *i.e.* the sum of the phenomena which are characteristic of living organisms.

The doctrine that a nucleated mass of protoplasm was the structural unit common to organisms generally, both plants and animals—though at the very bottom of the scale the phenomena of life could be manifested by a particle of protoplasm without a nucleus—received its most popular expression, in this country at least, in a well-known address by Prof. Huxley.[1] In this address he stated that protoplasm, simple or nucleated, is the formal basis of all life, and that all living forms are fundamentally of one character. His views, therefore, had undergone some modification, as to the element of the tissue in which vital activity was more especially centred, since the publication of his previous article on the cell theory.

But contemporaneous with these researches on the protoplasmic theory of cell structure and activity, an English physiologist, Dr. Lionel Beale, was conducting investigations into the structure of the simple tissues from an independent and somewhat different point of view. He considered that the elementary tissues of every living being consisted of matter in two states ("Structure of the Simple Tissues," London, 1861)—the one an active, living, growing substance, composed of spherical particles, capable of multiplying itself, and coloured red by carmine, which he named *germinal matter;* the other, named by him *formed material*, was situated peripherally to the germinal matter from which it was produced; it was passive, non-living or dead, incapable of multiplying itself, and not coloured red by carmine like the germinal matter. In adapting these terms to the ordinary nomenclature of the cell, Dr. Beale states:—

"In some cases the germinal matter corresponds to the 'nucleus'; in others, to the 'nucleus and cell contents'; in others, to the matter lying between the 'cell wall,' and certain of the 'cell contents'; while the formed material in some cases corresponds exactly to the 'cell wall' only; in others, to the 'cell wall and part of the cell contents'; in others, to the 'intercellular substance'; and, in other instances, to the fluid or viscid material which separates the several 'cells, nuclei, or corpuscles' from eachother."

According to this theory of the tissues, all the elementary parts of the body consist of two substances—an

[1] "On the Physical Basis of Life," a Lay Sermon delivered November 8 1868, *Fortnightly Review;* also in "Lay Sermons and Addresses," London, 1870.

active, living, germinal matter, an inactive, non-living, formed material. Every living elementary part is derived from a pre-existing living elementary particle. The nuclei of the germinal matter, though remaining for a long time, perhaps, in a comparatively quiescent state, may become active and give rise to new nuclei. Dr. Beale held that the cell wall was by no means constantly present in cells, and that, when present, both it and the intercellular substance were formed or produced by, or a conversion of, the germinal matter. In a subsequent work, Beale ("Bioplasm," London, 1872) substituted the term *bioplasm* for germinal matter, and included in it the nucleus, nucleolus, and some forms of protoplasm. It is, he says, from the bioplasm that the formed material is produced.

An important advance was made in the conception of the structure of the constituent parts of the cell when it was ascertained that protoplasm was not the structureless, granulated jelly, or slime, which it was originally supposed to be, but that it consisted of two parts, viz. a minute network of very delicate fibrils and an apparently homogeneous substance which occupied the interstices of the network. Stilling and Max Schultze recognized the fibrillated character of the protoplasm of nerve cells and axial cylinders, but Frommann, Heitzmann, Klein, and other histologists applied the observations to the structure of protoplasm generally.

The subject made yet a greater step forwards when it was ascertained by Strasburger and Flemming that the nucleus in its passive or resting stage consists, in addition to the nucleolus, of threads or fibres, some finer, others coarser, formed of *nuclein*, and arranged in a reticular network, so as to form little knots at the points of intersection of the fibres. In the interstices of the network an apparently structureless intermediate substance, nuclear fluid or *nucleoplasm*, is situated; and the nucleus is surrounded by a membrane.[1] By some observers the threads are regarded not as forming a network, but as a greatly coiled single thread. From the affinity which they have for colouring-matter, so that they easily stain with dye, Flemming has named them *chromatin fibres*.[2] But the whole question of the relation of the nucleus to the life of the cell, more especially in connection with the production of young cells, assumed a much more definite form when it was discovered that the chromatin nuclear fibres took a primary part in the division of the nucleus in the process of cell multiplication. The nucleus was now reinstated in its place as of primary importance in the structure of cells, and as an essential factor in the formation of new cells. The movements of the fibres within the nucleus, and their rearrangement so as to form definite figures, which changes precede the act of division, were named by Schleicher *karyokinesis*,[3] or nuclear movement, a term which has now been generally adopted.

Waldeyer states that Schneider, of Breslau, was the first to recognize these movements of the nuclear fibres, and to describe them in connection with the division of the ova, the sperm cells, and also the tissue cells of a flat worm, *Mesostomum*; but Bütschli and Foli made the process more generally known. The publication of their researches excited the greatest interest, and a host of observers, amongst whom I may especially name Strasburger, Flemming, Hertwig, Balbiani, E. van Beneden, Johow, Heuser, Pfitzner, J. M. Macfarlane, Carnoy, and Rabl, demonstrated the process in a number of plants and animals, and the literature of the subject is now very extensive. In order to express the appearances presented, and the changes which take place both in the nucleus and in the cell in the process of division, a new nomenclature has been introduced, and we now read of cytaster, monaster, dyaster, equatorial plate and crown, pithode or cask-shaped, spindles, ellipsoids, coils, skeins both compact and loose, pole radiations, spirem, and other terms. From the range of the literature it would be a work of considerable labour and time to make an analysis of the different observations so as to associate with the name of each observer the particular set of facts or opinions which he has made known. Fortunately, this is unnecessary on my part, as admirable *résumés* of the whole subject have recently been published both by Prof. McKendrick of Glasgow (Proc. Phil. Soc., vol. xix., Glasgow, 1888) and Prof. Waldeyer of Berlin (*Archiv für Mikros. Anat.*, Bd. xxxii., 1888).

Without entering into a detailed description, it may be sufficient for my present purpose to say that four stages may be recognized in connection with nuclear division.

The *first*, or *spirem stage*, exhibits several phases. At its commencement the finer threads, which connect the primary or coarser chromatin fibres of the resting nucleus together, and which give the network-like character, have disappeared along with the knots at their points of intersection and the nucleoli. The primary chromatin fibres, or *chromosome* as Waldeyer calls them, form a complex coil, the spirem or ball of thread, which divides into loops, about twenty in number, and forms a compact skein. The loops are placed with their apices around a clear space called by Rabl the "polar field," whilst their free ends reach the opposite surface of the nucleus or the "antipole." The nucleus also increases in size contemporaneously. The loops next become not so tightly coiled, and form the loose skein though the individual fibres thicken and shorten. A most important change then occurs, which was discovered by Flemming, and which consists in a longitudinal splitting of each loop or primary chromatin fibre into two daughter threads. A spindle-shaped figure, first seen by Kowalevsky, next appears in the nucleus; it consists of threads that stain much more feebly than the chromatin fibres.[1] The spindle has two poles and an equator, and it finally occupies a position in the deeper part of the nucleus; its equator lies in the plane through which division of the nucleus is about to occur. The loops of chromatin fibres group themselves in a ring-like manner around the equator of the spindle with their angles inwards, whilst from each pole of the spindle a radiated appearance (*cytaster*) extends into the protoplasm of the cell. The membrane of the nucleus has now disappeared, so that it is directly invested by the protoplasm of the cell; and it is possible, as Strasburger thinks, that there may be a direct flow of the protoplasm into the nucleus, and that the spindle may be produced by it. At the pole of the spindle, from the point at which the cytaster radiates, E. van Beneden has seen a small, shining, polar body, which Strasburger says is not found in vegetable cells.

The *second*, or *monaster stage*. When the chromatin loops have arranged themselves about the equatorial plane of the spindle with their limbs pointing outwards, and the angle of the loop towards the centre of the spindle, a single star-like figure (*monaster*, *equatorial plate* or *crown*) is produced. The two daughter threads, into which each primary chromatin thread had previously split longitudinally, now separate from each other, and, according to Van Beneden and Heuser, pass to opposite poles of the nuclear spindle, where they form loops. These changes are known as the process of *metakinesis*.

In the *third*, or *dyaster stage*, the chromatin loops at each pole of the spindle arrange themselves so that the angles of the loops, though not touching each other, are close together at the pole, and the limbs of the loops are bent towards the equator of the spindle. Two stars are thus produced (*dyaster*), one at each pole, and each star

[1] This membrane is perhaps nothing more than a somewhat differentiated layer of the protoplasm of the cell arranged around the nucleus.

[2] The chromatin fibres appear to be composed of granules or spherules, named "microsome-disks" by Strasburger.

[3] Flemming proposed the term *karyomitosis*, or nuclear threads, to express the thread-like figures formed in the process. M. Carnoy gives the name *enchylema* to the apparently structureless material which occupies the interstices of the network in both the nucleus and cell protoplasm.

[1] Owing to the feeble staining of the spindle figure and of the nucleoplasm, the substances which compose them have been named *achromatin*.

is formed of one of the daughter threads into which each chromatin fibre of the monaster divides by its longitudinal splitting. Each star is sometimes called a daughter skein; around each daughter skein a membrane appears at this stage, and a daughter nucleus is then formed.

In the *fourth* or *dispirem stage*, the chromatin threads thicken and shorten, and the loops of each star arrange themselves with the angles towards the polar field of the nucleus, and the limbs to the antipole.

The division of the mother cell into two new daughter cells is now completed by the cell protoplasm gradually constricting in the equatorial plane until at last it is cleft in twain, and each daughter nucleus is invested by its own mass of protoplasm. The chromatin threads of the daughter skein then form a network of coarser and finer fibres, a nucleolus appears, and the resting nucleus of the daughter cell is completed. Two daughter cells have thus arisen, each of which possesses its own independent vitality. Owing to the very remarkable longitudinal splitting of the fibres of the chromosome, and the distribution of the daughter threads from each fibre to the opposite poles of the spindle, it follows that each daughter nucleus contains about one-half of each chromatin fibre, so that whatever be the properties of the chromosome of the mother cell, they are distributed almost equally between the nuclei of the two daughter cells. As regards the cleavage of the protoplasm, there is no evidence that such a rearrangement of its constituent parts takes place as to give to each daughter cell one-half of the protoplasm from each pole of the mother cell. It is probable that each daughter nucleus simply becomes invested by that portion of protoplasm which lies in proximity to it at the time when the constriction of the protoplasm begins. The young daughter cell, seeing that it is composed both in its nucleus and protoplasm of a portion of each of these constituent parts of the mother cell, possesses therefore properties derived from them both.[1]

Owing to the disappearance of the nuclear membrane at the end of the spirem stage of karyokinesis, at least in cells generally (though it is said to persist in the Protozoa during the whole process of karyokinesis), it follows that the nucleoplasma and the cell protoplasm cease for a time to be separated from each other, and an interchange of material may take place between them in opposite directions—both from the protoplasm to the nucleus, as Strasburger contends, and from the nucleus to the protoplasm, as has in addition been urged by M. Carnoy. In every case it should be remembered that the nucleus, being surrounded by protoplasm, can only obtain its nutrition through the intermediation of that substance, and thus there is always a possibility of the protoplasm acting on the nucleus, and in so far modifying it.

Having now sketched the progress of knowledge of the structure of cells and their mode of production, I may, in the next instance, state the present position of the subject. We have seen that the original conception of a cell was a minute, microscopic box, chamber, bladder, or vesicle, with a definite wall, and with more or less fluid contents. This conception was primarily based upon the study of the structure of vegetable tissue; and, as regards that tissue, it holds good to a large extent to the present day. For the cellulose walls of the cells of plants, with their various modifications in thickness, markings, and chemical composition, constitute the most obvious structures to be seen in the microscopic examination of vegetable tissue. Within these chambers is situated the active, moving protoplasm of the cell, and in it the nucleus is embedded; the cell also contains the sap, crystals, starch granules, or other secondary products. The cell wall is to all appearance produced by a conversion of, or secretion from, the protoplasm. But even in plants a cell wall is not of necessity always present; for, in the development of the daughter cells within a pollen mother cell, there is a stage in which the daughter cell consists only of a nucleated mass of protoplasm, prior to the formation of a cell wall around it by the differentiation of the peripheral part of its protoplasm. Again, the so-called non-cellular plants or Myxomycetes, before they develop their spores,[1] consist of masses of naked protoplasm, on the exterior of which, in the course of time, a membrane of cell wall is differentiated; in the substance of these masses of protoplasm numerous nuclei are situated.[2]

In animal tissues the fat cell possesses a characteristic vesicular form, with a definite cell wall, but neither in it nor in the vegetable cells does the cell wall exercise any influence on the secretion either of cell contents or of matters that are to be excreted. In animal cells a cell wall is frequently either non-existent, or doubtful, and when present is a membrane of extreme thinness. Animal cells, therefore, do not have as a rule the chamber-like form or vesicular character of vegetable cells.

