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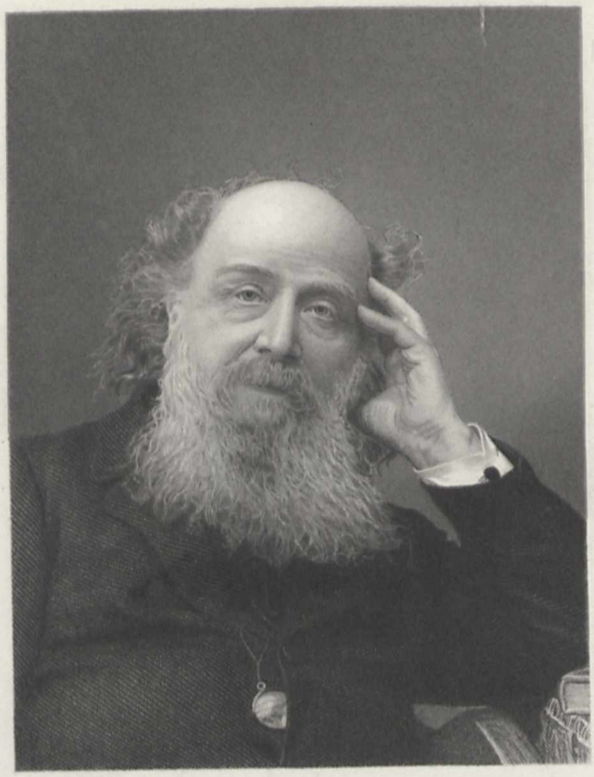

James Joseph Sylvester

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Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

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"*To the solid ground*
Of Nature trusts the mind which builds for aye."—WORDSWORTH

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, NOVEMBER 1, 1888.

GRESHAM COLLEGE.

MR. GOSCHEN—speaking on behalf of the London Branch of the Lecture Society which was started by Prof. James Stewart, of Cambridge, for the purpose of giving remunerative employment to some of the younger graduates of Oxford and Cambridge, and at the same time of affording instruction and amusement of an intelligent character to such audiences as the larger manufacturing towns afford—has publicly urged the claim of the Society to enter upon Gresham's heritage, and by the aid of the funds still in the hands of his trustees, and of such moneys as those trustees may think it incumbent upon them to restore to the Gresham trust, to carry out the purpose of that great founder, who, two hundred and fifty years ago, bequeathed property, now valued at several millions sterling, for the purpose of maintaining a College of Professors in London. There is no question as to what were the intentions of Gresham, nor as to the disgraceful nature of the transactions by which his trustees—the Corporation of London and the Mercers' Company—a little more than one hundred years ago were enabled to seize the property of the trust, and, with the sanction of an Act of Parliament, to assign a mere fraction of it to the payment of half a dozen lecturers, whilst appropriating the bulk of it to their individual and corporate use.

It is beyond question that the existing representatives of the Corporation of London and the Mercers' Company are ashamed of the neglect and spoliation of which their predecessors, in a corrupt age, were guilty. They would be glad to assign the money with which they at present pay so-called "Gresham Professors," and even a large additional sum, representing the misappropriated trust funds, to an institution more truly representing Gresham's purpose than the lecture-room now existing at the back of Mercers' Hall, in the heart of the City, could they be assured that any one of the various plans which have been from time to time urged upon them was really a wise and true method of carrying out that purpose.

We venture to think that Mr. Goschen has merely added to the perplexity in which Gresham's trustees find themselves by his ill-timed proposal that his Lecture Society should be supported by the funds disposed of by those trustees. The lectures given by this Society are, we feel assured, excellent in their way, and we do not doubt that they give a large amount of pleasure and of useful information to the persons who attend them. We are aware that the lectures are more serious in scope than the series of popular lectures frequently arranged by lecture associations, and consist of short courses, in which one teacher is able at some length to explain the outlines of his subject, instead of isolated lectures by numerous individuals on disconnected topics. It is only reasonable that any public or semi-public institution, having a lecture-theatre at its disposal, should encourage so excellent a Lecture Society as Mr. Goschen's, by giving it the use of rooms from time to time. Thus the various Vestry Halls of London may be (and we believe have been) made use of. The London Institution in Finsbury Circus, University and King's Colleges, and the University of London could easily lend a lecture-theatre from time to time to Mr. Goschen's *protégés* as they have to other similar Societies. And it is not unfitting that Gresham's trustees should lend the little-used theatre of the Gresham Professors for the same purpose. When, however, Mr. Goschen and his friends take advantage of this hospitality to urge that not only should Gresham's theatre be lent to them, but that Gresham's money should be assigned to the support of their lecturers, it seems to us that an unwarrantable pretension is put forward, and one which is to be deprecated on very special grounds. Those grounds are as follows.

Gresham's foundation was assigned by him to the support of a body consisting of seven learned men, to whom he proposed to furnish, not a mere fee for a short course of lectures, but a life-provision—in fact, a residence, laboratories, and the means of research, as well as a stipend, at the highest rate at which such persons were paid three hundred years ago, as shown by the payments made to the Professors and College officials of Oxford and Cambridge. Gresham assigned his own palace and garden, situated where Old Broad Street at present runs, for the dwelling-place of the Professors of his College; and here the first Gresham Professors did reside, and not merely give instruction to the citizens of London by means of lectures, but—what was far more important—carried on their studies and researches. Here the Royal Society met in its early days, and here, in fact, were the head-quarters of learning and science in London.

It is clear enough that what Gresham intended to found, and what actually was constituted by his trustees in the year 1596, was an institution similar to the Professorial Universities of Scotland and Germany of the present day. He distinctly founded seven Professorships—viz. of Physic, Law, Rhetoric, Geometry, Music, Astronomy, and Divinity—and ordered that the proceeds of the rents derived from the shops and houses around the Royal Exchange which were his property should be used in paying each of these Professors £50 a year—no small sum at that time, since the yearly value of Gresham House itself and the gardens attaching to it was, at the date of Lady Anne Gresham's death, in 1596, estimated at only £67!

In view of these facts, it is idle to pretend that the Lecture Society has any similarity to the institution designed by Gresham. Whatever good Mr. Goschen's Lecture Society is doing, it is not doing the work which Gresham intended his College to perform, although Mr. Goschen tells us that he thinks that it is.

To subsidize a series of innumerable short courses of lectures by innumerable young men of small experience is a totally different thing from housing and providing for life seven chosen teachers—the best, the most skilled, the most original in discovery, the most masterly in discourse, worthy to represent science and learning in this great city of London.

By the former course you may diffuse a little knowledge amongst a great many people who will not themselves pay for the pleasure thus presented to them. This is Mr. Goschen's plan. By the second you hold before younger men a prize to stimulate their endeavours; to the matured and chosen teacher you give the leisure and security necessary for research—that is, for the making of new knowledge; to the citizens of London you assure the presence in their midst, and the continual teaching, of the ablest discoverers and philosophers. That is Gresham's plan.

It may be, and, indeed, has been, argued that it is impossible to carry out Gresham's plan, and that the best thing to do with whatever can be got together of his trust funds is to administer it on the principle of *cy-près*, and, accordingly, to let Mr. Goschen's Society have it.

To this we reply that Mr. Goschen's Society has no claim whatever upon this principle, since there are institutions in London—namely, University and King's Colleges—which come near to realizing Gresham's intentions, and if endowed by his funds would actually realize them, whilst Mr. Goschen's Society is as different from Gresham's College as a pic-nic is from a military expedition. A very objectionable use is made of the word "University" in the endeavour to gain support for the Lecture Society. It is spoken of as a "Society for the Extension of University Teaching," and more briefly as "University Extension." The implication is that the teaching is such as is given at Universities, and it is an entirely false implication. The teaching given at Universities depends for its character on two chief factors—firstly, the selection and consequent ability of the teacher; and secondly, the continuous and entire devotion of the student's time to the training and instruction provided for him. In both these factors the Lecture Society differs *toto cœlo* from even the most eccentric University, and has no claim to employ that much misused term. Yet it is by taking advantage of the misconception created by its use in connection with the Lecture Society that a claim has been made for this Society both to take part in the organization of a new University of London and to benefit by Gresham's trust, which it is rightly alleged was intended for the introduction into London of University teaching.

If the present representatives of Gresham's trustees—the Corporation of London and the Mercers' Company—would simply carry out the provisions of his will as nearly as possible—much as they were carried out in the year 1596—all would be well, and the contentions of rival claimants to a share of the pickings still to be got from the bones of Gresham College would be silenced.

The original Gresham College began well enough, and caused the greatest satisfaction to the citizens of London. The lectures were largely attended, the Professors were men of great distinction, and a long and useful career was foreseen for the College. A similar institution—the Collège de France—was founded in Paris by the French King about the same time. The Collège de France exists to this day, and is one of the most effective and valuable institutions in the world for the production of new knowledge.

Our London College perished simply and solely through deliberate jobbery and corruption. The trustees purposely neglected their trust; incompetent persons were appointed by them to the Professorships; they themselves stole the land round about Gresham House, and excused the Professors from lecturing in order to avoid prosecution by the Professors for arrears of salary. In the beginning of the eighteenth century Gresham College was an object of contempt and derision to the citizens of London. The trustees had ruthlessly and systematically plundered the trust-funds and prostituted the Professorships, so that no one raised even a feeble protest when the work of perfidy was consummated, and Gresham House was pulled down, the site handed over to the Excise Office, and the worshipful trustees were spared all responsibility as to their dealings with property worth some millions at the present day, in consideration of a payment of £500 a year.

There are those who maintain that, were Gresham College reconstituted at the present day, it would have the same fate. We are not disposed to believe this. It was, no doubt, a mistake on Gresham's part to place such absolute confidence as he did in the Corporation of London and the Mercers' Company. We have invented, since Gresham's time, methods for keeping a check on erratic trustees; but what is of far greater importance is, that at the present time there is a real and earnest desire on the part of the great City Companies to do service to the State and honour to themselves by employing the funds in their possession for the good of the community. It is not improbable that—were a scheme for the establishment of a thoroughgoing Professorial University in London (similar in its aims and methods to Gresham's College, and by no means similar to Mr. Goschen's Lecture Society) forthcoming as the result of the deliberations of the Royal Commission now sitting to consider the question of the future University of London—the present representatives of Gresham's trustees would be willing and anxious to redeem the past by endowing in that University seven or more Gresham Professorships, with a sum representing in adequate degree the property long ago misappropriated by their predecessors. Sir Thomas Gresham, the greatest and most generous of merchants who ever desired to benefit the City where he lived and prospered, the man who, above all others, has been most shamefully betrayed by those whom he trusted and loaded with gifts, may yet be honoured and justly dealt with. It rests with the Corporation of London, and the Worshipful Company of Mercers, to give to the future University of London, Gresham's name and Gresham's money.

E. RAY LANKESTER.

BACON.

Bacon. By R. W. Church, Dean of St. Paul's. (London: Macmillan and Co., 1888.)

THE handsome volume before us, which forms the fifth volume of Dean Church's collected works, is a reprint (with, apparently, few or no alterations) of the small book on "Bacon," which originally appeared in Mr. Morley's series of "English Men of Letters." Like every literary composition which falls from the pen of its author, it is a model of candour in treatment, and of gracefulness in style. Other accounts of Bacon may be more profound, more detailed, or more appreciative, but certainly none is likely to be more interesting or attractive to the general reader.

The early chapters, constituting the larger portion of the book, are occupied with Bacon's life, and therefore, by implication, with the never-ceasing controversy about his character, conduct, and motives. On these topics, Dean Church's judgment decidedly inclines to the side of severity; nor does he, as it seems to us, make sufficient allowance for the temptations to which Bacon was exposed, arising largely from his financial embarrassments, the peculiarly difficult positions in which, as in the case of Essex, he was sometimes placed, or the habits and circumstances, so different in many respects from our own, of the times and circles in which he lived. At the same time, the sentence, however decisive, is always delivered in kindly and gentle tones, as that of a judge who regrets, rather than denounces, the faults which he condemns. The judgments of Dean Church, even when we regard them as erroneous, always demand our attention, and perhaps all the more so, because they are entirely free from the asperity and ferocity of tone which mark the utterances of some others of Bacon's more recent critics.

But our business is not so much with the chapters on Bacon's life and character as with the chapter on his philosophy. Here Dr. Church mainly follows the lead of M. de Rémusat, and consequently his account, though reflective and suggestive, and often singularly felicitous in expression, appears to us to be wanting in the definiteness and precision which are requisite in the estimate of a philosophical or logical system. He does not, for instance, bring out with sufficient emphasis the fact that Bacon was what in our own days we should call, not a philosopher, but a logician. His mission, as Bacon himself conceived it, was to bring about a thorough reform in the method of science, and through this new method to reconstitute, or, rather, to enable others to reconstitute, from their very foundations, the whole circle of the sciences—moral, mental, and political, as well as what are more strictly called natural. The inductive method was not conceived of by Bacon as antagonistic to the deductive method, but as its necessary antecedent and complement. Nor did he regard himself, nor would it be right to regard him, as the inventor of the inductive method, any more than Aristotle regarded himself, or it would be right to regard him, as the inventor of the deductive method. What both philosophers alike did, was to analyze, classify, and discriminate, with a view to distinguish between correct and incorrect reasoning, the methods of natural logic already in use. Only, while Aristotle performed this work effectively, and, considering the time at which he taught, with marvellous elaboration, for the syllogistic logic, he did little more than point out the existence and necessity of induction. This want of rules and of a sufficient analysis of the inductive side of reasoning easily accounts for the utterly unscientific character of the inductions with which men ordinarily satisfied themselves throughout the Classical and Middle Ages. What really constituted the most distinctive feature in Bacon's conception of a reformed logic was the profound idea that induction, instead of being the loose, vague, and uncertain process which was then in vogue, admitted of being presented with the force of demonstration, and thereby, if the facts on which it was founded were true, of supplying as firm a basis for the premises, as the premises, if they were true, supplied for the conclusion of the syllogism. "Inductionem enim censemus eam esse demonstrandi formam, quæ sensum tuetur et naturam premit et operibus imminet ac fere immiscetur" ("Distributio Operis"). "Verum ad hujus inductionis, sive demonstrationis, instructionem bonam et legitimam quamplurima adhibenda sunt, quæ adhuc nullius mortalium cogitationem subiere; adeo ut in ea major sit consumenda opera, quam adhuc consumpta est in syllogismo" ("Novum Organum," Book I. Aph. 105). Thus it is hardly an exaggeration to say that inductive logic—that is, the systematic analysis and arrangement of inductive evidence, as distinct from the natural induction which all men practise—was almost as much the creation of Bacon as deductive logic was that of Aristotle. Dean Church rightly calls attention to the wide interval which separates Bacon's "Tables of Instances" from the experimental methods of Mr. Mill; but the latter are, after all, only a corrected version of the former, and, historically, were derived from them through the medium of Sir John Herschel's discourse on "The Study of Natural Philosophy." Moreover, it is remarkable that the two divisions of the "Instantiæ Solitariæ," described in "Nov. Org.," Book II., Aph. 22, correspond respectively with Mill's "Methods of Agreement and Difference," and that the very words "method of agreement" and "method of difference" all but occur in the text. For these and many similar reasons, we certainly cannot accept the verdict of Dean Church, that "the course which he marked out so laboriously and so ingeniously for induction to follow was one which was found to be impracticable, and as barren of results as those deductive philosophies on which he lavished his scorn." This remark may be approximately true of the method of rejections or exclusions, which proceeds on the false assumption that the whole complex system of the material universe may be resolved into a small and definite number of "simple natures," just as the numerous words which constitute a language may all be resolved into the few and assignable letters of an alphabet; but it is most emphatically not true of the methods which are subsidiary to the method of exclusions, such as the "Tables" and "Prerogatives of Instances." The subsidiary methods have, happily, a value of their own quite independently of the main object which they were supposed to subserve. Nor, as it seems to us, can it be doubted that these methods have been actually fertile in the progress of scientific discovery. Not, perhaps, that the greatest discoverers have often consciously, deliberately, and designedly set to work to employ them; but methods and principles of this kind, when once enunciated and realized, are, as it were, "in the air," and their influence is often no less potent because it is one of which men are only dimly conscious.

The process of fault-finding, especially as applied to a book which we have read with interest and pleasure, is not one which we would gladly prolong; but, to prevent a very grave misconception of Bacon's philosophical position, we feel it incumbent on us to point out a serious error into which Dean Church has been led by too implicit confidence in the authority of Mr. Ellis. "Bacon's conception of philosophy," we are told, "was so narrow as to exclude one of its greatest domains; for, says Mr. Ellis, 'it cannot be denied that to Bacon all sound philosophy seemed to be included in what we now call the natural sciences.'" By "sound philosophy" is meant, it may be presumed, philosophy based on experience, and arrived at by the inductive method. In "Nov. Org.," Book I., Aph. 127, we have the question as to the range of the sciences to which the new method is applicable definitely propounded and definitely answered. "Etiam dubitabit quispiam potius quam objiciet, utrum nos de Naturali tantum Philosophia, an etiam de scientiis reliquis, Logicis, Ethicis, Politicis, secundum viam nostram perficiendis loquamur. At nos certe de universis hæc quæ dicta sunt intelligimus: atque quemadmodum vulgaris logica, quæ regit res per syllogismum, non tantum ad naturales, sed ad omnes scientias pertinet; ita et nostra, quæ procedit per inductionem, omnia complectitur." There are many other passages in the "Novum Organum," the "De Augmentis," and elsewhere, to the same effect. Indeed, it appears to us unquestionable that Bacon, while he regarded his method as primarily, and, perhaps, most easily, applicable to the natural sciences, contemplated its ultimate extension to all branches of knowledge alike. The few passages which seem to point in the opposite direction are, doubtless, ironical, and refer, not to science, or knowledge in the true sense, at all, but to rhetoric and disputation.

The last chapter of the book is on Bacon as a writer. Here the author is thoroughly at home, and the striking and suggestive remarks which he makes on this topic only cause us to regret that there are not more of them. Take, for instance, the following just and forcible sentences on Bacon's English composition:—"His manner of writing depends, not on a style, or a studied or acquired habit, but on the nature of the task which he has in hand. Everywhere his matter is close to his words, and governs, dominates, informs his words. No one in England before had so much as he had the power to say what he wanted to say, and exactly as he wanted to say it. No one was so little at the mercy of conventional language or customary rhetoric, except when he persuaded himself that he had to submit to those necessities of flattery, which cost him at last so dear."