The other constituents of the cell, and the only essential constituents, are the nucleus and the material immediately surrounding it, in which the nucleus is embedded. It is of secondary importance whether this material be called protoplasm, or bioplasm, or germinal matter. The term protoplasm, however, is that which has received most acceptance. In adopting this term, it should be employed in a definite sense to express the translucent, viscid, or slimy material, dimly granular under the lower powers, minutely fibrillated under the highest powers of the microscope, which moves by contracting and expanding, and which possesses a highly complex chemical constitution. The term ought not to embrace either the cell wall of the vegetable or animal cell, or the intercellular substance of the animal tissues. For although these have in all probability been originally derived from the protoplasm, by a chemical and morphological differentiation of its substance, or as a secretion from it, they have assumed formal and special characters and have acquired distinct functions. Protoplasm, as above defined, is a living structure endowed with great functional activity. It possesses a power of assimilation, and can extract from the appropriate pabulum the material that is necessary for nutrition, secretion, and growth. Growth takes place not by mere accretion of particles on the surface, but by an interstitial appropriation of new matter within its most minute organized particles. In cases, also, where the media in which the cell lives are suitable, as in the freely moving Amœba, or the white blood corpuscles, portions of the protoplasm may separate by budding from the general mass of the cell, and assume an independent existence; but the conditions under which the budding off of protoplasm can take place are exceptional in the higher organisms. Protoplasm, therefore, according to this definition, in addition to being a moving contractile substance, is the nutritive and secreting structural element of the tissues, and is always found relatively abundant where growth and the nutritive processes are most active.

In the fertilized ovum, after the process of segmentation has begun, and in the earlier stages of development of the embryo, the cells are nucleated masses of protoplasm, without cell-walls, and with no intercellular material. In the course of time, in animals more especially, an intercellular substance arises apparently by a

[1] Dr. J. M. Macfarlane has described as constantly present within the nucleolus of vegetable cells a minute body, which he terms *nucleolo-nucleus* or *endonucleolus*. He considers it, as well as the nucleolus, to become constricted and divided before the nucleus and the cell pass from the resting into the active phase of cell multiplication. See Trans. Bot. Soc. Edin., 1880, vol. xiv., and Trans. Roy. Soc. Edin., 1881–82, vol. xxx.

[1] "Lectures on the Physiology of Plants," by Julius von Sachs; translated by H. Marshall Ward, Oxford, 1887.

[2] The opinion for long entertained that the simpler algæ and fungi and cryptogams generally are destitute of nuclei has been shown by Schmidt and others to be incorrect.

differentiation of, or secretion from, the protoplasm. In many of the tissues this substance acquires such characters, magnitude, and importance as to overshadow the nucleated masses of protoplasm which it lies between and surrounds. The intercellular substance is the principal representative of the "formed material" of Dr. Beale. I cannot, however, agree with him in regarding it as passive and non-living or dead; for morphological and functional changes take place in it long after its original formation. Thus the hyaline matrix, or intercellular substance, of the young costal cartilages becomes converted into a fibrous matrix in the later period of life, and the striated substance of muscular fibre is one of the most physiologically active tissues in the animal body. In the general economy of the tissues, in the fitting of each to discharge the function for which it is specially intended, the intercellular substance plays an essential part. It gives strength to the bones, toughness and elasticity to ligaments and cartilage, motor power to muscles. It wastes by use and needs repair. But it is probably to the nucleated protoplasm within its substance that we are to look for the structural element which attracts to it the pabulum required for its nutrition, so that the interstitial waste which is consequent on its use may be made good.

The nucleus is also an active constituent of the cell, and in young cells is proportionately larger than when the cell is matured. It is doubtful if it plays a special part as a centre of attraction in secretion, or in the nutrition of the cell generally, an office which is most probably discharged by the protoplasm; but it undoubtedly acts as a centre for its own nutrition. Numerous observations, moreover, clearly prove the truth of the generalization originally propounded by Martin Barry, and confirmed by Goodsir, that the nucleus is intimately associated with the production of young cells. The karyokinetic phenomena which have been observed during the last fifteen years have established this on a firm basis, beginning with the segmentation of the yelk and nucleus within the fecundated ovum down to the latest period of cell formation.

But, along with the karyokinetic changes within the nucleus and its cleavage, there is also a cleavage of the protoplasm of the cell, so that the daughter cell consists of portions of both the nucleus and the protoplasm of the mother cell. The question therefore has been put whether the division of the protoplasm is a consequence or a coincidence of the division of the nucleus. I am inclined to think that the cleavage of the cell protoplasm is consequent on the nuclear changes; for it must be kept in mind that certain of the movements in and rearrangement of the chromatin fibres of the nucleus precede any rearrangement of particles in the cell protoplasm so far as yet observed, and, still more, the process of cleavage. Applying, therefore, to the cell the well-known economic principle of division of labour, and that differentiation of structure carries with it differentiation of function, I regard the protoplasm as the nutritive and secreting element of the cell, and the nucleus as its primary reproductive factor.

The present position of the cell theory differs therefore in many important respects from the doctrine advocated by Schwann and his immediate successors. Cells are no longer regarded as of necessity bladders or vesicles. A cell wall is not constant but of secondary formation. A free formation of cells within an extracellular blastema by deposition around a nucleolus to form a nucleus, and then around the nucleus to form a cell, does not take place. Young cells arise from a parent cell by division of the nucleus, followed by cleavage of the cell protoplasm, so that each cell is directly descended from a pre-existing cell. Although in so many of its details, therefore, the theory of Schwann has been departed from, yet the great generalization of the cellular structure of plants and animals holds good, and his work will continue to mark an epoch in the progress of biological science.

The study of the very remarkable series of karyokinetic phenomena above described has given an impulse to speculation and thought in connection with some of the most abstruse problems of life and organization. The question of the hereditary transmission of properties, both as regards the constituent tissues of the organism and the individual as a whole, has been put on a more definite physical basis. The penetration of the ovum by the spermatozoon, originally seen by Martin Barry in the rabbit, and extended to other animals some years afterwards by Newport, Bischoff, and Meissner, has been completed by the recent researches of Bütschli, Auerbach, Fol, Hertwig, and E. van Beneden. The conjugation or incorporation of the male pronucleus or head of the spermatozoon with the female pronucleus derived from the germinal vesicle, and the consequent formation of the segmentation nucleus, has been demonstrated. The segmentation nucleus is built up of chromatin fibres and nucleoplasm, derived from both the nucleus of the male sperm cell or the spermatozoon and the nucleus of the female germ cell. It is therefore a composite or hermaphrodite nucleus, and represents both parents. The cells derived from the segmentation nucleus in the early stage of segmentation contain chromatin nuclear particles, which are in direct descent from the chromatin fibres of the segmentation nucleus, and through it from the corresponding fibres of both the sperm and germ cells. From Nussbaum's and E. van Beneden's observations it would seem that each nucleus of the first pair of segmentation cells contains one-half of the chromatin threads of the male, and one-half of those of the female pronucleus. It is possible that an equal division of the male and female components of the nuclei takes place in every subsequent nuclear division, in which case the nucleus of every cell would be hermaphrodite or composite—that is, would represent both parents. The segmentation cells arrange themselves to form the blastoderm, which, in the more complex organisms, by the continuous subdivision of the cells, forms three layers; from which, by a prolonged process of cell division and differentiation, all the tissues and organs of the adult body are ultimately derived. Karyokinetic changes mark the process of cell division throughout, and each daughter cell receives from the mother cell chromatin nuclear material derived from both parents, which, without doubt, conveys properties as well as structure.

In the division of the segmentation nucleus within the ovum a cleavage of the protoplasm of the egg also takes place, and each daughter nucleus is enveloped by the protoplasm of the maternal egg. If during the period of nuclear division there is no interchange of matter between the nucleus and the protoplasm which incloses it, the cell protoplasm would then be derived solely from the ovum, and would represent maternal characters only, whilst the nucleus would possess characters derived from both parents. But if, as is most likely, during the process of karyokinesis, when the nuclear membrane has disappeared, an interchange of matter takes place between the nuclear substance and the cell protoplasm, the latter would then become, if I may say so, inoculated with some at least of the nuclear substance, and be no longer exclusively of maternal origin. Again, it should be stated that, as E. van Beneden has described, when the spermatozoon enters the egg it takes with it a portion of the protoplasm of the sperm cell. This apparently blends with the protoplasm of the egg itself. With Waldeyer, therefore, I would ask the question, Is this altogether without significance? It would seem, therefore, as if the whole of the cells of the body and the tissues derived from them are, as regards both nucleus and cell protoplasm, descended from material originally belonging to both parents.

Although ova in different organisms differ materially from each other in size, shape, the relative amount of food yolk which they contain, the mode of segmentation, and the presence or absence of a segmentation cavity, they all agree in this that the primordial cells of the egg are nucleated masses of protoplasm. Notwithstanding the general resemblance of the morphological units which thus mark the first stage in the production of young organisms, each fertilized ovum gives rise to an organism resembling that in which the egg itself arose. Hence the offspring resemble the parents, and the species is perpetuated by hereditary transmission, so long as individuals remain to keep up the reproductive process. During sexual reproduction the substance of the segmentation nucleus undergoes karyokinetic changes during the act of segmentation, and the question arises if the process of karyokinesis is the same for all organisms, whether plants or animals, or if there are specific differences. As the fertilized ovum is potentially the organism which is to arise from it, specific differences not unlikely exist in the minute structure of the segmentation nucleus, which may perhaps be expressed by modifications in the arrangement of the chromatin fibres and in the number of their loops. The varieties which have been described in the forms of the karyokinetic figures and polar radiations in different plants and animals may perhaps mark these specific differences.

But there is another question which merits consideration. Are the karyokinetic phenomena which show themselves in the cells of a given tissue characteristic of that tissue? and, if so, would it be possible to distinguish one tissue from another in the same organism by differences in the process of cell division? On this point a commencement seems to have been made towards obtaining some positive knowledge. Strasburger and Heuser think that they have obtained evidence in certain plant cells that such is the case; Rabl concludes, from observations on the epidermic cells of salamander, that the loops of chromatin fibres are constantly twenty-four in number in the same kind of cell in the same species of animal.

But in considering the different kinds of tissue, and the possibility of each kind possessing its characteristic karyokinetic process, it has to be kept in mind that more than one kind of tissue, each of which has its characteristic structure and function, arises from each layer of the blastoderm, so that there is a stage in development—a stage of indifferentism, if I may use the expression—when the blastoderm represents several tissues which have not yet differentiated. From the epiblast, for example, tissues so diverse in structure and function as cuticle and nerve tissue arise. Now, if there be a special karyokinetic process for the epidermal cells, and another for the nerve cells, does either of these correspond with the process of nuclear division in the cells of the epiblast in their stage of indifferentism, or do they both differ from it? When does the impulse reach the layers of the blastoderm, so as to produce in their constituent cells changes which so alter the characters of the cells as to lead to a differentiation into various forms of tissues, and to what is that impulse due? In the development of each species there seems to be a definite time within certain limits when the differentiation shall begin, and when the process of development of the tissues and organs shall be completed. This is an hereditary property, and is transmitted from parents to offspring. Is the impulse derived from the nucleus or from the cell protoplasm, or do both participate? As already stated, the nucleus is the element which is immediately descended from both parents, and which may therefore be supposed to be the primary morphological unit through which hereditary qualities are transmitted. But, as is most probable, the nucleus reacts on the cell protoplasm—on the element of the cell through which the ordinary nutritive functions are discharged. As a consequence of this reaction, when the appropriate time arrives in the development of each species for the commencement of the differentiation of the protoplasm of a cell, or group of cells, into a particular kind of tissue, the necessary morphological, chemical, and physiological changes take place. When once the differentiation has been effected, it is continued in the same tissue throughout the life of the organism, unless, through some disturbance in nutrition, the tissue atrophies or degenerates. Every multicellular organism, in which definite tissues and organs are to arise in the course of development, has therefore a period, varying in its duration in different species, in which certain of the properties of the cells are as it were dormant. But, under the influence of the potent factor of heredity, they are ready to assume activity as soon as the proper time arrives. When the process of differentiation and development is at an end, the organism has attained both its complete individuality as regards other organisms, and its specific characters.

Every organism, therefore, has to be viewed from both these points of view. Its specific position is determined by that of its parents, and is due to the hereditary transmission of specific characters through the segmentation nucleus. Its individuality is that which is characteristic of itself, and arises from the fact that in the course of development a measure of variability within the limits of a common species, from the organic form exhibited by its parents and by their other offspring, is permitted. In all likelihood the variability, as Weismann suggested,[1] is, to a large extent, occasioned by the bisexual mode of origin of so many organisms. By the expulsion of the polar bodies, during the maturation of the egg, portions of the ancestral germ plasm may be removed, and as corresponding molecules need not be expelled from each ovum, similar ancestral plasms would not be retained in each case, so that diversities would arise. There is also a possibility of the molecular particles of the segmentation nucleus and of the nuclei of the cells descended from it, having a method of arrangement and adjustment, and a molecular constitution characteristic of the individual as well as of the species. On this matter we have, however, no information. It is as yet a mere hypothesis. When we consider the extreme minuteness of the objects referred to, and recollect that it is only about fifteen years since karyokinetic phenomena were first recognized, it is astonishing what progress in knowledge has been made within this limited period. We owe this great advance to the much more complete magnifying and defining power of our microscopes, to the improved method of preparation of the objects, and to the acute vision and clear-thinking brains of those observers who have worked at the subject. By continuing the work, and extending it over a wider area, we may hope in time to be able to solve many questions to which we cannot now give an answer.

The nuclear material which makes up the substance of the male and female pronuclei, by the fusion of which the segmentation nucleus is formed, has been termed by Prof. Weismann the *germ plasm*. In a series of elaborate papers he has developed a theory of heredity,[2] based upon the supposed continuity of the germ plasm. He believes that in each individual produced by sexual generation a portion of the germ plasm derived from both parents is not employed in the construction of the cells and tissues of the soma, or personal structure of that individual, but is set aside unchanged for the formation of the germ cells of the succeeding generation—that is, for reproduction and the perpetuation of the species.

[1] See his essays, "The Significance of Sexual Reproduction in the Theory of Natural Selection," and "On the Number of Polar Bodies and their Significance in Heredity," translated in "Essays on Heredity" (Oxford, 1889).

[2] Translations of these papers have been published by the Clarendon Press, Oxford, 1889.

According to this theory, the germ plasm, more especially through the chromatin fibres, is the conveyer of hereditary structure and properties from generation to generation. Further, he holds that the cells, tissues, and organs, which make up the somatic or personal structure of the individual, exercise no modifying influence on the germ or reproductive cells situated in the body of that individual, which cells are also, he thinks, unaffected by the conditions, habits, and mode of life. In its fundamental idea Weismann's theory is in harmony with one propounded a few years earlier by Mr. Francis Galton (Proc. Roy. Soc. London, 1872; and Journ. Anthrop. Inst., vol. v., 1876).

In an address delivered at Newcastle in September last to the Anthropological Section of the British Association (NATURE, September 26, 1889), I reviewed this theory of heredity, and, whilst finding in it much with which one could coincide, I directed attention to points to which, I thought, objection might be taken. More especially I took exception to the idea that the germ plasm was so isolated from the cells of the body generally as to be uninfluenced by them, and to be unaffected by its surroundings.

On this occasion I propose to say a few words on the bearing of this theory on the development of the tissues and organs of the individual. If we examine the development of the embryo, say of one of the Vertebrata, we find that it makes a certain advance, varying in its time and extent according to the species, without any differentiation of a reproductive organ with its contained germ plasm being discoverable. I shall not enter into the much-disputed question of the layer or layers of the blastoderm from which the reproductive cells take their rise. But I may say that in the chick, both in the third and fourth day of incubation, a layer of germinal epithelium may be seen in close relation to the Wolffian duct and the pleuro-peritoneal cavity. At the end of the fourth day or in the fifth day this epithelium becomes thickened, and the primordial ova appear in it as distinctly differentiated cells. In the rabbit a corresponding differentiation does not appear to take place before the twelfth or thirteenth day. Up to the period of differentiation of the primordial ova, no isolation or separation of the reproductive cells and germ plasm has taken place; and, so far as observation teaches, there is nothing to enable one to say which cells of the blastoderm may give rise to primordial ova, or which may differentiate into cells for other histogenetic purposes. But before the germ cells appear, the rudiments of the nervous, vascular, skeletal, muscular, tegumentary, and alimentary systems, and the Wolffian bodies or primordial kidneys have all been mapped out. Up to this time, therefore, in all probability, a more or less complete diffusion of the germ plasm throughout either one or more of the layers of the blastoderm has taken place. The hereditary influence conveyed by the germ plasm would thus be brought to bear upon the cells of the blastoderm generally, so as to impart to them the power of undergoing at the appropriate period the morphological and chemical differentiation to form the several tissues. As the tissues and organs are derived through division of the nuclei from the cells of the blastoderm, the continuity of the hereditary influence exercised over them is kept up, even after the germ plasm has become isolated, and the entire organism is moulded so that it acquires its specific and individual characters.[1]

But the diffusion of the germ plasm throughout either the whole of the blastoderm, or a part thereof, of necessity so intimately associates it with the formative cells of the tissues generally, that it is difficult, if not impossible, to comprehend how in its turn it can be unaffected by them. Before, therefore, it again becomes stored up or isolated in an individual, in the form of ova or sperm cells, it has in its stage of diffusion been brought under precisely the same influences as those which in the embryo affect the formative cells of the whole body.

From the observations and reasoning of Wilhelm His (Proc. Roy. Soc. Edin., April 2, 1888), there can, I think, be no question that the layers of the blastoderm are affected by pressures and other mechanical conditions. These pressures would produce or modify flexures, or occasion a diminution in dimensions in some directions and an increase in others; and in this way would tend to affect either the form of the entire organism, or the form and relations of its constituent parts, or perhaps both. Should such modifying influences come into operation either before the isolation of the germ plasm, or when it was in a plastic or impressionable condition, one could conceive that it might be affected by them. Molecular changes might thus be induced in the germ plasm of such a kind as to modify the properties of the chromatin constituent of the nuclei, so as to induce in it and the germ plasms descended from it corresponding modifications, which would become hereditary. If such an hypothesis be granted, it would follow that the external conditions would exercise a perceptible influence on the germ plasm of the reproductive cells, both in the individual in which they first manifested their effect and in the generations which are descended from him.

If the germ plasm, from the first stage of development of each organism, were completely isolated from the cells from which all the other cells of the body were produced, it would be possible to conceive its transmission from generation to generation unaffected by its surroundings. But as in each individual a stage of diffusion or non-isolation precedes that of differentiation into the special reproductive apparatus, it follows that the conditions which would secure the germ plasm and the soma cells from mutual interaction are not complied with. On this ground, therefore, as well as for the reasons previously advanced in my Newcastle address on heredity, I am unable to accept the proposition that there can be no transmission to the offspring, through the reaction of the soma on the germ plasm, of characters which may be acquired under direct external influences. But in questioning the accuracy of the proposition that somatogenic "acquired characters" are incapable of being transmitted, I do not of course contend that all the characters which may be acquired during the lifetime of an individual are perpetuated in his descendants.

THE LABORATORY OF VEGETABLE BIOLOGY AT FONTAINEBLEAU.

THIS Laboratory, the establishment of which we have already announced, has now been in full working order, as far as the present buildings will permit, since May 15. We are enabled to furnish our readers with the following account of its scope and design, with the accompanying sketches, from an article supplied by M. Jumelle to the *Révue Générale de Botanique.*

The Laboratory was established at the suggestion of M. Liard, the Director of Higher Instruction in France, and

[1] On the question of the influence exercised by the germ plasm on the tissues, I may refer to some most suggestive remarks by Sir James Paget, published forty years ago, in the *London Medical Gazette*, 1849, in one of his lectures (VI.) on "The Processes of Repair and Reproduction after Injuries:"—"In every impregnated germ we must admit that properties are implanted which, in favourable conditions, issue in the power to form, of the germ and the materials it appropriates, a being like those from which it sprang. And, mysterious as it may seem, yet must we conclude that a measure of those properties is communicated to all the organic materials that come within the influence of the germ; so that they, being previously indifferent, form themselves in accordance with the same specific law as that to which the original materials of the germ are subject. So through every period of life the same properties transmitted and diffused through the whole organism are manifested in the determination of its growth and maintenance in its natural degeneration, and its repair of every part, in accordance with that type or law which has prevailed in every individual of the species." See also a lecture "On the Formative Process," in "Lectures on Surgical Pathology," vol. i., London, 1853.

is regarded as an *annexe* of the Botanical Laboratory of the Faculty of Sciences at the Sorbonne, being under the direction of M. Gaston Bonnier, the Professor of Botany at the Sorbonne. Its foundation was due to a consideration of the difficulties which necessarily attach to culture-experiments and physiological researches when carried on in large towns. For these purposes an advantageous locality presented itself in Fontainebleau, with the rich herbaceous and arborescent flora of the neighbouring forest, an abundant supply of water, and ready access to Paris. A portion of the forest (see Fig. 1) is inclosed within the territory attached to the Laboratory.

It is intended in the future to make important additions to the building at present constructed. The room for experimental researches is represented by S in Fig. 2; it will accommodate 24 workers. Those who are engaged in microscopical researches, or the study of the lower forms of vegetable life, work in galleries placed at about one-half the height of the room; the floor is intended for physiological experiments, which, with the necessary apparatus, require a larger space. Here are placed the instruments required for the study of vegetable chemistry—furnaces, balances for delicate work, glycerin-troughs, apparatus for sterilization, &c.; others will be added as needed. Opening out of this hall (B and P, Fig. 2) are the director's room and the library. Other rooms (A, A, Figs. 2 and 3) are occupied by M. Duval, the director of cultures; and on the upper story are chambers for some of the students. In the grounds attached are frames (C, Fig. 1), and a greenhouse (S)

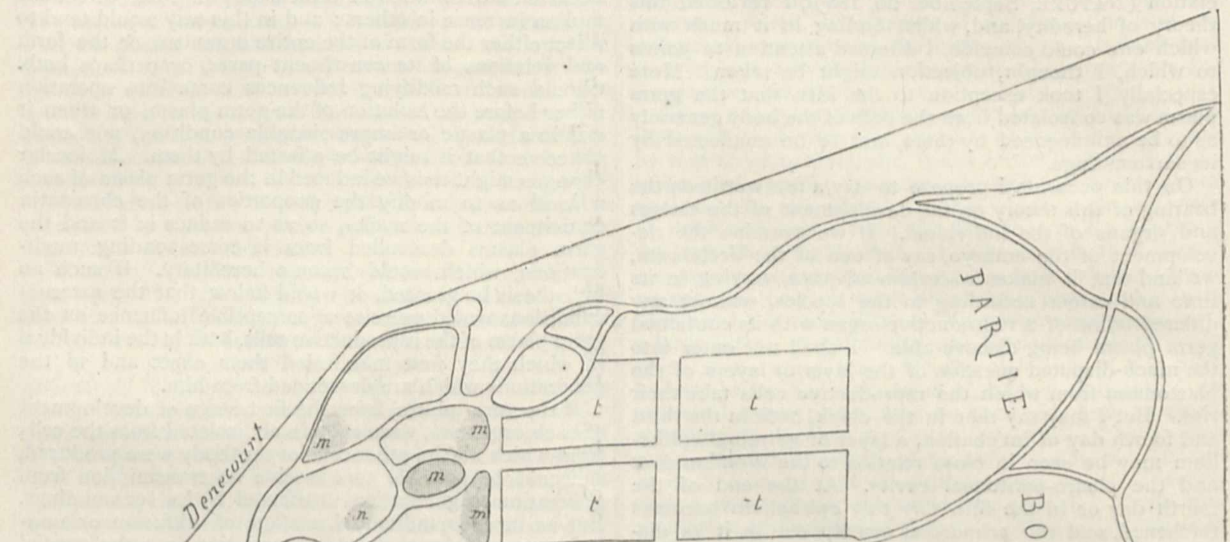
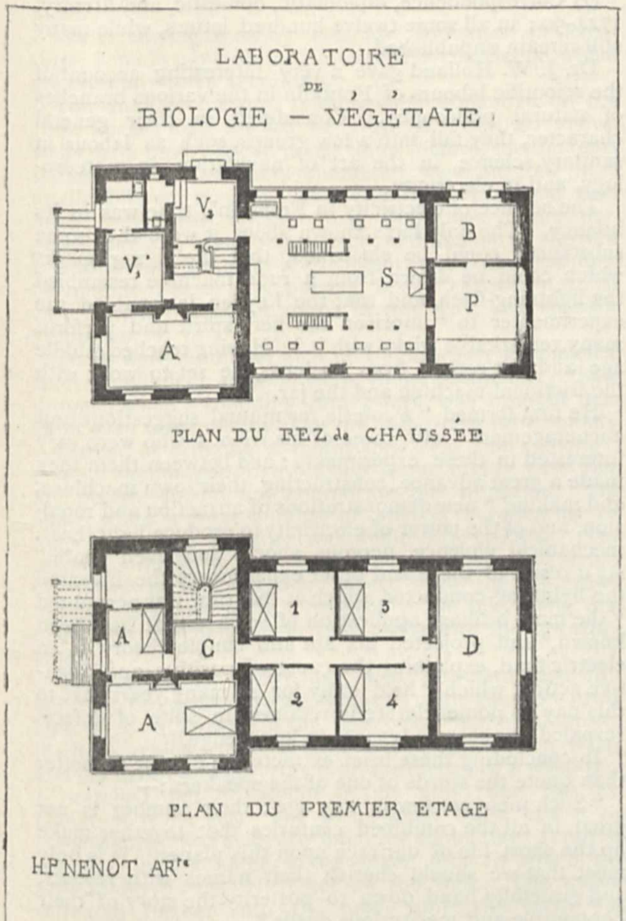


FIG. 1.—Plan of the grounds attached to the Laboratory (2½ hectares). P, entrance; L, building, S, greenhouse; C, frames; B, basin; *m m*, clumps of trees; *t t*, plots for experimental culture.

divided into a hot and cold portion; in the latter is placed apparatus necessary for physiological experiments.