T. FOWLER.

KARYOKINESIS.

Ueber Kern- und Zelltheilung im Pflanzenreiche, nebst einem Anhang über Befruchtung. Von E. Strasburger, o. ö. Professor der Botanik an der Universität Bonn. Mit drei lithographischen Tafeln. (Jena: Gustav Fischer, 1888).

PROF. STRASBURGER intends this volume to constitute only the first of a new series of contributions to our knowledge of vegetable histology. In these 258 pages the phenomena attending indirect or mitotic nuclear division, and the earlier stages in the formation of the cell-membrane, are entered on in detail. During the four years which have elapsed since the appearance of the author's last contribution to this subject ("Die Controversen," &c.) numerous memoirs have been published relating to the nucleus and its division. Prof. Strasburger not only contributes a vast number of new facts, but also reviews the whole nuclear question in a masterly fashion, so that the work may be regarded as a critical text-book of our present knowledge of the subject. It will be seen from what follows, that, although many of his former conceptions have been confirmed, there still remain points which are doubtful, and some positions formerly held by him which are now abandoned.

The book commences with a long account of a renewed investigation of the nuclear processes in *Spirogyra*, the research in question being carried out on a new species, *S. polytæniata*, which presented many facilities for the purpose. This account is full of interest, but difficult to do justice to here, without figures. During the early stages of division, whilst the nuclear fibrils are making their way to the equatorial plane and the nucleolus undergoing solution, but before the breaking down of the nuclear wall, a mass of cytoplasm is formed on the two faces of the nucleus which are directed towards the end-walls of the cell, and in these a striation becomes apparent, representing the commencement of the spindle. Soon the nuclear wall becomes indistinct where the striation abuts upon it, and spindle-filaments appear within the nucleus; these form an undoubted continuation of those which appeared outside. There would appear to be no ground for supposing these later-appearing filaments of the spindle to have an origin differing from those which appeared first of all, but rather they are their direct continuation, and due to the intrusion of cytoplasm into the nucleus.

It is the view of the author that in this, and in all other cases, the spindle has a cytoplasmic origin, and this is in agreement with his former tenets. The occurrence of an almost complete spindle within the nucleus in *S. nitida*, before the break-down of the nuclear wall, is shown to be very probably due to the entrance of cytoplasm through a number of small pores; since the wall, as seen in its polar aspect, shows a sieve-like dotting from which a perforation is inferred. The event in *S. nitida* differs thus only in degree from that in *S. polytæniata*. Throughout the whole process of division the nucleus is enclosed in a cytoplasmic mantle or pocket, which is suspended freely in the cell-lumen by delicate protoplasmic filaments. As the two halves of the nuclear plate separate, a cavity is formed—at first traversed by the uniting-filaments (*Verbindungsfäden*)—which increases in size by a continuous absorption of fluid through its wall, and is regarded by the author as a mechanism by means of which the two young daughter-nuclei are driven apart. For further details the reader is referred to the original, and to the figures on Plate I.

We pass on now to the typical events in the nucleus of higher plants. In the "resting nucleus" (used in the conventional sense only, in contradistinction to "dividing nucleus") there exists a definite, limiting layer, the nuclear wall, which consists undoubtedly of cytoplasm. The nuclear reticulum consists of a number of fibrils so interwoven that it is difficult to say whether they have fused into a genuine network, or really retain their individuality, and are simply in contact with one another. The author is distinctly of the opinion that the latter is the case, and that after a division the nuclear segments or fibrils remain separate, never losing their individuality. The probability of this view is greatly increased by the constancy in number of these fibrils as shown especially by investigation of division-stages of pollen-mother-cells in Liliaceæ. The number of segments is very commonly sixteen, the relatively high number obtaining in developing endosperm-cells being due to the fusion of the two nuclei, which gave rise to the secondary nucleus of the embryo-sac. Thus, in the endosperm of *Lilium Martagon*, Guignard found twenty-four or more segments, though but twelve or sixteen in the daughter-nuclei of the primary embryo-sac nucleus. Although information on this head is limited, it has been shown that where a sudden considerable increase in the number of segments has been observed there has been a previous fusion of nuclei, as often occurs in the young endosperm cells of *Corydalis pallida*. A slight increase, however, may often be due to better nutrition. Absolute constancy in number of segments is only met with in the case of generative nuclei, so far as investigation as yet shows.

Lying between the fibrils, and adhering to them, are one or two nucleoli. Bathing the fibrils and nucleoli is the nuclear sap, which at this period is not stainable. The fibrils consist of a non-staining substance, the nucleo-hyaloplasm, in which are embedded a number of irregular, strongly-staining granules, the chromatin-granules. The author prefers to speak of the nucleo-hyaloplasm, with Schwarz, as Linin. The name nucleo-microsomata for these chromatin-granules is here definitely abandoned, as there exists no true parallel between them and the microsomata of the cell-protoplasm. In the resting vegetable nucleus Prof. Strasburger finds no trace of the faintly staining "bridges" described by Flemming and Rabl as uniting the nuclear fibrils in the Salamander. When division is about to take place a shortening of the nuclear fibrils occurs, accompanied by a definite increase in thickness. The chromatin-granules at the same time run together into plates, separated from one another by linin (nucleo-hyaloplasm). These plates of chromatin grow at the expense of the linin. The fact, that this takes place in *Fritillaria* before the disappearance of the nucleoli, precludes the possibility that the chromatin grows at the expense of the nucleoli. It is probable that this equal distribution of substance in the nuclear fibrils insures completely similar products when the subsequent longitudinal fission takes place.

The dividing nucleus now enters on the "skein-phase," and the arrangement of the fibrils may be seen with distinctness. At this period in many nuclei—as, for instance, in the young endosperm of *Fritillaria imperialis*—the separate segments lie, for the most part, parallel, each segment being loop-shaped with legs of approximately equal length. The points of bending converge on one side of the nucleus—its polar side; the free ends terminate towards the antipolar side. The polar side of the nucleus would appear to bear a definite relation to the point of convergence of the daughter-segments of the previous division, and generally the line joining the polar and antipolar sides will cut the nuclear plate at right angles. It is during this stage that the nucleoli disappear. Hitherto they have occupied an eccentric position, lying it would seem towards the polar side—this being the region least occupied by nuclear fibrils. As the nucleoli disappear, the nuclear sap becomes capable of staining, and the inference is that this is due to the presence in the sap of the dissolved nucleolar matter. The author regards it as improbable that the nucleoli go to nourish the nuclear fibrils. The structures to which Prof. Strasburger formerly gave the name of paranucleoli, he now acknowledges to be simply nucleoli late in disappearing, so that all the theoretical deductions based on the appearance of those structures, by the author and others, fall to the ground.

The nuclear membrane now breaks down, the segments place themselves in the equatorial plane forming the nuclear plate, and the spindle makes its appearance. The author at great length details the evidence in favour of the cytoplasmic origin of this structure, but into this we cannct enter here. The poles of the spindle are determined before the solution of the nuclear wall, but they do not influence the nuclear fibrils in their transpositions before the breaking down of the wall. It must not, however, be concluded from this that the changes within the nucleus are entirely independent of the cytoplasm until the end of the skein-phase. The division of nuclei within the embryo-sac, which is almost simultaneous, would negative such a view. The cytoplasm does not exert any directive influence on the fibrils until the breaking down of the wall. The fibrils now depend for support on the filaments of the spindle, and these are generally equal in number to the segments—one to each, or, after the fission of the segments, one to each segment-pair. The completion of transposition and the separation of the segment halves are carried out under the influence of the spindle, a certain directive action of the poles being exerted; the segments themselves are not passive, but possess a movement of their own held in control by polar influences.

For details relating to the complicated transpositions of the fibrils, their longitudinal fission, and subsequent separation, the reader is referred to Chapters VII. and VIII.

The two groups of daughter-segments separate, the segments travelling along the filaments of the spindle. Prof. Strasburger considers the hypothesis that the travelling is due to streaming of the protoplasm improbable, as this would involve the running of two opposite currents in each spindle-filament. Further, no streaming, either in or on the filaments, has been observed in the living, dividing nucleus. The fibrils themselves probably possess a capacity for movement, using the spindle-filaments only as supports. What stimulus the segments may receive from the poles is difficult to say—perhaps one similar to the chemical stimulus which causes directive movements in Bacteria, Plasmodia, &c. As the groups of daughter-segments move apart, the spindle-filaments, which are continuous from pole to pole, on the view of Strasburger, are seen stretching over the interval. These constitute the primary uniting-filaments, and there is some diversity of opinion as to their origin. Soon, more cytoplasm makes its way into the equatorial region, and a great increase in the number of the filaments takes place. These additional, or secondary, uniting-filaments are formed from this intrusive cytoplasm, and not by multiplication of the primary ones.

The nuclear sap, and dissolved nucleoli, lie between the uniting-filaments; and even after the collection together of the daughter-segments to form the daughter-nuclei, there remains a considerable residuum of stainable nuclear sap which makes its way to the equatorial region of the spindle and appears to play a most important part.

At this moment a small bead-like thickening appears on each uniting-filament—both primary and secondary—in the equatorial plane, and it is by the fusion of all these thickenings that the cell-plate or primitive cell-membrane arises. Throughout, Prof. Strasburger speaks of this occurrence with the greatest confidence, in opposition to the view of Zacharias and Flemming. These swellings which constitute the elements of the cell-plate, are spoken of as *dermatosomata*, although the same word has been recently used by Weisner with another significance. Fresh uniting-filaments continue to arise at the periphery of the young cell-plate, each bearing a local swelling (*dermatosome*), and in this manner the cell-plate is completed.

In cases of free-cell-formation a temporary cell-plate appears, but is not completed, and subsequently disappears.

It is at this stage that Prof. Strasburger attaches great importance to the part played by the stainable nuclear sap. As above mentioned, a portion of this has collected in the equatorial region, and everywhere bathes the dermatosomata. At the same time a demonstrable change takes place in their constitution; the dermatosomata offer a greater resistance to such a reagent as *eau-de-javelle*, and show an increased refrangibility. In other words, the cell-plate has been converted into the first layer of the new cell-wall. These changes are traced to the stainable nuclear sap which is present. A direct proof of this is very difficult, but the hypothesis is a most taking one; accounting, as it does, for a number of phenomena which have long baffled explanation; and it possesses also the added charm of simplicity. The chief objection to this theory is the difficulty in imagining the continued presence of the nuclear sap in regions where the cell-wall is undergoing a thickening; for will not the process of conversion throughout be identical, whether it be primary or secondary layers that are being formed? Perhaps in a future contribution this will be explained; but for the present this hypothesis must remain a hypothesis, and will—be it hoped—stimulate investigation into a matter on which more light is much needed.

As the daughter-nuclei are formed, a considerable portion of the nuclear sap is taken in, and lies, in the first instance, on the antipolar side of the nucleus, where in some few cases (embryo-sac of *Hyacinthus orientalis*) the nucleoli appear, and the sap loses its staining property. In the majority of cases the nucleoli, as stated above, appear towards the polar side.

In a chapter dealing with the function of the nucleus the view is put forward that it has the same relation to starch-formation as very probably exists between it and the development of cell-membrane. The fact that Klebs found, in plasmolyzed filaments of *Spirogyra*, a formation of starch occurring in masses of protoplasm destitute of a nucleus, Prof. Strasburger considers due to the fact that the pyrenoids physiologically replace the nucleus in this connection. This finds support in the fact that in plasmolyzed cells of *Funaria* the chlorophyll-corpuscles in fragments of cells without a nucleus are unable to form starch.

The book concludes with a chapter on fertilization, in which controversial matters are discussed. The author adheres to his former view that in higher plants fertilization consists of the fusion of an equal number of nuclear segments, as also of the nuclear sap of the two conjugating nuclei. He finds no evidence for the view of Zacharias that the male and female nuclei differ essentially in any way.

It is impossible here to do full justice to this remarkable book, and there are many matters traversed in it to which we have not even alluded. Thus, the detailed comparison drawn between the vegetable and the animal nucleus. It seems that the differences in this respect occurring between lower and higher plants find their parallel in comparable differences in more lowly and more highly organized animals.

A careful perusal of the original will repay the labour so expended, and the style and arrangement of the subject-matter are such as to make us unwillingly lay it aside. Perhaps some idea of the pace at which knowledge in minute cell-histology has progressed may be obtained when we remember that only seventeen years ago a botanist, who now stands in the foremost rank of plant-histologists, was prepared to maintain as a thesis, and to dispute with all comers, "that in the vegetable kingdom nuclear division does not occur."

F. W. O.

OUR BOOK SHELF.

Chambers's Encyclopædia; a Dictionary of Useful Knowledge. New Edition. Vol. II. (London and Edinburgh: W. and R. Chambers, 1888.)

THE second volume of the new edition of "Chambers's Encyclopædia," which extends from "Beaugency" to "Cataract," maintains the high standard set by the first volume. The names of the writers are a guarantee for the excellence of the work; and, where not wholly rewritten, the articles have been revised and brought up to date. Mr. J. Arthur Thomson is responsible for the zoological articles, which in this volume are Bee (in which Sir John Lubbock has assisted), Bird, and Butterfly; Mr. Patrick Geddes is the writer of the articles on Biology, Botany, Bud; Dr. W. Inglis Clark writes on Carbon, Prof. James Geikie on the Carboniferous System, Prof. Wm. Thomson on Capillarity, and Mr. A. Fraser on the Calculus. The articles on engineering and architectural subjects are contributed by Messrs. D. and T. Stevenson, D. K. Clark, and David MacGibbon. In geography, Sir Charles Warren writes on Bechuanaland, Sir Charles Bernard on Burmah, Mr. S. Lane-Poole on Cairo, Mr. Macdonald, of the *Englishman*, on Calcutta, Prince Kropotkine on the Caspian Sea. Amongst other geographical articles are those on Belfast by Mr. T. Macknight, Birmingham by Mr. S. Barnes, Bolivia by Mr. W. Dundus Walker, Bristol by the Rev. W. Hunt, Brittany by Mr. Thos. Davidson, Bulgaria by Mr. A. Silva White, Cambridge by Mr. G. H. Smith, Canada by Mr. J. G. Colmer, C.M.G., Cape Colony by the Rev. J. Mackenzie, and Cashmere by Major Holdich. Five excellent maps accompany this volume—namely, (1) Belgium; (2) Burmah, Siam, and Assam; (3) Canada, Eastern Provinces; (4) Canada, Dominion of; (5) Cape Colony and South Africa. The less important articles are also very satisfactory. For those who desire further information on the various subjects a list of authorities is given. Many of the articles are models of compression. The article on Carlyle is an instance of this. Here the large and growing literature relating to Carlyle, published since his death, is compressed into the space available in a manner that is little short of amazing. In this and one or two articles which we have noticed, the very difficult art of saying much in a little space, of reducing volumes to paragraphs, and even to lines, is exhibited in a high degree of excellence.

Star Atlas, containing Maps of all Stars from 1 *to* 6·5 *Magnitude between the North Pole and* 34° *South Declination, and all Nebulæ and Star-clusters in the same Region, which are visible in Telescopes of moderate powers, with Explanatory Text.* By Dr. Hermann J. Klein. Translated and adapted for English readers by Edmund M'Clure, M.A., M.R.I.A. (London: Society for Promoting Christian Knowledge, 1888.)

THIS is a most important addition to the stock-in trade of the amateur astronomer. The eighteen maps, printed by Funke, of Leipzig, are as clear as they can be, the letters and constellation boundaries being given in red ink.

There are some useful tables given in the introduction, and these are followed by a catalogue of the most interesting objects, which seem to have been very carefully chosen by a practical astronomer, and the editor has done his best to bring the accompanying notes down to the latest date.

In addition to the maps, some excellent illustrations of clusters and nebulæ are given, and no pains have been spared to give as much useful and trustworthy information as possible.

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.*]

Alpine Haze.

FOR some years past, occurrences in the Alpine atmosphere have frequently reminded me of effects produced in the "experimental tubes" with which I worked some years ago. When the experimental tube was already occupied by a fine "actinic cloud," it was a common experiment to precipitate within the tube an ordinary cloud by dilatation. The melting away of this latter, and the reappearance of the finer and more persistent cloud, which it had for a short time disguised, were curious and instructive effects.

In the valleys of the Alps floats, not unfrequently, a fine haze, much resembling the actinic clouds. This year the haze was more than usually prevalent, being sometimes very curiously distributed. It frequently filled the great Rhone Basin, below Alp Lusgen. Amid the haze, patches of true cloud would appear, extending till they became continuous, and filled the basin. A floor of cloud, usually shining white, would then spread below us. Under a strong sun, the cloud would disappear, leaving the more permanent haze behind. The haze could not have been aqueous. I have seen the dense true cloud disappear early in the morning, and the haze continue through a fervid summer day, until the moon came out at night to illuminate it. The distribution of the haze this year, and the consequent precipitation, were often remarkable. Looked at from our eminence, the haze would be seen filling the lower valley, but divided above into long horizontal striæ, which were obviously the edges of haze-layers, foreshortened from our point of view. Mr. Stirling's beautiful observations were frequently brought to mind by the obvious tendency of the aqueous clouds to form in, and to follow, the haze. A highly picturesque distribution of the clouds was often thus produced. What the haze *is* I do not, for a certainty, know; but that it is not water is proved by its persistence in presence of a powerful sun, and above the heated earth-surface. The late Prof. De la Rive would probably have referred it to floating germs (see letter to myself "On the Organic Dust of the Air," *Phil. Mag.*, 1870, vol. xxxix. p. 229). The prevalence of autumn pollen in the air may, perhaps, account for the singularly striking cloud effects invariably observed at Alp Lusgen, at the end of September and the beginning of October.

JOHN TYNDALL.

Hind Head, Haslemere, October 30.

Prophetic Germs.

MY desire in this controversy has been to bring the Duke of Argyll's theory to the test of fact. But I cannot obtain from him any statement of fact which tends to support his belief in prophetic germs. He cites the well-known observation that in the growth of the individual from the egg, organs pass through rudimentary stages, during which they are not used. He then says: "On the Darwinian hypothesis this fact applies equally to the birth of species." Does it? It is not worth while posing opinion against opinion. Let us have some facts. Can the Duke of Argyll, or anyone else, adduce an observation of fact which necessarily leads to the conclusion that a given organ in a given animal or plant has passed through rudimentary stages in ancestral evolution in which that organ's rudiment had no use?