One object aimed at by the establishment of the Laboratory is to provide facilities, already afforded in the case of animals in zoological laboratories, for the study of plants in the localities and under the conditions in which they are found in Nature. Hitherto, experiments in vegetable physiology have been mainly carried out on specimens which have been transplanted for the purpose, and which are therefore subjected to unfavourable or unnatural conditions of light, air, soil, &c., which may materially invalidate the results. This objection applies largely to experiments carried on in botanic gardens. To meet this difficulty, a portion of the actual forest (see Fig. 1) has been inclosed within the precincts of the Laboratory; and numerous plots (*t*, *t*) are also set apart for experimental cultures. In the former are a number of trees and herbaceous plants growing in their natural habitat in all stages of development. It is hoped that in this way much light will be thrown on the diseases, whether due to the attacks of parasites or to unfavourable vital conditions, to which plants are subject. It is intended that the culture-plots shall not be devoted exclusively to the use of students in the Laboratory, but that other experiments shall be carried on by M. Duval at the desire of, and under the conditions prescribed by, outside workers. The study of vegetable pathology, and especially of the diseases which attack vines and forest-trees, is one of the special objects for which the Laboratory has been established; and, to aid in these researches, relations have already been opened with horticulturists and viticulturists, and with the Administration of Forests; and the occupiers of neighbouring estates have placed their resources at the disposal of the director.

In addition to the Laboratory at Fontainebleau, a new one is also being built at the Sorbonne itself, with a large lecture-room, galleries for collections, a library, a



FIGS. 2, 3.—Ground floor: V V, vestibules; S, hall for research; P, Director's laboratory; B, library. First floor: C, landing; D, 1, 2, 3, 4, chambers for students; A A, rooms of the director of cultures.

greenhouse, a photographic room, and twelve workrooms.

The Director of the Laboratory at Fontainebleau offers a cordial invitation to foreign botanists who may desire to avail themselves of the facilities for work afforded by it.

BENJAMIN FRANKLIN.

THE Official Report, issued by the American Philosophical Society, of the celebration of the centennial anniversary of the death of Benjamin Franklin, April 17, 1890, has just been sent to us. The Society, in January last, held a stated meeting, at which it was resolved to form a Committee of five members, to be appointed by the President, who should be empowered to take all necessary action. The following was the form of the resolution that was drawn up by the Committee:—"That we commemorate in a becoming way the approaching centennial anniversary of the death of Benjamin Franklin, and that a series of short addresses upon his life, character, and work be delivered before the Society upon this occasion."

The Society is to be congratulated on the success with which the idea was carried out. It is right that the world, on fitting occasions, should be reminded of the achievements of so great an investigator. Franklin had all the qualities of mind which are necessary for the extension of knowledge by means of observation and experiment, and his career marked one of the most important stages in the development of science. Englishmen regard his work with hardly less pride than Americans, and the memory of what he accomplished must always be one of the links that serve to unite the two peoples.

In the evening of the anniversary day, members and their guests assembled at the Association Hall in the city of Philadelphia. Mr. Talcott Williams began the proceedings with a few remarks on the occasion of the gathering. He then informed the audience that the Society had summoned the biographer of Franklin; it had called upon the historian of the land in which he served his country, upon the man of science, upon one who was both the man of science and of letters, and lastly upon the President of the Society, to represent the civic and associated activities in which Franklin was engaged.

In the following notes we shall give brief extracts from some of the speeches that were delivered. Franklin, the youngest son of a family of seventeen, began his career at Boston. He wished to go to sea, but his mother thought it would be better for him to become a minister. His father, having tried hard to make him a tradesman, bound him over to an elder brother to learn printing. The apprenticeship did not last long, as the brothers disagreed, and what with insults, quarrels, and blows, they parted—"the one to drag out a humble existence, the other to become the most illustrious American of his day." Travelling about looking for work, Franklin came across William Keith, who sent him to Boston, and then to London. On reaching the latter place he found out that "Keith was a knave, and himself a dupe." During his stay in London he wasted his substance, misused money, and kept bad company; but after some time he made the acquaintance of a merchant, who gave him a situation. Going back to Philadelphia with him, he commenced to "keep books, sell goods, and learn the secrets of mercantile affairs." Owing to the death of the merchant, Franklin was once more at large, and this time, with the help of a friend, he set up a "new printing office in High Street near the market."

From that hour he prospered, bought out his partner, married, founded one of the best newspapers, published the famous almanac, and was made Postmaster-General. Having now become wealthy by a strict adherence to the maxims of "Poor Richard," he sold his shop, newspaper, &c., and gave his time to the study of science. Before he had reached the age of fifty he had won for himself the Copley Medal, and membership of the Royal Society.

He now dropped scientific studies and returned to politics, and was loaded with public duties. Among other things he was appointed Postmaster-General of the Colonies, sent by the Assembly with its Speaker to hold a conference with the Indians at Carlisle, and then to the Albany Conference, where he presented his famous plan of union. On his return to Philadelphia in 1761, his intention was to settle down again and study, but he was again drawn into politics by the conspiracy of Pontiac, and the massacre of the Conestoga Indians by the men of Donegal and Paxtang.

After this he wrote many articles on American affairs for the English newspapers, and it was about this time that he republished a London edition of the "Famous Letters," and brought out "The Votes and Proceedings of the Freeholders and other Inhabitants of

Boston"; he also sent over the "Hutchinson Letters," and underwent the memorial examination before the Privy Council.

Having been abroad ten years and six months, he turned his face homewards, and found that great changes had taken place; the city had grown considerably, and the people were more prosperous. The greatest change seems to have occurred in his family; his wife was dead, his daughter married, and his son estranged in politics. Luckily, Franklin was soon absorbed again in public affairs, so that he had no time to consider his misfortunes.

The day after he landed, he "was chosen a member of the Continental Congress, took his seat four days later, and served for 14 months; was on eleven committees, was made Postmaster-General; was sent on one mission to Washington at Cambridge, and on another to Arnold at Quebec; was despatched after the disastrous battle of Long Island, to confer with Lord Howe; and in September 1776, was sent out to join Arthur Lee and Silas Diane in France."

There he was received with great enthusiasm, and "became the sensation of the hour." He concluded the treaty of alliance with France, the treaty of amity and commerce, negotiated loans for great sums of money, and in 1783 signed the treaty of peace with Great Britain.

In 1785, old and loaded with honours, he returned to Philadelphia. Here he was made a Member of Council, and the Council and Assembly made him President of the State, and while holding this office he was sent to the Convention that framed the Constitution of the United States. It was about this time that his fame was at its highest, and everyone honoured and looked up to "the venerable Dr. Franklin, our illustrious countryman and friend of man," "the father of American independence." The closing years of his life were passed among his friends and admirers, and he died on April 17, 1790.

The epitaph that was placed over his tomb was written by himself, and is quite worth repeating:—

"The body
of
BENJAMIN FRANKLIN,
Printer
(like the cover of an old book,
its contents torn out,
and stript of its lettering and gilding),
lies here food for worms.
Yet the work itself shall not be lost;
for it will, as he believed, appear once more
in a new
and more beautiful edition
corrected and amended
by
The Author."

Franklin was a voluminous writer, and wrote with expression. To use the words of Mr. Brown Goode, who spoke on "the literary labours of Benjamin Franklin," "he wrote habitually with a single eye to immediate practical results. He never posed for posterity. Of all the writings to which he mainly owes his present fame, it would be difficult to name one which he gave to the press himself or of which he saw the proof. Yet he never wrote a dull line, nor many which the century of time has robbed of their interest or value."

The literary remains of Franklin may be classified as follows:—

(1) "The Autobiography," from 1706–57.

(2) "Poor Richard's Almanac," in twenty-six annual issues, 1732–58, culminating in "Father Abraham's Speech at the Auction."

(3) Essays upon manners, morals, and the science of life, including the so-called "Bagatelles"; in all sixty titles or more.

(4) Tracts and papers upon political economy, finance, and the science of government; in all about forty titles.

(5) Essays and tracts, historical and political, concerning the American Revolution and the events which immediately preceded and followed, 1747–90.

(6) Scientific papers from 1737–90; in all 221 titles, and nearly 900 octavo pages.

(7) Correspondence, diplomatic, domestic, and literary, 1724–90; in all some twelve hundred letters, while many still remain unpublished.

Dr. J. W. Holland gave a very interesting account of the scientific labours of Franklin in the various branches of natural philosophy. Considered in their general character, they fall into a few groups, such as labour in sanitary science, in the art of navigation, in meteorology, and in electricity.

The science of electricity in Franklin's time was in its infancy. The only facts known about it were that some substances could be electrified, that the zigzag sparks which could be drawn from a rude machine resembled the lightning-flash, and that the Leyden jar enabled the experimenter to "imprison the fiery spirit and perform many remarkable tricks with it." Having reached middle age and just retired from business, he set to work with the frictional machine and the jar.

He first formed "a coterie for mutual suggestions and encouragement" with three of his friends who were very interested in these experiments; and between them they made a great advance, constructing their own machines, and making "new demonstrations of attraction and repulsion, and of the power of electricity to produce light, heat, mechanical violence, nervous shock, and even death." As a result of these and other experiments, he invented the lightning-conductor, which at that time was accounted "the most brilliant application of science that had been known," and projected his apt and simple theory of an electric fluid, explaining the cause of positive and negative action, which "held sway for so many years that to this day its nomenclature is retained in spite of defects revealed by recent advances in knowledge."

In concluding these brief extracts, we cannot do better than quote the words of one of the speakers:—

"Such men are few in any age; their number is not great in all the combined centuries that together make up the short life of our race upon this planet. It is only meet that we should cherish their names with respect, and gratefully hand down to posterity the story of their honourable and meritorious deeds."

NOTES ON THE HABITS OF SOME COMMON ENGLISH SPIDERS.

SOME years ago I sent to NATURE (vol. xxiii. p. 149) an account of the behaviour of the common small garden spider when a sounding tuning-fork is brought near. If the fork is made to touch any part of the web, or the twigs or leaves by which the web is supported, the trembling of the web completely deceives the spider, so that, after rapidly finding which radial line is most disturbed, she runs along this one and attempts to secure the tuning-fork. She fails to discover in the cold and polished steel anything different from her usual food; or rather, being led by instinct to eat that which buzzes, she struggles in vain to find a soft place in the armour of her prey.

On the other hand, if the tuning-fork is brought near one of these little spiders while she is waiting in the centre of her web, she generally drops instantly, but will climb up again as quickly as possible if the vibrating fork is made to touch the web.

More recently Mr. and Mrs. Peckham, who have made an elaborate study of the mental powers of spiders (*Journal of Morphology*, vol. i. p. 383), have repeated these experiments, and have confirmed them in every essential particular.

They found that many geometrical spiders would drop when a vibrating tuning-fork was brought near them, but that after much teasing in this way they would sometimes learn to take no notice. They conclude that this dropping habit is of direct service to them, in enabling them to escape from birds or wasps which prey upon them.

While staying recently with Mr. Romanes, in Ross-shire, I made some observations in this connection which are possibly worth recording.

The small geometrical spiders which abounded on the gorse bushes near the sea behaved as described above, while, as I have noticed many times before, the diadema spiders, which also were abundant, were affected in a totally different manner. If the tuning-fork is held near them, they throw up their four front legs, either perpendicularly or even further back, and as soon as the fork is within reach strike at it so violently that the blow may be plainly heard. A buzzing insect carried near is caught by the diadema spider in this way, and speedily wound up.

There were a number also of small brown geometrical spiders, which I believe were young diademas; these dropped when a sounding tuning-fork was brought near them even more readily than the full-grown little spiders.

Instead of bringing a tuning-fork near the spiders, I made a sudden and high-pitched shout, taking care that my breath should not complicate the situtation. The effect, when a great number of spiders were resting on their webs near together, was sufficiently striking. The diademas threw up their legs simultaneously, and struck in the air at the imaginary insect, while the full-grown little spiders, and what I believed to be the young diademas, all dropped out of their webs into the branches below.

The suggestion of Mr. and Mrs. Peckham, that this habit is a protection against wasps, is made the more probable by the difference in the behaviour of the full-grown diadema, which would certainly not be afraid of a wasp, and the little spiders. However, the tactics of a wasp that I watched left no doubt in my mind that this explanation is correct. The wasp, when I first saw it on a gorse spray, was evidently intent on something. It ran up the spray until it came to the silken tube in which the little spider dwells when not on the web. The spider retreated further into the tube, while the wasp was struggling among the spines and the silk to dislodge her. After a short time the wasp gave up the attempt, and flew away for a few yards. It then very suddenly darted at another spider, seized her before she had time to drop, and carried her off to a branch close by. This was done so quickly that I could not follow the details of the attack; but it is certain that the wasp, which did not carry a spider a moment before, had without alighting taken the spider off her web. It would appear that the dropping habit of the spider has reacted on the wasp, and has developed in it a speed of attack sufficient to counteract the spider's only means of escape.

I have not found that the little spider is less attracted by low notes than by high; a variety of forks, forceps from a box of chemical weights, or a carpenter's square banged on the knee, all seem to deceive her equally well, but a vibration of great amplitude causes her to retreat to a place of safety. The spider seems to judge of the necessity for prudence by the violence of the insect rather than by the natural note of its wings. She is terrified by a heated tuning-fork, which is not too hot to hold.

Mr. and Mrs. Peckham have formed a low estimate of the spider's intelligence as distinct from instinct. They found that a spider which has the habit of carrying its cocoon was quite satisfied with a lead shot slipped into the silk covering of the eggs, and laboriously carried it about. The following are a few of many experiments which I have made, which lead to the same conclusion. A large diadema which had just caught and wound up a large fly, and had carried it up to its retreat, left it hanging by a short line while she proceeded, according to the usual habit of this kind of spider, to carefully clean herself before the meal. Meanwhile I managed to replace the fly by a piece of cork without disturbing the spider. When the toilet was complete, she pulled up the line from which the supposed fly was suspended, and tried to eat the cork. She was a long time trying every part of the cork before she finally let it drop. A piece of an india-rubber ring was twisted up until it had acquired a state (well known to school-boys) of spasmodic recoil. This was placed on the carpet-like web of a large black house-spider, which Mr. Pocock tells me is known to naturalists as *Tegenaria atrica*. These, like other house-spiders, appear to be far more wary than the geometrical sort. The india-rubber was made to move slightly by being pinched from below, and then the spider pounced upon it. I did not allow the spider to carry it off, but made it seem to struggle and resist by manipulation with a pair of forceps under the web. The spider became more and more desperate, and at last, when the web was much damaged by the battle, I dragged the rubber away; but the spider could not allow this, and clambering through the hole made in the web, and hanging by her fourth pair of legs, seized the escaping insect. I then let go, and the spider carried the piece of india-rubber away to her den, perfectly satisfied. However, she did not seem to appreciate her meal, for, after biting it on every side, she was obliged to take it to the edge of her web and drop it. I then picked it up, and was surprised to find the spider willing to be similarly deceived again.

These spiders will come to a tuning-fork once or twice perhaps, but the moment they touch it they fly terrified, as they do from a common bluebottle with mica on its wings. They seem generally thirsty, and will drink water placed upon the web, and if it is scattered in drops they are able to find the drops, but by what process I do not know. The diademas, too, especially when old, and only able to mend old webs, not to spin new ones, are always ready to drink. They will hold a piece of wheat straw six or eight inches long which has a drop of water upon it until they have drunk the water; but while the little spider is so insensitive in taste as not to entirely reject a fly that has been soaking in a parafin lamp, especially if it is made to buzz with a tuning-fork, the diadema has a strong objection to alcohol, even well diluted, and rubs her mouth against anything near by after tasting it, so as to get rid as quickly as possible of the noxious fluid. Is it possible that the numerous spiders which are found in secondary batteries have been killed by the acid when attempting to drink, or are they destroyed by accidentally meeting the acid in their ordinary descents? The *Tegenaria* is aware of the shout which causes the diadema to strike and the little spider to drop, but the effect is a jump such as is executed by anyone when suddenly startled.

It would appear that the only sense which is developed to any extent, and that most marvellously, is the sense of touch; hearing, taste, and smell to a small degree; but sight, as we understand the term, in spite of their numerous eyes, seems to be absent. The *Tegenaria* will stand within half an inch of a fly feigning death, without being able to find it; while the geometrical spiders, under like circumstances, gently pluck line by line until the effect of the inertia (not weight) of a motionless object guides them to the proper place.

These remarks do not apply to the hunting spiders.

C. V. BOYS.

NOTES.

The following is the list of names recommended by the President and Council of the Royal Society for election into the Council for the year 1891, at the forthcoming anniversary meeting on December 1:—President: Sir William Thomson. Treasurer: Dr. John Evans. Secretaries: Prof. Michael Foster, the Lord Rayleigh. Foreign Secretary: Archibald Geikie. Other members of the Council: Prof. William Edward Ayrton, William Henry Mahoney Christie, Prof. W. Boyd Dawkins, James Whitbread Lee Glaisher, Dr. Hugo Müller, Prof. Alfred Newton, Sir William Roberts, William Chandler Roberts-Austen, Prof. Edward Albert Schäfer, Sir George Gabriel Stokes, Bart., Lieut.-General Richard Strachey, R.E., Prof. Joseph John Thomson, Prof. Thomas Edward Thorpe, Sir William Turner, Prof. Sydney Howard Vines, General James Thomas Walker, C.B.

The recent delimitation of the spheres of influence of Great Britain and Germany in Tropical Africa will probably give a considerable impulse to the systematic investigation of its flora by the travellers and botanists of either nation. An arrangement has, therefore, been made between Kew and the Royal Botanic Museum at Berlin, for the regular exchange of African collections. In accordance with it, the extensive herbarium of Marocco plants formed by the late John Ball, F.R.S., after the selection for Kew of all unique speci mens, is about to be transmitted to Be rlin.

The Geological Photographs Committee, appointed by the British Association to arrange for the collection, preservation, and systematic registration of photographs of geological interest in the United Kingdom, have issued a circular in the co-operation of geologists in their work. At the Leeds meeting of the British Association, the Committee exhibited, as the result of their first year's operations, a collection numbering upwards of 270 photographs, many of which illustrated geological sections, and other features of considerable scientific interest. The Committee, however, point out that, so far as the work has yet proceeded, only a small proportion of the counties in the British Islands have been represented; and they urge upon geologists the desirability of further assisting the scheme, with the object of forming a national collection of photographs illustrating the geology of our own country, which will ultis mately be deposited in some convenient centre. The Committee wish to receive copies of suitable photographs, which will be duly numbered and registered, or to be favoured with the following information, viz.:—(1) Lists and details of photographs of geological character already in existence. (2) Names of local societies, or persons, who may be willing to further the objects of the Committee in their own district. (3) Particulars of localities, sections, boulders, or other features which it may be desirable to have photographed. A circular of instructions has been drawn up, copies of which will be supplied to any persons who may desire to have them. The Secretary of the Committee is Mr. Osmund W. Jeffs, 12 Queen's Road, Rock Ferry, Cheshire.

The American Association for the Advancement of Science will hold its session for 1891 at Washington. Among the subjects on which papers and discussion are especially invited are: the absorption of gases and of fluids by, and the movements of water in plants, the aëration of aquatic plants, and transpiration.

The eighth Congress of the American Ornithologists' Union will meet at Washington on November 18. The meetings will be held at the U.S. National Museum.

The Society of Arts has issued its programme of "sessional arrangements." The following are the Cantor Lectures, which will be delivered on Monday evenings at eight o'clock: Prof. Vivian B. Lewes, "Gaseous Illuminants" (five lectures), November 24, December 1, 8, 15, 22; A. J. Hipkins, "The Construction and Capabilities of Musical Instruments" (three lectures), January 26, February 2, 9; Gisbert Kapp, "The Electric Transmission of Power" (three lectures), February 16, 23, March 2; Prof. R. Meldola, F.R.S., "Photographic Chemistry" (three lectures), March 9, 16, 23; Hugh Stannus, "The Decorative Treatment of Natural Foliage" (four lectures), April 13, 20, 27, May 4.

One lamentable result of the very rainy summer and autumn has been the partial submergence of the Botanic Garden at Prague, by which incalculable damage has been done to the very fine collection of plants under the care of Prof. Willkomm, the work of many years' careful and untiring labour. The fires in the hot-houses were extinguished, and one glass-house entirely destroyed. The unique collection of succulent plants, including 200 species of *Sempervivum* and 320 of *Cactus*, suffered irreparable injury. The splendid collection of models and preparations only recently made has been rendered almost valueless; in the lecture-room, where it was placed, the water stood at a height of about 5 feet 6 inches.

A quaint custom, dating back to Anglo-Saxon times, known as payment of "wrath silver," was recently observed at Knightlow Hill, a tumulus between Rugby and Coventry. It consists of tribute payable by certain parishes in Warwickshire to the Duke of Buccleuch. The silver has to be deposited at daybreak in a hollow stone by representatives of the parishes, he penalty for default being forfeiture of a white bull with a red nose and ears. The representatives afterwards dined together at the Duke's expense.

The Deutsche Seewarte and the Danish Meteorological Institute have just issued two more quarterly volumes of synchronous daily weather charts of the North Atlantic, bringing the series of this valuable publication down to November 1886. These volumes show very clearly the difference of conditions existing over that ocean between summer and autumn; the difference of atmospheric pressure is much less in summer, and consequently the winds are lighter. A cursory glance at the low-pressure areas shows their important effect upon the weather of their vicinity, and the history of the severe gale which visited this country on October 15–16, 1886 (a discussion of which appeared in the Quarterly Journal of the Royal Meteorological Society for January 1887), may be clearly traced on the charts, as well as several other disturbances which reached our coasts from the Atlantic. The importance of such work can hardly be overestimated, but its value would be further enhanced if the publication could be made nearer to current date.

The year ending last April was remarkable in point of weather in St. Petersburg. Thus (as Dr. Woeikof points out) only once in 130 years was the mean temperature of the seven months October to April warmer than in this year—viz. in 1821–22, when the excess was 4°·2 C. (this year 3°·6). The normal order of the months was not disturbed, as so often occurs in warm winters. It looked as if St. Petersburg had moved into a warmer and more continental climate. In the number of warmest days of the 130 years series, October and April (1889–90) are unequalled. Reckoning as summer days those with 16° (the mean of summer) or over, it appears that between the last and the first summer day the number of days in 1889–90 is 24 less than the shortest period hitherto observed, two months shorter than the mean, and 112 days shorter than in 1821–22. And it is curious that the period in question is longest in the year in which October to April was warmest (1821–22), but shortest in the next warmest (1889–90).

The following details of the earthquake in Persia in June, last have been received from Dr. Jellisew, a Russian doctor who, on the evening of the 28th inst., was at a considerable distance from Teheran, on his way from Meshed to the capital. The centre of the earthquake seemed to be Tasch, a village on the side of a mountain, and close to a deep precipice. The noise of the shocks was so loud that Dr. Jellisew was awakened from his sleep, and in a few minutes several houses fell together. Others had great cracks in their walls. Many people rushed into the fields; most of those who remained in the houses were killed. Large blocks of rock are said to have burst asunder.

A STALACTITE cave has been discovered recently in one of the State forests near Bissingen, in Würtemberg. The entrance is said to be 15 metres high, and 3 or 3½ wide.

PROF. J. MARK BALDWIN contributes to *Science*, October 23, a note of some interesting experiments relating to the "origin of right- or left-handedness." The subject of them was his own child, and they extended over the greater part of the first year. The following are the points recorded:—(1) He found no trace of preference for either hand as long as there were no violent muscular exertions made (based on 2187 systematic experiments in cases of free movement of hands near the body, *i.e.* right hand 585 cases, left hand 568 cases, a difference of 17 cases; both hands 1034 cases; the difference of 17 cases being too slight to have meaning). (2) Under the same conditions the tendency to use both hands together was about double the tendency to use either (seen from the number of cases of the use of both hands in the statistics given above), the period covered being from the child's sixth to her tenth month inclusive. (3) A distinct preference for the right hand in violent efforts in reaching became noticeable in the seventh and eighth months. Experiments during the eighth month on this cue gave, in 80 cases, right hand 74 cases, left hand 5 cases, both hands 1 case. In many cases the left hand followed slowly upon the lead of the right. Under the stimulus of bright colours, from 86 cases, 84 were right-hand cases, and 2 left-hand. Right-handedness had accordingly developed under pressure of muscular effort. (4) Up to this time the child had not learned to stand or to creep; hence the development of one hand more than the other is not due to differences in weight between the two longitudinal halves of the body. As she had not learned to speak, or to utter articulate sounds with much distinctness, we may say also that right- or left-handedness may develop while the motor speech-centre is not yet functioning.

AT a recent meeting of the Paris Société de Biologie, M. J. Kunckel d'Herculais announced that he had been able to trace the entire development of the parasitic *Mylabris schrebersi*, which, like the *Epicauta* studied by C. V. Riley, live parasitically on different *Acridia*, on *Stauronotus maroccanus* particularly.

WE learn, from the *Oesterreichische botanische Zeitschrift*, of interesting botanical results obtained from Herr J. Bornmüller's expedition to Asia Minor. From Amasia he had paid a five-weeks' visit to the mountain district of Siwas, Kaisarieth, and Jusgat, where he found, at altitudes varying from 1800 to 2500 metres, a flora differing widely from that of Amasia; many Alpine species with showy flowers, belonging to the genera *Primula*, *Gymnadenia*, *Papaver*, *Ranunculus*, *Globularia*, *Geranium*, *Centaurea*, *Bupleurum*, *Fritillaria*, &c., being found in great abundance. The ascent of the steep cone of Yildiz-dagh, 2520 metres, occupied 12 hours. Four days were required for the ascent of Mount Argæus, the higher elevations of which were covered with immense masses of snow. The mountain is 13,000 feet high, and for the last 1500 metres nothing but snow and glacier was traversed; the actual summit of 150 feet was found inaccessible. At a height of 2900 metres all traces of trees had disappeared, and the only shrubs found were starved specimens of *Juniperus nana* and tragacanth in the fissures of the rocks; but the pastures were covered with an abundant and brilliant vegetation. In the snow-covered regions the night-temperature was + 2°–3° R. Several new species were collected, among them a beautiful orange-yellow *Fritillaria*. On his return to Amasia he found the herbaceous vegetation almost entirely scorched up by the heat of the sun. Herr Bornmüller was then starting for the sources of the Gök-Irmak in Paphlagonia, whence he hoped to bring rich collections, the only botanist who has hitherto visited that district being Wiedemann, in 1840; and his collections are to be found only in the herbarium at St. Petersburg.