I am inclined to think that there are some cases which might appear to be of this nature, but are to be explained as due to "concomitant variation" or "correlation of growth" in a complex highly-elaborated organism, one part developing, though without use, as the necessary mechanical or structural condition of the development of another part which *has* use.

Such cases will not serve the purpose of establishing a general law. Will the Duke undertake to tell us what were the rudimentary stages of the limbs of Vertebrata in which actual use was impossible? Will he give a similar history of the vertebral column, or of the brain and spinal cord, or of the eye? In short, are there any facts in support of the theory of prophetic germs? Unless such facts are cited, your readers will conclude that the theory of prophetic germs is devoid of basis.

E. RAY LANKESTER.

45 Grove End Road, N.W., October 26.

Mr. Romanes's Paradox.

I SHOULD be sorry to have misrepresented the views of Mr. Romanes, especially on so formal an occasion as a Presidential address at a meeting of the British Association. But, if I have done so, I must plead in extenuation that I know of no recent writer whose papers I find so difficult to thoroughly comprehend. With an appearance of lucidity there seems to me to be often an underlying obscurity of ideas by which I find myself as often completely befogged.

It appears to me that it is sometimes overlooked that what is usually called the "Darwinian theory" is set out in a book which bears as its title the words, not, as they are usually quoted, "The Origin of Species," but "The Origin of Species by Natural Selection." These words I regard as a proposition of which the book itself affords what is intended to be the proof. It seemed to me that Mr. Romanes intended to distinctly traverse this proposition, and, this being so, the careful consideration of his views became a matter of very great importance. Mr. Romanes now denies that he intended anything of the kind. But the denial comes rather late in the day, because the impression which I received from his paper at the Linnean Society was certainly shared at the time by others. For example, though it is unusual for a purely scientific paper to receive an extended notice in large print in the *Times*, Mr. Romanes was so favoured, and here is what the *Times* (August 16, 1886) says on one of the points on which Mr. Romanes complains that I have misrepresented him:—

"The position which Mr. Romanes takes up is the result of his perception, shared by many evolutionists, that the theory of natural selection is not really a theory of the origin of species, but rather a theory of the origin and cumulative development of adaptations." Now, I suppose Mr. Romanes would call this an "absurd misrepresentation." If so, it is singular that, as far as I remember, he took no steps to correct the statement of his views to which the *Times* gave its wide circulation.

But is it a misrepresentation? It is not, I think, difficult to cite a good deal of evidence that it is not. Anyone who will take the trouble to refer to the Journal of the Linnean Society, Zoology, vol. xix. p. 345, will find printed in capital letters across a page of Mr. Romanes's paper, "Natural Selection not a Theory of the Origin of Species." Now, everybody knows that the idea of the evolution of organic nature existed in men's minds long before Mr. Darwin. He did not originate it; what he did originate was the theory that "natural selection" is the mechanical means by which that evolution has been brought about. Mr. Romanes says roundly that it is not, or words have ceased to have meaning. Well, coming from "the biological investigator upon whom," the *Times* tells us, "in England, the mantle of Mr. Darwin has most conspicuously descended," I thought that a "startling paradox," and I said so. There was nothing very novel in this: it only put into other words what Mr. Wallace had already said (NATURE, vol. xxxiv. p. 467), when he took exception to Mr. Romanes's "extraordinary statement that, during his whole life, Darwin was mistaken in supposing his theory to be 'a theory of the origin of species,' and that all Darwinians who have believed it to be so have blindly fallen into the same error."

The next point on which Mr. Romanes complains is that I make him say specific differences are not adaptive, while those of genera are. And he calls this an absurd misrepresentation! It is really too comical, because it is the key of his whole strategic position. When Mr. Romanes read his paper at the Linnean Society, he began by saying that he regarded it as the most important work of his life. And the expression would certainly not have been exaggerated if he had succeeded in establishing what he terms (capitals again) the "inutility," *i.e.* non-adaptiveness, "of specific characters." Even Mr. Romanes could not assert that all specific characters are non-adaptive. But he asserts (NATURE, *l.c.*, p. 314) that "a very large proportion, if not the majority, of features which serve to distinguish species from species are features presenting no utilitarian significance." If this could be proved, it would be quite as effective as proving the proposition universally in inflicting a deadly blow on the Darwinian theory, the very essence of which is that specific differences must be advantageous. I agree with Mr. Wallace (NATURE, *l.c.*, p. 467) "that there is no proof worthy of the name that specific characters are frequently useless."

I am of course prepared to admit that, in regard to plants, about which only I feel competent to speak, there are a vast number of specific differences the adaptive significance of which we are either wholly ignorant of, or, at any rate, very imperfectly understand. But Mr. Darwin has himself led the way in a host of discoveries which have shown in innumerable directions, which had never been previously suspected, the adaptive significance of plant structures. We seem to me justified, then, in drawing the conclusion that all specific differences in plants are probably adaptive. This Mr. Romanes calls reasoning in a circle; to me it seems only a reasonable induction, the validity of which is strengthened every day by fresh observation.

As to the distinction which Mr. Romanes draws between specific and generic differences, I only summed up what he repeats again and again. Here is a specimen:—"It is comparatively seldom that we encounter any difficulty in perceiving the utilitarian significance of generic and family distinctions, while we still more rarely encounter any such difficulty in the case of ordinal and class distinctions. Why, then, should we encounter this difficulty in the case of specific distinctions?" In my opinion the actual state of things is exactly the reverse. But, as I discussed this point at some length in my Bath address, I need not touch upon it further.

I do not undertake to follow Mr. Romanes into all his dialectical subtleties. But the position which I understood him to have taken up in his paper was quite intelligible, and was of very great interest to the biologist. I briefly analyze it as follows:—Mr. Darwin explained the origin of species by natural selection; this implies that specific differences are adaptive; but this is not universally the case; it follows, then, that natural selection is not the explanation of the origin of species except when specific differences are adaptive, which, in point of fact, they are not in the majority of cases. It is clear that this shrivels up the part played by natural selection to very small dimensions, and minimises pretty effectively in proportion the position of the Darwinian theory in the field of biological speculation. The force, however, of the whole train of argument obviously depends, as I have remarked before, on the proof which can be given of the proposition that the majority of specific differences are non-adaptive. When we turn to the part of Mr. Romanes's paper dealing with this vital point, we only find some not very convincing assertions—some of which I think are erroneous—and no facts whatever. This is, however, not very surprising. Mr. Romanes is not a practised naturalist. His method is the very inverse of that of Mr. Darwin. We know that the latter for more than twenty years patiently accumulated facts, and then only reluctantly gave his conclusions to the world. Mr. Romanes, on the other hand, frames a theory which looks pretty enough on paper, and then, but not till then, looks about for facts to support it.

In my view, one is not called upon to give much attention at present to physiological selection. Still, a word or two may be devoted to it. The *Times* took an exception to the phrase of which I am surprised that Mr. Romanes has taken so far no notice. It says:—"How his theory can properly be termed one of selection he fails to make clear. If correct, it is a law or principle of operation rather than a process of selection." In point of fact, what Mr. Romanes calls physiological selection may be more accurately described as reproductive isolation. He supposes that individuals of a particular species arise which from some cause or other are incapable of breeding with other conspecific individuals. They are therefore in one aspect isolated, as if they were on an oceanic island. This being so, any casual variations which they exhibit will be perpetuated, he thinks, whether adaptive or not. And in this way he also thinks that species distinguished by non-adaptive characters have arisen. The idea is interesting, and Mr. Romanes believes that Mr. Darwin would have welcomed it. We know, however, that it occurred twelve years earlier to Mr. Belt, that Mr. Darwin was acquainted with it, and that "he did not regard it with any great favour." I myself have carefully considered it in connection with a variety of facts, and I have arrived at the conclusion that it is not a principle of very much value. It would take too long to set out the grounds for that conclusion here. But I may point out that such an isolated race would get no immunity from the general struggle for existence, while it would lose all the advantages to be obtained from free intercrossing. I am disposed to agree, then, with Mr. Wallace that, far from such races being "unable to escape the preserving agency of physiological selection," they would be very short-lived. Before leaving the subject, I cannot but remark on Mr. Romanes's singular choice of an alternative name for physiological selection—the "segregation of the fit." Segregation, I agree, is an improvement; but "fit" lets in the whole train of adaptive ideas, while Mr. Romanes insists that "the variations on the occurrence of which it [physiological selection] depends are variations of an unuseful kind."

One remark, and I shall conclude all that I propose to say about Mr. Romanes and his theory. What I introduced into my Bath address I had had long before in my mind. While I was writing it, Prof. Huxley's obituary notice of Mr. Darwin came into my hands. I read it with the keenest pleasure, as everyone must; and I pointedly referred to it with a pardonable anxiety that a piece of work, perhaps one of the most remarkable that ever came from that admirable literary workshop should attract a wider attention than from its mode of publication it might possibly receive. Personally, with regard to indifferent variations, I am a little disposed to think that Mr. Huxley is inclined to make too great concessions. I quite admit that correlated variation does give rise to a large class of non-significant characters. But I feel more and more that natural selection is a very hard taskmaster, and that it is down very sharply on structural details that cannot give an account of themselves. I doubt if there is much room in Nature for indifferent variations; and even correlated variations must be anchored, as it were, to an adaptive variation which has to bear the brunt of the maintenance of the whole correlated train.

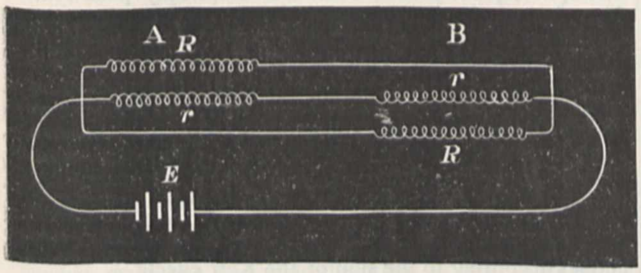
W. T. Thiselton Dyer.

Royal Gardens, Kew, October 26.

Electro-Calorimetry.

In a paper read at the British Association meeting at Bath, Messrs. Stroud and Haldane Gee describe the method used by them for heating the liquids under experiment. Will you allow me to point out that the series arrangement of the coils is electrically in unstable equilibrium, since any difference of temperature between the baths causes less power to be spent in the cooler one, thus tending to increase the difference. With the coils in parallel less power is spent in the hotter bath, but the method is still imperfect from the want of equality of heating at different temperatures.

Coils may, however, be so arranged as to completely overcome these defects in an otherwise very simple and convenient apparatus. In the figure let A and B represent the two baths and the



coils therein, each bath being heated partly by a series coil of r_{ω}, partly by a parallel coil of R_{ω}. All four coils should be made of the same metal.

The necessary relation between R and r to secure equal heating may be found by writing $\frac{d \text{ watts in A}}{d\theta} = \frac{d \text{ watts in B}}{d\theta}$, where θ is the difference of temperature between the baths. When worked out this gives $R = 4r$; a result which is obviously true provided the coils have only a small temperature coefficient.

Sydney Evershed.

2 Victoria Mansions, S.W., October 10.

The "Tamarao" from Mindoro (Philippine Islands).

I have only just seen, in Nature of August 16 (p. 363), Dr. Sclater's communication of Prof. Steere's letter concerning the discovery of a new species of *Anoa* (*A. mindorensis*) in the Island of Mindoro. I beg to say that I forwarded a note on this imperfectly-known animal, whose native name is *Tamarao* (not "*Tamaron*," as far as I know), to the Zoological Society of London, and the note was printed in the Proceedings of the Society for 1878, pp. 881-82, under the title, "Letter concerning the supposed existence of the *Anoa* (*Anoa depressicornis*) in the Philippines." Since then, Dr. Hoffmann, formerly Assistant at the Royal Zoological Museum of Dresden, has published the results of his investigations on a skull of the *Tamarao*, which has belonged to the Dresden Museum since 1878, and which was brought by Prof. Semper from his travels in the Philippines (see *Abhandl. und Berichte d. k. Zool. und Anthr. Ethnogr. Museums zu Dresden*, 1886-87, No. 3, p. 26 *et seq.*, Plate 6, *a-f*). He proves, by a comparison of this skull with the skull of *Anoa* from Celebes, and with buffalo skulls from the Philippines and elsewhere, that this *Tamarao* has nothing to do with the genus *Anoa*, but is a true buffalo, viz. either *Bubalus indicus*, Rüt., or an undescribed variety of this species, or, perhaps, a new species of *Bubalus*. Between these alternatives we were unable to decide from the single skull in our hands, which, besides, is not that of a full-grown animal. If Prof. Steere be right in asserting that there exists a true *Anoa* in Mindoro, I can only conclude that the skull brought by Prof. Semper as that of the *Tamarao* of Mindoro, is not the true *Tamarao*.

R. Museum, Dresden, October 17. A. B. Meyer.

Pallas's Sand-Grouse (*Syrrhaptes paradoxus*).

It is obvious that this bird no longer appears to come much, if at all, under observation in Europe, although it was reported from almost every part during the months from April to June (see Meyer and Helm, *Orn. Jahresbericht der Beobachtungstationen im Königreich Sachsen*, iii. p. 117 *et seq*), and even later. I suppose nearly all the specimens have flown into the sea, and been drowned there. As regards its former appearances in Europe, a specimen of *Syrrhaptes paradoxus* is said to have been killed near Grenzdorf, in Silesia, about four years ago; and it is also said to have been observed near Sagan, in Silesia, in the years 1874-78; and in the year 1883 near Münster, in Westphalia. Whether these reports are authentic, I, of course, cannot say, the specimens not being in my hands.

R. Museum, Dresden, October 17. A. B. Meyer.

The Species of Comatulæ.

The writer of the notice of vol. xxvi. of the *Challenger* series, which appeared in Nature of October 11 (p. 561), remarks that the total number of living species of Comatulæ is given on p. 383 as 180, but that from the distribution list itself there would seem to be 188 species, and he adds that "possibly the seven additional species of Antedon and the one species of Actinometra named but not described may account for this discrepancy." If he will look at the list again he will find that though it contains the names of 8 MS. species, three of them belong to Actinometra and only five to Antedon. These, however, do not account for the apparent discrepancy, which is due to the fact that eight species are dimorphic, so that their names appear twice over, as is fully explained in the systematic tables on pp. 54, 58.

It will, of course, be understood that these lists only contain the names of such species as have yet been baptized, some few having received names before they could be described, on account of their serving as hosts to Myzostomida, which have been reported on by Prof. von Graff. But some time must unfortunately yet elapse before it becomes possible to make out a complete systematic and distribution list of all the Comatula-species which are still awaiting description in various Continental Museums. Some very interesting forms were obtained by the German ship *Gazelle* and by the Italian cruiser *Vettor Pisani*. Prof. Semper's Philippine collection, which contains several unusually fine individuals, is as yet undescribed, and I know of many other new types from various localities. At present, however, the fine collections made by the *Blake* in the Caribbean Sea during the years 1877-79 are occupying most of my little working time, and they well repay investigation.

Eton College, October 26. P. Herbert Carpenter.

Voracity of the Haddock.

A small haddock (*Gadus æglefinus*), alive when purchased on the fish quay this morning, was so much distended that curiosity prompted an investigation of the cause. In the stomach were found fourteen young whiting (*G. merlangus*) from 4 to 5 inches long, and a small crab (*Carcinus mænas*), with hard carapace, about 1 inch in diameter, all quite fresh, and digestion barely commencing. The haddock was 17 inches long, and weighed, when gutted, 26 ounces. The weight of the young fry and crab was 6½ ounces, or almost one quarter of the weight of the fish. Doubtless this record is often beaten in the deep, though the evidence of so healthy an appetite among fishes is not often so apparent.

Chas. O. Trechmann.

Hartlepool, October 30.

The Queen's Jubilee Prize Essay of the Royal Botanic Society of London.

In your issue of October 18 appears (p. 594) a review of the essay for which I was awarded the medal of the Royal Botanic Society, in which the writer makes a great point of my omitting all reference to drugs. He does not state, for the information of your readers, that the prize was offered for the best (not necessarily complete) essay on the "Vegetable Substances introduced into Britain for use in the Arts, Manufactures, Food, and Domestic Economy during the Reign of Her Majesty Queen Victoria." It is not necessary that one should be either "a member of the medical profession" or have "a wholesome dread of drugs" to know that drugs used as medicines could not with any fitness be introduced into this essay; indeed, inquiry from the Secretary elicited the fact that they had been purposely excluded.

Had your reviewer read the essay with any care, he would have observed that I quote Dr. Forbes Watson to the effect that China grass and rhea fibre are products of the *same plant*, but prepared in different ways; while an unprejudiced reviewer would have mentioned that the quotation having reference to *Phormium tenax* is preceded in the essay by the words, "In one of the authorities consulted it is stated that New Zealand flax . . . was introduced into England about 1840; but the author has found a reference to an unsatisfactory attempt to weave it at Knaresborough at a much earlier period than this, and that it had been experimented upon in the Portsmouth Dockyard about 1819, the ropes made from it being satisfactory."

It was evident that the judges considered that "gun-cotton and its derivatives" *are* "direct products of the vegetable kingdom," or they would not have printed this chapter of the essay.

The limited time allowed for the preparation of the essay (about four months), and the inability of the author to avail himself of any collection of economic botany and of many of the most recent books on the subject, naturally led to many deficiencies in the list of substances mentioned, and of this no one was more conscious than the author himself; and all he claims for his essay is that, in the opinion of the judges (one of whom was Prof. Bentley), it was the best of the half-dozen sent in in competition. JOHN W. ELLIS.

3 Brougham Terrace, Liverpool, October 23.

I HAVE but few remarks to make in answer to Mr. Ellis's letter. First, I cannot follow his reasoning that completeness should not in some measure count as a test of quality, nor can I see anything in the preamble of the offer of the prize to exclude drugs. Mr. Ellis is justified, however, in having done so by receiving direct information from the Secretary to that effect.

On the subject of China grass and rhea, the author, in his essay, distinguishes them under separate heads, describing the first rightly as the produce of *Bœhmeria nivea*, and the second as "the produce of the East Indian *Bœhmeria* (*Urtica*) *tenacissima*, a congener of the species producing China grass." It is after this authoritative statement that he refers to Dr. Forbes Watson's opinion.

Regarding New Zealand flax (*Phormium tenax*), Mr. Ellis, in his essay, follows up the quotation given in his letter by the following paragraph: "Not having been introduced during the period to which this essay refers, any further mention of this interesting fibre—for which it has frequently been attempted to find a place in the British market—is unnecessary;" thus justifying my remarks on this head.