WITH reference to our Notes on scientific guide-books to Switzerland, a correspondent sends us the following list:—(1) "Scientific Guide to Switzerland," by J. R. Morell, H.M. Inspector of Schools (Smith, Elder, and Co., London, 1867), 396 pages and index (same size as International Scientific Series). It treats of orography, geology, hydrography, meteorology, glaciers, fauna and flora of Switzerland. (2) "Le Monde des Alpes," a picturesque description of the Alps, and particularly of the animals which inhabit them, translated by O. Bauritt from the German of Dr. F. von Tschudi, "Das Thierleben der Alpenwelt," published by H. Georg, at Geneva and Bâle, 864 pages (same size as Prestwich's "Geology"), and 24 full page woodcuts, tinted, published in 1870, from the second German edition. (3) "Les Alpes," par H. A. Berlepsch (same size as Prestwich's "Geology"), with 16 tinted full plate cuts, published by H. Georg, at Geneva, 1870. The original is in German, with 441 pages. It contains an excellent description of the natural phenomena of Switzerland and the life of the inhabitants of the mountains. 10 francs unbound, 14 francs bound. It has been translated into English.

MM. G. ROUY AND J. FOUCAUD have undertaken the preparation of a "Flora of France," intended to take the place of that of Grenier and Godron. In order to render the work as accurate and as complete as possible, they earnestly request the co-operation of those who are acquainted with the botany of any portion of the extensive region which their task will cover.

MESSRS. OLIVER AND BOYD publish the introductory lecture to the Agricultural Class at the University of Edinburgh, delivered by Prof. R. Wallace on October 22. The subject is, "American Cattle, and the American Export Trade in Beef and Live Cattle to Great Britain."

A PAMPHLET on "The Philosophy of Cycling," by Mr. W. K. Fulleylove, has been issued by Messrs. Curtis and Beamish, Coventry. It is the first of a "popular series of pamphlets on every-day science."

THE latest work issued in the series entitled "Smithsonian Miscellaneous Collections," is a valuable "Index to the Literature of Thermodynamics," by Dr. Alfred Tuckerman. The work is similar to Dr. Tuckerman's "Index to the Literature of the Spectroscope," published in the same series. All the titles are given in full in the author-index, but in the subject-index, to save useless repetition, only the authors and the places where their works are to be found are given—except in the case of books. The work has been brought down to the middle of the year 1889.

A USEFUL summary of progress in mineralogy and petrography in 1889 is presented in the form of a pamphlet compiled by Mr. W. S. Bayley (Waterville, Me.). It consists of a series of monthly notes which appeared originally in the *American Naturalist*.

THE Frankfort publisher H. Bechhold is issuing what promises to be a valuable "Handlexikon" of the natural sciences and of medicine. The editors are A. Velde, W. Schauf, V. Loewenthal, and J. Bechhold. Especial attention is paid to the practical applications of the sciences.

THE seventh volume of the Proceedings and Transactions of the Royal Society of Canada for the year 1889 includes, among other papers, the following: the cartography of the Gulf of St. Lawrence, from Cartier to Champlain, by W. F. Ganong; trade and commerce in the Stone Age, by Sir Daniel Wilson; expeditions to the Pacific, by S. Fleming; notes on mathematical physics, by J. Loudon; on the variation of the density with the concentration of weak aqueous solutions of certain salts, by J. G. McGregor; on new species of fossil sponges from the Siluro-Cambrian at Little Metis on the lower St. Lawrence, by Sir J. W. Dawson.

MR. C. C. VEVERS, Leeds, has published an illustrated catalogue of photographic apparatus, materials and catalogues, and optical lanterns and accessories.

MESSRS. R. FRIEDLÄNDER AND SON, Berlin, have just issued two catalogues of books which they have for sale, one relating to comparative anatomy, the other to *Arachnida*, *Myriopoda*, *Crustacea*, and *Rotatoria*.

BY authority of the Consul-General of Uruguay, London, a catalogue has been issued of the minerals from Uruguay shown at the recent International Exhibition of Mining and Metallurgy at the Crystal Palace. Associated with the catalogue are various allied documents, one of which is the mining code of the Republic.

COLONEL HOLABIRD, of Los Angeles, has lately returned to San Francisco from an exploring expedition in the cañons of Colorado. He penetrated districts never before explored, and found in an almost inaccessible cañon 100 miles north of Williams, and near the Grand Cañon of the Colorado, the Yava Supai tribe of Indians, who had never seen any white man, except Lee the Mormon, who was shot for the Mountain Meadows massacre. Colonel Holabird, in relating his experiences to a correspondent of the *New York Tribune*, said:—"These Indians are of the Apache family, but of ancient origin. The men are magnificent specimens. The valley in which the tribe has lived for many years in seclusion has only two ways of approach. It contains 2000 acres, and is inclosed by almost perpendicular walls 4000 feet high. We travelled over 15 miles along a cañon —a lifeless country. Suddenly we came to two boiling springs under cotton-wood trees. From these springs a river starts, which winds its way through a luxuriant valley. The water in the river is clear as crystal, and so strongly impregnated with lime that it petrifies everything it touches. There are three immense cataracts in the cañon. These look as if centuries ago a huge cotton-wood tree had fallen across the stream and lodged. Mosses, ferns, and creepers formed a barrier. All these have been turned to limestone. The grass caused the deposit to increase until the barricade extended across the cañon, making a fall of 250 feet. Along the front of these high cataracts, limestone ridges have formed 20 to 50 feet one above the other. Over all these the water falls like a sheet of glass. Underneath, between the ridges, thousands of plants, with flowers in full bloom, are seen, while millions of humming-birds dart in and out. The chief of the strange tribe is an old man of sixty—'Captain Tom.' I found these Indians in a starving condition, subsisting on berries and grass-seed. I appealed to the Government for them, but the Indian Department said it could not help wandering people."

THE November number of the *American Journal of Science* contains an account of the preparation of pure metallic cadmium, by the process of distillation *in vacuo*, recently carried out by Mr. E. A. Partridge in the laboratory of the University of Pennsylvania. The successful experiments described a few months ago by Messrs. Morse and Burton, in which it was shown that metallic zinc could be obtained in a state of purity by distillation at a high temperature in a vacuum constantly renewed by means of a Sprengel pump, led Mr. Partridge to make a similar attempt in the case of cadmium, with the ulterior purpose of utilizing such a sample of the pure metal for a re-determination of its atomic weight. The process has proved perfectly successful, and yields a metal of such purity that even spectroscopic examination fails to detect any traces of admixed foreign metals. The retorts employed were of glass—naturally of the hardest kind that could be procured. They were made of tubing of 20–25 mm. diameter, and at a distance of about 11 cm. from the closed end were drawn out into a neck of 12 mm. diameter, through which the volatilized metal passed into the receiving portion of the tube. This latter portion was finally drawn off in such a manner that it could be tightly connected with a treble-fall Sprengel pump. About a hundred grams of cadmium were introduced into the retort before drawing off, and after the latter operation had been performed the apparatus was exhausted by means of the pump, which was kept working during the whole period of the distillation. The retort was then heated in the combustion furnace in which it was supported, the temperature being so regulated that most of the liquefied metal ran back into the retort, only the more volatile vapours passing through the neck into the receiver. The distillation was continued until about sixty grams of metal had passed over, the operation lasting about an hour. The volatilized cadmium condensed partly in the bottom of the receiver in the form of a bar, and partly upon the upper portion and sides in the form of brilliant perfectly-developed crystals. The product was redistilled in a similar manner in order to minimize the risk of traces of foreign metals being carried over. The precaution, however, appears to be unnecessary, for the residue left after re-distillation of the greater portion was found to contain no trace of impurity when examined spectroscopically. The atomic weight of cadmium was determined by three distinct methods, the salts employed being prepared from this redistilled metal. In the first series the loss of weight on converting the oxalate into the oxide by ignition formed the basis of calculation, in the second series the loss of weight on converting the sulphate into sulphide by ignition in a stream of sulphuretted hydrogen, and in the third series the loss brought about on similarly converting the oxalate into sulphide. The mean values obtained for the atomic weight, when O = 16, from ten experiments in each series were respectively 111·80, 111·79, and 111·80. The final value deduced from the whole of the experiments is thus 111·8.

THE additions to the Zoological Society's Gardens during the past week include two Squirrel Monkeys (*Chrysothrix sciurea*) from Guiana, presented by Mr. E. Leech; a Brown Bear (*Ursus arctos*) from Russia, presented by Mr. W. H. Stuart; an English Wild Cow (*Bos taurus*, var.) from Bangor, North Wales, presented by Mr. G. W. Assheton-Smith; two Masked Weaver Birds (*Hyphantornis personata* ♂ ♀) from Abyssinia, a Short-winged Weaver Bird (*Hyphantornis brachyptera*) from Africa, presented by Commander W. M. Latham, F.Z.S.; a Viverrine Cat (*Felis viverrina*) from India, a White-crested Touracou (*Corythaix albo-cristata*) from West Africa, deposited; a —— Shrike (*Lanius lahtora*) from India, purchased.

OUR ASTRONOMICAL COLUMN.

MEASURES OF LUNAR RADIATION.—The Proceedings of the American Academy of Arts and Sciences (vol. xxiv.) contains an account of some measures of lunar radiation made by Mr. C. C. Hutchins by means of a new thermograph. This instrument consists of a single thermal junction of nickel and iron placed in the focus of a small concave mirror. The author finds that the condensing mirror fulfils the functions of multiplied junctions, while the single union rapidly attains thermal equilibrium. A comparison was made between the thermograph and a thermopile of forty-eight couples, the result being that the former was found about twelve times as sensitive as the latter. Measures of the radiating power of some rocks, mostly of volcanic origin, show a remarkable uniformity. If the radiation from a blackened surface of quartz be taken as 100, the lowest radiating power is possessed by common white pumice, and is represented by 71·3. The temperature at which the measures were made was near 100° C. The measures of lunar radiation were made with an arrangement similar to that of a Herschel's telescope with the thermograph in place of an eye-piece. The results of the experiments indicate that the heat which our planet receives from the moon is to that of the sun as 1 is to 184,560. Some observations were made during the lunar eclipse of January 28, 1888, for the purpose of determining whether our atmosphere allowed radiations from the heated lunar surface to pass through it. When the moon was in the penumbra, the reading of the galvanometer scale was 254·4, nineteen minutes before totality it was 11·2, eight minutes before totality it was 7·3, and the mean of thirty readings taken during the total phase gave the value 2·09. The inference drawn from these observations is, that all but a minute portion of the rays from the lunar soil and rock are cut off by our atmosphere, for it seems impossible to conceive that a surface like that of the moon, upon which the sun has been shining for many days, should suddenly cease to radiate when the sun's light is withdrawn. A comparison of lunar rays with solar rays reflected from various rocks shows that the selective absorption by the rocks is altogether insufficient to explain the great absorption of the lunar rays observed during the eclipse. An attempt has been made to construct a curve representing the change of transmission of lunar rays by our atmosphere with changes in the altitude of the moon. The measures show that our atmosphere, at the ordinary pressure, transmits 89·25 per cent. of the vertical lunar beam.

THE STAR D.M. + 33° 470.—The Rev. T. E. Espin announces, in *Wolsingham Observatory Circular*, No. 27, that this star (R.A. 11h. 28m. 16s., Decl. + 33° 38′, 1855), magnitude 9·2, was observed on November 7 as 7·5 magnitude. Hence the star is probably variable. The spectrum is that of Group II.

THE NYASSALAND REGION.

ON Tuesday evening, at the opening meeting of the new session of the Royal Geographical Society, Mr. H. H. Johnston read a paper on his recent visit to the region lying between Lakes Nyassa and Tanganyika. While Mr. Johnston dealt largely with matters bearing on British interests and the industrial development of the region, he was also able to make additions to our knowledge of its geography. Mr. Johnston, in H.M.S. *Stork*, sailed up the Chindé mouth of the Zambesi, and for some distance up the Shiré River, where he was transferred to the Lakes Company's steamer *James Stevenson*. He visited the well-known station at Blantyre, then sailed up the lake to Karonga, the British station on the north-west shore of the lake. After bringing the hostile Arabs to terms, Mr. Johnston went on across the plateau to the south end of Lake Tanganyika, visiting, by the way, Lake Hikwa or Rukwa, first seen by Mr. Joseph Thomson on his first expedition into Africa. Of the navigation of the Zambesi, Mr. Johnston said:—

"The navigation of the Zambesi from its mouth to Vicente is by no means an easy matter to those unacquainted with the intricate windings of the river's navigable channel. The great stream, which is, on an average, three or four miles broad, is studded with islands and beset with sand-banks. Vast stretches of the river are covered by scarcely more than six inches of water. To the eye of a man accustomed to the study of great rivers, the existence of these shallows is at once apparent by the mirror-like calm of the water that covers them, and the warm, pinkish tone of the sandy bottom which subtly permeates the blue reflections of the sky. On the other hand, the course of the deep channel is marked by the swirling water, the tiny whirlpools, and the sharply-cut sides of the bank, which, instead of tapering off into the stream, look as if they had been recently sliced with a large knife. There is a crying need for what at present does not exist, or, if it does, is not known to the outside world—a good, accurate, and detailed chart of the course of the Lower Zambesi. Although the course of the deep channel varies and alters, as it does in all great rivers, it does not generally change so quickly but that a little careful supervision might easily keep such a chart up to date."

The following account of what is to be seen on the Shiré is of interest:—

"Continuing the ascent of the Shiré, we skirt the strikingly picturesque range of the Pinda Mountains, all jagged peaks and sugar-loaves, on the east, and the Matunda Mountains on the west, while in the far, far distance northwards there rise the vast dim outlines of higher and higher peaks, culminating in Mount Tshiperoni (or 'Clarendon,' as it was named by Livingstone). The scenery on this stretch of the Shiré is really very fine. In the foreground there are the serpentine windings of the broad river through the great Morambala marsh, which is here and there dotted by little lakelets of clear blue water, but for the most part covered with wide stretches of tall reeds. These reeds bear large heads of creamy-white flower-tufts, almost as big as those of the pampas grass, and as the wind blows across the marsh it sways the reeds into wave-like undulations, wherein the great white heads of blossom appear like fluctuating foam cresting the billows of shining green leaf-blades beneath. Rising above this white-flecked sea of glistening grass are the abrupt ranges of fantastically-shaped hills and mountains, which girdle in the Shiré valley with great semicircles of blue mountain wall. Occasionally a glaucous-green Borassus fan-palm rises on a column-like stem from an island in the river or a dry patch in the marsh. These landscapes are drawn in large traits, and their harmonies are simple, and not complicated by the admixture of any human habitation or cultivation. It is not until one is within a relatively short distance of the Ruo that the banks of the Shiré begin to be inhabited again, and the marsh yields to thin forest and plantations of maize, tobacco, millet, and pumpkins.

"A short distance above the Ruo one enters the Elephant Marsh, a district of great grassy flats, flooded occasionally when the Shiré overflows its banks, but ordinarily a dry level stretch of prairie dotted with pools of water.

"At the close of the dry season, when the tall grass has been burnt down, and there is little or no cover for the game to hide in, it is really a remarkable spectacle, as seen from the deck of a steamer, to watch the great herds of big animals wandering over these savannahs in search of the young verdure springing up amid the charred stubble of the old grass. With an opera-glass you may distinguish water-buck, gnu, buffalo, eland, pallah, reed-buck, and zebra, and occasionally some dark blue-grey blobs, much larger than the other specks and forms which are in their vicinity, turn out to be elephants. Occasionally a lion has been known to come down to the river and stare at the steamer, and on one or two occasions these beasts have actually been shot from the deck in passing. Both in the Elephant and Morambala marshes, and in the Upper Shiré, the hippopotamuses are a real source of danger and inconvenience to any boats of ordinary size which are not propelled by steam. The hippopotamuses are particularly dangerous at night, but even during the day they will deliberately chase and endeavour to upset boats and canoes which enter their domain; and in the development of the Shiré navigation it is essential that the hippopotamuses should be mercilessly exterminated."

Mr. Johnston described as follows the fine country on the north of Lake Nyassa:—

"Here there are no fewer than nine perennial rivers, some of them of considerable volume, which descend from the lofty mountain ranges of Buntali, Wukukwe, and Ukinga, and enter the lake between Karonga and Parumbira Bay, the moisture which percolates from them through the soil giving the Konde plain an appearance of perpetual spring. The land at the north end of the lake is a veritable African Arcadia. You may walk for miles and miles through banana plantations; then you may emerge on wide-stretching fields of maize and millet and cassava. All the oozy water-meadows are planted with rice; but, above all, the great wealth of the country is in cattle, which, elsewhere by no means common in Nyassaland, thrive remarkably in the Konde district, and consequently milk and beef are cheap and abundant. The inhabitants of this happy land are a contented, pleasant-dispositioned folk, who knew no trouble until the Arabs sought to subdue them a few years ago."

From a geographical point of view probably the most interesting part of his paper was that describing his visit to the remarkably desolate region around Lake Rukwa lying on the south-east of Lake Tanganyika. Rising from the fertile plateau are the

Wungu Mountains, some 6000 feet high, and Mr. Johnston thus described what he saw on ascending them :—

"We looked down on what I thought at first was a very broad sheet of water, surrounded on three sides by high ranges of mountains. But by degrees, with the aid of a field-glass, I discovered that what appeared to be a spacious lake in reality consisted of a narrow contorted strip of water on the one side, and between us and the water a wide extent of absolutely flat plain, so uniformly covered with blue-grey forest that from those heights above it was hard to distinguish it by its colouring from the real lake. When I had taken a number of angles from our camp on the mountain crest, we began a most arduous descent from the heights into the plain below. As we descended, our impressions and forebodings became of a somewhat dismal character. Everything around us bore witness to the dearth of water. On the other side of the mountain range we had left a country in the fully beauty of spring, intensely green with the gentle showers of the commencing rainy season, but here on the slope facing Rukwa, the farther we descended the more arid the country became. At the base of the mountains we crossed a three-mile stretch of level plateau, covered with the dismal grey growth of innumerable thorn-trees, so gnarled and contorted in shape, and provided with such cruelly ingenious hooks and barbs and stiletto-like thorns, that they might have been the enchanted forest round some wizard's lair.

"This plateau came to a sudden and abrupt termination, and from its edge we made a precipitous descent along a blood-red path into a blood-red ravine, the sides of which were fantastically planted and festooned with clumps of purple-green aloes, and those weird candelabra euphorbias with grey spectral stems, the segmented stalks of which looked like the tails of innumerable scorpions. Down through the dark gloomy depths of this cleft of the earth we floundered, slipped, and fell into the gorge of a dry river, cut deeply in a winding channel between precipitous red walls, the sides of which were scoured and polished and striated as if by glacial action. There were scattered stagnant pools of water in the red, red rocks and sand, and water oozed from places in the river bed when our porters dug below the surface. The trees clinging to the sides of the ravine were emerald green, with a metallic-tinted harsh verdure. Evidently this dried-up stream had once been an important river and a powerful torrent, and nothing is more remarkable in the vicinity of Rukwa than to observe the traces of a once abundant rain supply, which, from some unexplained cause, has—so the natives say—suddenly ceased during the last two or three years, as though the country had been literally blasted by some terrible curse.

"Crossing the dry bed of this river we entered on another level stretch of country gently sloping northwards, its surface uniformly clad with a forest of grey thorn-trees, but with the ground at their bases bespangled in a strange contrast with gorgeous flowers, which were almost unaccompanied by leaves, just the vividly-coloured petals rising from the hard grey soil.

"These consisted chiefly of purple, yellow, and white anemones, arborescent lilies, with white star-like flowers springing from a grey branching stem, and great heads of pink crinums resembling the 'kafir lily' of South Africa.

"We passed an occasional dry water-course choked with grey-green life-in-death vegetation, and then at length reached a broader dried-up stream-valley, with shadier trees and a stockaded village, the first we had met with in the land. . . . As soon as we got out of the broad, shaded stream-valley where the village was situated, we entered the frying, blazing heat of the parched plain, and found ourselves in a white, light, bright hell of dazzling sunshine. The shadeless acacias with their cruel thorns, the dry yellow grass, and the yellow withered Borassus palms, in no way mitigated the pitiless glare of the vertical sun, while a raging wind, hot as the breath of a furnace, swept over the plain and burnt the skin of our faces, so that we felt as if we wore tight masks. Every quarter of an hour the wretched caravan had perforce to stop and pant under the thin film of shade which might descend from the skeleton branches of a dead tree. At length, after frequent halts and protestations from the sun-stricken men that they could go no farther, we saw ahead of us an emerald-green line in the grey wilderness, which marked the presence of water. This turned out to be a welling, brackish pool thronged with bulrushes and reeds, a kind of circular spring of overflowing water apparently connected with the lake by a long lane of rush-choked marsh, very distinct from the arid plains of baked mud. We camped here, where the scenery was a little less ghastly in its dead ugliness. The acacias exhibited a little green foliage among their thorns, and they were frequented by thousands of cooing doves, while the scanty bushes on the ground served as cover for many francolin and guinea-fowl. Game, in the shape of antelopes and buffaloes, was evidently abundant, and no doubt was attracted to the vicinity of this brackish pool by the flakes of salt which remained on the soil where the water had evaporated; and the game in its turn was followed by hyenas, lions, and vultures. The hyenas laughed and the lions roared outside our camp fires, and the next day I noticed many scattered fragments of bones and skulls in the vicinity, which were the relics of previous feasts on the part of these Carnivora.

"I was anxious to proceed direct to the lake from here, as we were only about three or four miles distant, but the Wuñgu people would not allow us to do so until we had first seen their Sultan, so we travelled in a north-easterly direction, always through this scorching, glaring wilderness, till we reached the bank of the Soñgwe River. Here I camped so that the men might be close to fresh water, but it appeared to us that even the water of the Soñgwe was brackish, though it was a running river. It seemed to have no effect in quenching one's thirst, and contained some irritating property which occasioned diarrhœa, and even dysentery. Leaving my men at the Soñgwe, I went with Mr. Nicoll and Dr. Cross to visit Mwinyi-Wuñgu, who lived about a mile from its banks in a stockaded town. I can hardly describe the heat of the atmosphere in walking thither; it was like passing through fire. When we got into the town, we eagerly crept under the shade of the overhanging eaves of the houses, which extended so near the ground, for the sake of coolness, that one had to get down on all fours to get under them."

As there was really a famine both of food and water in this dreadful wilderness, Mr. Johnston and his large party of men were compelled to hasten out of it, without his actually being able to get to the edge of the lake itself. What he has told us about this region makes us desirous of knowing more. It is a remarkable fact that, while in the Nyassa-Tanganyika plateau there had been no lack of rain, in the lake basin itself not a drop had fallen for three years.

THE BOTANICAL MYTHOLOGY OF THE HINDOOS.

At a recent meeting of the Anthropological Society of Bombay, Dr. Dymoke read a very interesting paper entitled "The Flowers of the Hindoo Poets," in the course of which he referred to the mythical conceptions which have gathered round trees and plants in the minds of the Hindoos. The ancient Eastern poets saw in the tree a similitude with the heavens and with the human form; in the "Gitagovinda" a comparison is drawn between the clouds and the thick dark foliage of the *Tamala*. These fancies gave rise to the numerous poetical myths concerning the tree of life, of knowledge, of the *Amrita* or Ambrosia, as well as those concerning cosmogonic and anthropogonic trees. The *Soma* or *Amrita* is represented as the king of plants, the eternal essence which constantly sustains and renews the life of plants and animals; it is the symbolical drinking of this eternal essence as a holy ceremony to which constant allusion is made in the Vedas :—

"We've quaffed the Soma bright,
And are immortal grown;
We've entered into light,
And all the gods have known."
—*Rigveda*, viii.