I leave it to anyone who has read Mr. Ellis's chapter on "Gun-cotton and its Derivatives," to say whether they are direct products of the vegetable kingdom.

The latter part of Mr. Ellis's letter, I think, supports the truth of my review generally. THE REVIEWER.

October 27.

MODERN VIEWS OF ELECTRICITY.[1]

PART IV.—RADIATION.

XII.

WE must now mention one or two phenomena which depend entirely upon a modification of ether by the neighbourhood of matter, and which we have reason to believe would not occur in free ether at all. These are the optical phenomena of Faraday and Kerr, and the electric phenomenon of Hall.

Faraday discovered, long before there was any other connection known between electricity and light, that the plane in which light-vibrations occur could be rotated by transmitting light through certain magnetized substances along the lines of magnetic force. To make this effect easily manifest, one uses plane-polarized light and transmits it through a fair length of magnetized substance, analyzing it after emergence, and showing that, though it remains plane-polarized, the plane has been rotated, possibly through a right angle or more.

Now, in a general way it is easy to imagine that, inasmuch as something of the nature of a rotation is going on in a magnetic field round the lines of force, vibrations travelling into such a field along these lines should be twisted round, corkscrew fashion, and emerge vibrating in a different plane. But when one tries to follow out this process into detail, one finds it not quite so simple a matter. It has no business to be a very simple and obvious consequence of the existence of a magnetic rotation round the rays of light, else would it occur in free space, and in the same direction in all media. But the facts are that in free space—that is, in free ether—it does not occur at all, and the direction of rotation is not the same for all media: substances can, in fact, be divided into two groups, according to the way in which given magnetization shall rotate the plane of polarized light passing through them.

Similarly with the electrostatic optical effect discovered by Dr. Kerr, who showed that plane-polarized light transmitted across the lines of force in an electrostatic field could, in certain media, come out elliptically polarized. Now, inasmuch as an electric field is a region of strain, and strain in transparent bodies is well known to make them slightly doubly refracting and able to turn plane-polarized into elliptically-polarized light, it is very easy to imagine such a result in an electric field to be natural and probable. But the explanation is not so simple as that, else it ought to be a large effect, occurring in all sorts of media in the same direction, and likewise in free space. But the facts are that it does not occur at all in free space, and it occurs in different senses in different substances; so that again they can be grouped into two classes according to the sign of the Kerr effect.

Thus, then, the rotatory effect of a magnetic field upon light, discovered by Faraday, and the doubly refracting effect of an electrostatic field upon light, discovered by Kerr, agree in this: that they are both small or residual effects, depending on the existence of a dense medium, and both varying in sign according to the nature of the medium.

The only substance in which the Faraday effect is large is iron, including with iron the other highly magnetic substances. The discovery of the effect in these bodies was likewise made by Kerr. The difficulty of dealing with them is that they are very opaque, and hence that the merest film of them can be used. The film can be used either by way of transmission or by way of reflection, it matters not which, but reflection is perhaps the more convenient. Light reflected from the pole of a magnet has indeed barely penetrated at all into the substance of the iron before being sent back; still, it has penetrated deep enough to be distinctly rotated by the tremendous magnetic whirl which it finds there. All these highly magnetic substances are metallic conductors, and are therefore very opaque.

Whether there is any real connection between high magnetic susceptibility and conductivity is more than I can say. But it is quite natural, and indeed necessary, that the greatest portion of light should be reflected on entering a highly magnetic medium, because in such a medium the ethereal density, μ, is so great, and hence the

[1] Continued from vol. xxxviii. p 592.

velocity of wave transmission must undergo a sudden and immense decrease—a circumstance always causing a great amount of reflection, just as when sound tries to pass from any one medium to a much denser one.

But the opacity of iron and other magnetic substances may be explained by the mere fact of their conducting power, just like other metals, and no noteworthy effect of their large value of μ need be detectable.

If a non-conducting highly magnetic substance could be found, it would probably reflect a great deal of light at its surface, though it would not dissipate that which entered it. Such a substance would be most interesting to submit to experiment, but perhaps its existence presupposes a combination of impossible properties.

As to the phenomenon detected by Hall, it appears intimately associated with that of Faraday, and it will be most simple to omit all reference to it for the present.

A general idea of what is happening in the Faraday and Kerr phenomena can be given thus. A simple vibration, like a pendulum-swing, or any other oscillation in one plane, can be resolved into two others in an infinite variety of ways; just as one force can be resolved into any number of pairs of equivalent forces. The two most useful modes of analyzing a simple vibration into a pair of constituents are these: (1) two equal components, likewise plane vibrations, each inclined at 45° to the original one, as when P Q is resolved into A B and C D (Fig. 49); and (2) two equal circular or rotatory oscillations in opposite directions,

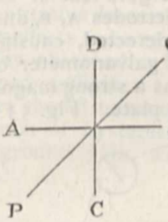


Fig. 49.

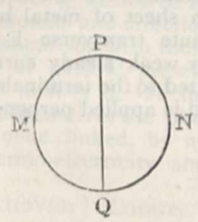


Fig. 50.

as when P Q is resolved into P M Q and P N Q (Fig. 50). The first method of resolution is useful in explaining Kerr's effect, the second in explaining Faraday's.

Of the two component vibrations, A B and C D, into which P Q can be supposed analyzed, let some cause, no matter what, make one gain upon the other, so that in travelling along a line perpendicular to the paper one goes a little the quicker: the effect at once is to change the character of the vibration into which they will recompound. After the gain, they no longer reproduce the original simple vibration P Q: they give rise to elliptic, or it may be to circular, vibrations; this last, if the retardation is equal to a quarter period.

These are matters fully treated in any elementary treatise on polarized light, and they are quite easily illustrated by means of a simple pendulum. One may assume them known.

Similarly with the second system of analyzing the vibration into two opposing circular ones. If the components travel through any interposed medium at the same rate, they will, on emergence, reproduce the original vibration in its original position; but if one travels quicker than the other they recombine into a vibration of the same character as at first, but turned through a certain angle. Thus anything which retards one of the *rectangular* components behind the other changes the character of the vibration from plane into elliptical; while anything which retards one of the *circular* components behind the other leaves the character of the vibration unaltered, but rotates it through a certain angle.

So far one has said nothing but the simplest mechanics. The next point to consider is what determines the rate at which light travels through any substance? This we have discussed at length, and shown to be $\frac{1}{\sqrt{(K\mu)}}$. Anything which increases either the electric or the magnetic permeability of the medium decreases the velocity of light. Now, when a medium is already subject to a violent strain in any one direction it is possibly less susceptible to further strain in that direction and responds less readily. Not necessarily so at all: such an effect would only be produced when the strain was excessive, when the medium was beginning to be overdone, and when its properties began thereby to be slightly modified. There are reasons for believing the specific inductive capacity of most media to be very constant; of some media, perhaps, precisely constant; but if there were any limit beyond which the strain could not pass it is probable that on nearing that limit the specific inductive capacity would be altered—possibly increased, possibly diminished—one could hardly say which. Quincke has investigated this matter, and has shown that the value of K is affected by great electric strain.

Suppose now that a dielectric is subject to a violent electrical stress, so that its properties along the lines of force become slightly different from its properties at right angles to those lines. The value of K will not be quite the same along the lines of strain as across them, and accordingly the rectangular component of a vibration resolved along the lines of force will travel rather quicker or rather slower than the component at right angles, because the velocity of transmission depends upon K as already explained: such a medium at once acquires the necessary doubly-refractive character, and will show Kerr's effect.

Similarly with magnetization. It is well known that for many media μ is not constant. Take iron, for instance. For very small magnetizing forces the susceptibility is moderate, and increases as they increase; at a certain magnetization it reaches a maximum, and then steadily decreases. But not only is it thus very inconstant, its ascending and descending values are not the same. To forces tending to magnetize it more, the susceptibility has one value; to forces tending to demagnetize it, it has another and in general smaller value. This property has been specially studied by Ewing, and has been called by him "hysterĕsis." Slightly susceptible substances cannot be magnetized to anything like the same extent, and hence the property in them has been less noticed, perhaps not noticed at all. Nevertheless it must exist in every substance which exhibits a trace of permanent magnetism, and every substance I have tried appears to show some such trace (see NATURE, vol. xxxiii. p. 484).

An already strongly magnetized medium will be rather differently susceptible to additional magnetizing forces in the same direction than to those in a contrary direction. Nothing more is wanted to explain Faraday's effect. The vibration being resolved into two opposite circular components, one of them must agree in direction with the magnetism already in the medium and try to magnetize it for the instant infinitesimally more; the other component will for the instant infinitesimally tend to demagnetize it. The value of μ offering itself to the two components will be different, hence they will go at different rates, and the plane of vibration will be rotated.

The direction of rotation will depend on whether the value of μ is greater for small relaxations or for small intensifications of magnetizing force; and diamagnetic substances may be expected to be opposite in this respect to paramagnetic ones. Any substance for which μ is absolutely constant, whatever the strength of magnetic polarization to which it is submitted, can hardly be expected to exhibit any hysterĕsis; the ascending and descending curves of magnetization will coincide, being both straight lines, and such a substance will show no Faraday effect. Similarly, any substance for which K is absolutely constant, whatever the electric polarization to which it is submitted, can show no Kerr's effect. Free space appears to be of this nature; and gases approach it very nearly, but not quite.