The Amrita appears in various forms in stories and legends. A famous poet says that the drop (*Svedavindu*) which fell into the shell became a pearl; in the mouth of the black snake it became poison; and in the flower of the plantain, nectar. Several plants bear this name, and are supposed to be endued with an extra particle of the eternal essence; among others, the *Neem*, on which account the Hindoos, on their New Year's Day, eat the leaves of this tree upon the supposition that the Amrita contained in them will insure longevity. In Hindoo flower lore the large black bee (*Buramara*) plays an important part: he is the inconstant lover who delights in gathering sweets from every flower. The queen of Indian flowers is the lotus: the Hindoos compare the newly-created world to a lotus flower floating upon the waters, and it thus becomes symbolical of spontaneous generation. The golden lotus of Brahminic and Buddhistic mythology is the sun, which floats in the waters which are above the firmament, like an earthly lotus in the deep blue stream below. From it distils the Amrita, the first manifestation of Vishnu. Brahma and Buddha (the supreme intelligence) were born of this heavenly lotus. Lakshmi, the Indian Venus, is represented sitting on this flower. The Hindoos see in the form of the lotus the mysterious symbol, *Svastika*. The allusions to this flower by Indian poets are innumerable. No praise is too extravagant for it; it is the chaste flower, and its various synonyms are bestowed as names upon women. The red lotus is said by the poets to be dyed with the blood of Siva that flowed from the wound made by the arrow of Kama, the Indian Cupid. The face of a beautiful woman is compared by the poets to a lotus blossom, the eyes to lotus buds, and the arms to its filaments. The bee is represented as enamoured of the lotus. Although a humble little flower, the *Tulasi* is almost as great a favourite as the lotus; it is addressed to the goddess Sri or Venus. The heart of Vishnu is said to tremble with rage if a branch of his beloved is injured. The plant must be gathered only for medicinal or religious purposes, such as the worship of Vishnu or Krishna, or the wife of Siva. It is a kind of amrita, symbolical of the eternal essence; it protects the worshippers and gives children to women. The plant is often worshipped as a domestic deity, and its branches are placed on the breasts of the dead. The Champa is chiefly celebrated for its overpoweringly sweet odour and golden colour; so strong is its perfume that the poets affirm that bees will not extract honey from it; but they console it for this neglect by dedicating it to Krishna, who loves garlands of yellow flowers as becoming to his dark complexion. One of the greatest favourites of the poets is the Asoka; its flowers, which are yellow when they first open, gradually change to red. In March and April it is in its glory, and at night perfumes the air with its delicate odour. The tree is the *kul* or anthropogonic tree of the Vaisya caste, who call it Asupala. The Kadamba (*Anthocephalus cadamba*) is sacred to Kali or Parvati, the consort of Siva; it has many synonyms, such as "protecting children," "dear to agriculturists," &c. It blossoms at the end of the hot season, and its night-scented flowers form a globular orange-coloured head, from which the white-clubbed stigmas project. The flowers are fabled to impregnate with their honey the water which collects in holes in the trunk of the tree. In Delhi the goldsmiths are fond of imitating the flowers. The well-known prickly gold beads so often seen in Delhi jewellery are meant for kadamba flowers. In this part of India the Marathas will not gather the flowers for profane purposes as it is their anthropogonic tree. The Kadamba Rajas claim their descent from it, as recorded in the following legend:—"After the destruction of the demon Tripura, a drop of perspiration fell from the head of Isvara into the hollow of a kadamba tree, and assumed the form of a man with three eyes and four arms. He became the founder of Vanavasi or Jayantipur." There are other versions of the story, but all agree in connecting the origin of the family with this tree, a branch of which is necessary to represent the Kai at a Marathi marriage ceremony.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—At the biennial election to the Council of the Senate held on November 7, the following were nominated (the * indicates retiring members):—Heads (2 seats)—*Dr. Atkinson, Clare, *Dr. Ferrers, Caius, Dr. Hill, Downing; Professors (2 seats)—*Dr. Cayley, Trinity, Dr. Sidgwick, Trinity, Prof. Ryle, King's; Members of the Senate (4 seats)—*Dr. D. MacAlister, St. John's, Dr. Forsyth, Trinity, *Mr. Whitting, King's, Mr. R. T. Wright, Christ's, Mr. E. H. Morgan, Jesus, Mr. C. W. Moule, Corpus, Mr. C. H. Prior, Pembroke. The voting was as follows:—Dr. Ferrers, 184, Dr. Atkinson, 137; Dr. Cayley, 191, Dr. Sidgwick, 127; Dr. D. MacAlister, 158, Mr. Whitting, 156, Dr. Forsyth, 153, Mr. Wright, 117. These were elected. Dr. Hill received 109 votes, Prof. Ryle, 103, Mr. Prior, 111, Dr. Lea, 82, Mr. Morgan, 81, Mr. Moule, 71. The newly-elected members hold office for four years. The result is interpreted as a gain for those who favour the modern development of the University.

It should have been stated that the election of Fellows referred to in our last number took place at St. John's College.

Mr. Frank McClean, M.A., of Trinity College, has offered securities of the value of £12,000 to be held in trust for the University by Trinity College, for the purpose of founding three "Isaac Newton Studentships" in Astronomy, Astronomical Physics, and Physical Optics. The students are to hold their emoluments for three years, to be Bachelors of Arts, and of high mathematical attainments.

R. S. Cole, B.A., of Emmanuel College, has been appointed a Junior Demonstrator of Physics at the Cavendish Laboratory, in the place of Mr. L. R. Wilberforce, promoted to be Demonstrator.

The General Board of Studies propose the foundation of an additional Demonstratorship in Physiology, under Prof. Michael Foster, without stipend from the University Chest.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Microscopical Society, October 15.—Dr. C. T. Hudson, F.R.S., President, in the chair.—Mr. G. F. Dowdeswell's note on a simple form of warm stage was read, and the apparatus exhibited.—The President said he had with great regret to record the deaths of two honorary Fellows of the Society—Prof. W. Kitchen Parker, F.R.S., and Mr. J. Ralfs. In place of these two gentlemen Dr. H. B. Brady, F.R.S., and Prof. W. C. Williamson, F.R.S., were nominated.—Mr. Mayall said he must ask the indulgence of the meeting to enable him to clear himself from possible ambiguity. In notifying the fact that at the first photographic trials of the new objective of 1·6 N.A. the visual and actinic foci had been found by Mr. Nelson and himself to be not coincident; and that when the objective was returned to Jena immediately after, Dr. Czapski found the foci were coincident; he had hazarded what he had imagined would appear a mere playful admission of the state of general puzzlement of both sides by suggesting that "the transit of the objective from London to Jena had somehow got rid of the 'chemical' focus." That sentence had unhappily been construed both in England and abroad into a reflection upon the good faith of Dr. Czapski, or Dr. Abbe, or the firm of Zeiss. Whatever blame was due to himself for the ambiguity of the expression, he must, of course, accept. At the same time he thought the Society would be interested to learn that upon his conveying his explanation to Dr. Czapski and Dr. Abbe, those gentlemen had expressed their complete satisfaction with it. He believed that the existence of a "chemical" focus was probably due to a slight difference in the adjustment of the front lens, especially, as Dr. Abbe had pointed out, in view of the fact that with an objective of such large aperture the colour correction was, as it were, "balanced on a needle-point" in the matter of an alteration in the distance of the front lens from the posterior combinations; and that a very minute alteration in that distance, though producing no perceptible difference in the visual image, was quite competent to lengthen or shorten the focus of the violet rays to such an extent as to exhibit a "chemical" focus non-coincident with the visual focus when tested photographically.—The President gave formal notice that a special general meeting would be held in the Library at 5 p.m. on Wednesday, October 22, for the purpose of considering alterations in the bye-laws, the terms of which he read.—Mr. G. C. Karop exhibited and described an improved students' microscope, made by Swift and Son. The new instrument embodied Mr. Nelson's "horse-shoe" stage for convenience of readily seeing the condenser, and for estimating by the touch the approximation of the focus on the slide, and on which the Mayall mechanical stage was easily applied, together with a centring sub-stage focussed by sliding on the tail-piece, the whole of superior workmanship and design, and supplied at a moderate outlay.—Prof. J. W. Groves communicated a note by Mr. P. C. Waite on a new method of demonstrating intercellular protoplasmic continuity. A specimen in illustration was exhibited.—Mr. J. D. Aldous exhibited some early forms of microscope slides made of boxwood, similar to those formerly made of ivory, with the objects between pieces of talc.—The President called attention to some original drawings of a new Rotifer by Mr. W. B. Poole, of South Australia; also to a specimen of *Œcistes mucicola* exhibited by Mr. G. Western.—Mr. E. M. Nelson exhibited upon the screen a series of thirty-one photomicrographs, which he described.—Dr. H. B. Brady's paper on a new type of Foraminifera was taken as read.

—Dr. Maddox's paper on the structure of Spermatozoa was postponed until the next meeting in consequence of the lateness of the hour.

PARIS.

Academy of Sciences, November 3.—M. Duchartre in the chair.—Notice of the works of M. Pierre de Tchihatchef, by M. Daubrée. M. de Tchihatchef died at Florence on October 13. He was born at St. Petersburg in 1815, and elected a correspondent of the Academy in the Geographical Section when about thirty years of age. An account is given of his many scientific works.—A photo-chronographic apparatus that may be used to analyze every kind of motion, by M. Marey. A photographic film is caused to move across the focus of the lens of a camera. The motion is imparted by an electric motor, and with the arrangement described the film may be arrested fifty times a second for the production of as many views of the object being photographed. A plate giving six views of a trotting horse accompanies the note.—On the relation of gangrenous septicæmia to lock-jaw, with special reference to the associations of virulent microbes, by M. Verneuil. From a series of surgical and chemical experiments, the author is led to believe that the co-existence in man of certain forms of mortification and lock-jaw is not accidental, but results from the simultaneous production in the wounds of two microbes well known to Pasteur and Nicolaïer.—On the movements of a double cone, by M. A. Mannheim.—On the periodic functions of two variables, by M. Appell.—On a particular case of Lamé's equation, by M. V. Jamet.—Undulatory pressures produced by the combustion of explosives in a closed vessel, by M. Vieille.—On Bunsen's photometer, by M. R. Boulouch.—The rotation of the earth on its axis produced by the electro-dynamic action of the sun, by M. Ch. V. Zenger. The author has caused a hollow sphere to rotate under the action of the two poles of a Wimshurst machine, and thence argues that the planetary motions in our solar system have an electro-dynamic origin.—Action of borax in alkaline developing baths, by M. P. Mercier.—On the affinities of iodine in the dissolved state, by MM. Henri Gautier and Georges Charpy. The authors have studied the chemical behaviour of solutions of iodine in different media. Shaking the solutions with a lead amalgam, they find the colours of the mixture of iodides obtained in each case—that is, the proportions of the iodides of lead and mercury respectively—depend on the kind of solution employed.—On the γ-cyanoacetoacetic ethers and the hydrochlorides of the corresponding imides, by MM. A. Haller and A. Held.—Researches on the conditions of the reactions of the isopropylamines: limit to the production and development of propylene, by MM. H. and A. Malbot. The authors have studied (1) the action of isopropyl iodide on very concentrated aqueous ammonia in equi-molecular proportions, at the ordinary temperatures; (2) the same at 100°; (3) the same above 100°; (4) the action of isopropyl chloride upon aqueous ammonia at 140°. From the results of experiment, they have summarized their conclusions as to the character of these reactions between aqueous ammonia and isopropyl iodide and isopropyl chloride.—The Hanneton parasite, by M. Le Moult.—On certain formations on copper and bronze, by M. Raphael Dubois. The author has observed and studied some white mycelium flakes, very similar to those of *Penicillium* and *Aspergillus*, in solutions of concentrated copper sulphate neutralized by ammonia and used for the immersion of the gelatine plates employed in photogravure. Similar formations have been observed on bronze.—On some rocks from the Lunain valley, supposed to have been used to polish stone implements in Neolithic times, and on the action of water in the Stone Age, by M. Armand Viré.—On the formation of abrupt escarpments of earth that interrupt the slope of valleys in the north of France, where they are known as *rideaux*, by M. A. de Lapparent.—Experimental contribution to the history of the dendrites of manganese, by M. Stanislas Meunier.

DIARY OF SOCIETIES.

LONDON.

THURSDAY, NOVEMBER 13.

MATHEMATICAL SOCIETY, at 8.—The Influence of Applied on the Progress of Pure Mathematics: the President.—Spherical Harmonics of Fractional Order: R. A. Sampson.—Proofs of Steiner's Theorem relating to Circumscribed and Inscribed Conics: Prof. G. B. Mathews.—On an Algebraic Integral of Two Differential Equations: R. A. Roberts.—Some Geometrical Theorems: Osher Ber.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.

FRIDAY, NOVEMBER 14.

PHYSICAL SOCIETY, at 5.—On Certain Relations existing among the Refractive Indices of some of the Chemical Elements: Rev. T. Pelham Dale.—Tables of Spherical Harmonics, with Examples of their Practical Use: Prof. Perry, F.R.S.

ROYAL ASTRONOMICAL SOCIETY, at 8.

AMATEUR SCIENTIFIC SOCIETY, at 8.—Geological Travels in France, Spain, and Algeria: G. F. Harris.

SUNDAY, NOVEMBER 16.

SUNDAY LECTURE SOCIETY, at 4.—Captain John Smith, the Heroic Pioneer of English Colonization in America: Willmott Dixon.

TUESDAY, NOVEMBER 18.

ZOOLOGICAL SOCIETY, at 8.30.—A Catalogue of the Reptiles and Batrachians of Barbary (Morocco, Algeria, Tunisia), based chiefly upon the Notes and Collections made in 1880–84 by M. Fernand Lataste: G. A. Boulenger.—Remarks on the Chinese Alligator: G. A. Boulenger.—On some New Species and Two New Genera of Araneidea: Rev. O. P. Cambridge, C.M.Z.S.—On some Upper Cretaceous Fishes of the Family Aspidorhynchidæ: A. Smith Woodward.

ROYAL STATISTICAL SOCIETY, at 7.45.—Inaugural Address: Dr. Frederic John Mouat, President.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Steam on Common Roads: John McLaren. (Discussion.)—The Vibratory Movements of Locomotives: Prof. J. Milne, F.R.S., and John McDonald.

THURSDAY, NOVEMBER 20.

ROYAL SOCIETY, at 4.30.—The following papers will *probably* be read:—On the Determination of the Specific Resistance of Mercury in Absolute Measure: Prof. J. V. Jones.—The Spectroscopic Properties of Dust: Profs. Liveing and Dewar, F.R.S.—On the Specific Heats of Gases at Constant Volume; Part I., Air, Carbon Dioxide, and Hydrogen: J. Joly.—Magnetism and Recalescence: Dr. Hopkinson, F.R.S.

CHEMICAL SOCIETY, at 8.—Ballot for the Election of Fellows.—The Estimation of Cane-Sugar: C. O'Sullivan and F. Tompson.—New Method of Determining Specific Volumes of Liquids and their Saturated Vapours: S. Young.

LINNEAN SOCIETY, at 8.

ZOOLOGICAL SOCIETY, at 4.

SATURDAY, NOVEMBER 22.

ROYAL BOTANIC SOCIETY, at 3.45.

CONTENTS. PAGE