In iron, μ is greater for an increasing than for a decreasing force, as is shown by the loops in Ewing's curves; hence the circular component agreeing in direction with the magnetizing current will travel slower than the other component, and hence the rotation in iron will be against the direction of the magnetizing current. The same appears to hold in most paramagnetic substances, and the opposite in most diamagnetic, but the mere fact of paramagnetism or diamagnetism is not sufficient to tell us the sign of the effect in any given substance. We must know the mode in which its magnetic permeability is affected by waxing and by waning magnetization respectively.

Possible Electrical Method of detecting the Faraday Effect.

Thus far we have considered the rotation of electric displacement by a magnetic field as being examined optically, the displacements being those concerned in light, and the rotation being detected by a polarizing analyzer suitable for determining the direction in which the vibrations occur before and after the passage of light through a magnetized substance. This is the only way in which the effect has at present been observed in transparent bodies. But one ought not to be limited to an optical method of detection.

Electrical displacements are easily produced in any insulator, and if it be immersed in a strong magnetic field so that the electric and magnetic lines of force are at right angles to each other, every electric disturbance ought to experience a small rotation. A steady strain will not be affected; it is the variable state only which will experience an effect, but every fresh electric displacement should experience a slight rotatory tendency just like the displacements which occur in light.

Now to rotate a displacement A B into the position A C requires the combination with it of a perpendicular displacement B C (Fig. 51). Hence the effect of the magnetic

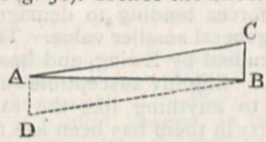


FIG. 51.

field upon an electric displacement, A B, may be said to be the generation of a small perpendicular E.M.F., B C, which, compounded with the original one, has the resultant effect A C. It will be only a temporary effect, lasting while the displacement is being produced, and ceasing directly a steady state of strain is set up.

An inverse E.M.F., A D, will be excited by the same magnetic field directly the displacement is reversed.

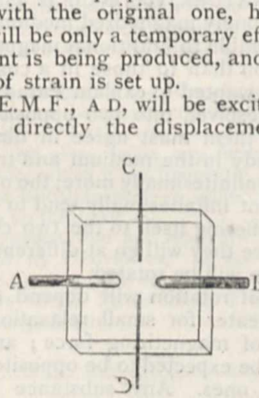


FIG 52.

And so, if a continual electric oscillation is kept up between A and B in a magnetic field, an accompanying very minute transverse oscillation may be expected, and may be looked for electrically.

Some such arrangement as that here shown (Fig. 52) may be employed. A square of heavy glass, perforated with four holes towards the centre, supplied with electrodes; one pair of electrodes, A, B, to be connected with the poles of some alternating machine, and the other pair, C, D, connected to a telephone or other detector of minute oscillatory disturbance. So soon as a strong steady magnetic field is applied, by placing the glass slab between the poles of a strong magnet, the telephone ought to be slightly affected by the transverse oscillations. This effect has not yet been experimentally observed, but it seems to me a certain consequence of the Faraday rotation of the plane of polarization of light.

Hall Effect.

Although the existence of this transverse E.M.F., excited by a magnetic field in substances undergoing varying electric displacement, has at present only been detected optically in transparent bodies, *i.e.* in insulators, yet in conductors the corresponding effect with a steady current has been distinctly observed electrically. By many persons it had been looked for (by the writer and Prof. Carey Foster, among others, though unfortunately they were not sufficiently prepared for its extreme smallness); by Mr. Hall, at Baltimore, was it first successfully observed.

In conductors it is natural to use a conduction-current instead of a displacement-current. A steady current can be maintained in a square or cross of gold-leaf or other thin sheet of metal between the electrodes A, B, and a minute transverse E.M.F. can be detected, causing a very weak steady current through a galvanometer connected to the terminals C, D, so soon as a strong magnetic field is applied perpendicularly to the plate. Fig. 53 will

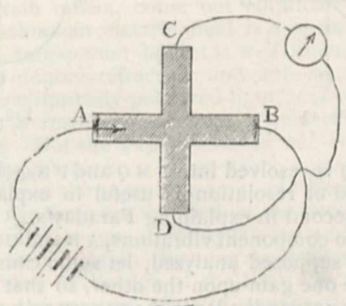


FIG. 53.—The direction of the transverse E.M.F. excited by the earth's vertical magnetic field in this conductor, conveying a current as shown, is C D if it represents gold, D C if it represents iron.

sufficiently indicate the arrangement. The poles of the magnet are one above and one below the paper.

In iron it is easy to see which way the transverse E.M.F. ought to be found. It has been shown that a displacement will be rotated in iron against the magnetizing current; hence, to rotate the displacement A B to A C (Fig. 51), requires in iron a clockwise magnetizing current. Such a current, or, what is the same thing, a south pole below the paper, a north pole above, excites, in the cross of Fig. 53, E.M.F. in the direction D C, and this by Ampère's rule is just the direction in which the conductor itself is urged by the magnetic forces acting on the current-conveying substance. Most diamagnetic substances should exhibit a transverse E.M.F. in the opposite sense. This transverse E.M.F. excited in conductors conveying a current in a magnetic field is the effect known by the name of Hall. It is, as Prof. Rowland and others have pointed out, intimately connected with the Faraday rotation of light.

Unfortunately a pure and simple Hall effect is a difficult thing to observe. Magnetism affects the conductivity of metals in a rather complicated manner, and strain affects their thermo-electric properties. Now, a metal conveying a current in a magnetic field is certainly more or less strained by mechanical forces, and hence heat will be developed unequally in different parts, by a sort of Peltier effect; and the result of this will be to modify the resistance in patches and so to produce a disturbance of the flow which may easily result partly in a transverse E.M.F. This has been pointed out by Mr. Shelford Bidwell.

The more direct effect of magnetism on conductivity may be negligibly small in many metals, but in bismuth it is certainly large. Both of these spurious effects seem to be large in bismuth, and probably quite mask any true Hall effect there may be in that metal. In all cases the existence of these spurious effects makes it difficult to be sure of the magnitude and sign of the real rotational effect.

But, it may be asked, what right have we to distinguish between a real and a spurious Hall effect? If a transverse E.M.F. can be predicted by reason of known strains and thermo-electric properties, as well as by known rotation of light effects, why should the two things be considered different? Why should they not be different modes of regarding one and the same phenomenon?

In other words, may not the Faraday rotation of light vibration be due to infinitesimal temporary strains and heatings in the medium caused by the fact that minute electric displacements are occurring in a violent magnetic field? This is a question capable of being answered by a quantitative determination of the amounts and direction of the effects to be expected, and a comparison with those actually observed. I do not know of data at present obtained sufficient to enable us to answer it. If the answer should turn out to be in the affirmative, the phenomenon of hysteresis will be at once linked, by an underground path, with those of thermo-electricity and strain.[1]

OLIVER J. LODGE.

(*To be continued.*)

[1] Perhaps I ought to caution students not to accept my connection of Faraday's or Hall's effect with hysteresis as in any way authoritative. Until these views have been criticized it will be wise to place no reliance on them.

IRREGULAR STAR CLUSTERS.

IT is not always easy to distinguish between a casual "sprinkle" of stars and a genuine cluster. The movement-test, by which so many physical have been discriminated from optical double stars, is here inapplicable. The Pleiades are the only considerable group possessing an ascertained common proper motion. All other clusters, debarred as yet from the appeal to this demonstrative argument of their physical nature, have to depend solely upon evidence from probability, with its indefinite variations of conclusiveness according to the circumstances of each particular case. It is, however, in general, amply sufficient. Among five hundred clusters registered as such, there are few indeed as to which there can be any doubt of their forming separate systems; although many real aggregations may exist unrecognized, owing to their loosely scattered character.

Two inferences may be safely derived from the results of recent inquiries into the constitution of the Pleiades. First, that interstitial movements in clusters are likely to be so extremely slow that centuries must elapse before they can become conspicuous; next, that stars showing somewhat marked displacements are presumably mere travellers across, and no genuine components of, the cluster they seem to belong to. An example of this kind of temporary association is almost certainly furnished by an apparent member of a scattered group in Ophiuchus ("Gen. Cat." 1440), the position of which was found, by the comparison of photographs taken by M. von Gothard in 1886 with Vogel's measures of eighteen years previously, to have changed to the extent of 45", or at the rate of 2½" annually (*Astr. Nach.*, No. 2777). Its motion, if rectilinear, would carry it from end to end of the collection it is projected upon, in 360 years; and its eventual detachment from it may have become palpably inevitable within ten. The star is of the eleventh magnitude, and is by far the swiftest-moving yet known of so small a size.

Several of the stellar gems surrounding κ Crucis are suspected of considerable mobility. Sir John Herschel, during his visit to the Cape, determined the relative places of 110, all included in an area of about 1/48 of a square degree ("Cape Observations," p. 17); and the process was, by Mr. H. C. Russell, of Sydney, in 1872, repeated and extended to 130 components (*Monthly Notices*, vol. xxxiii. p. 66). The result was to bring out discrepancies which, if really due to movements of the grouped stars, would be of extreme interest. Herschel's measurements, however, were necessarily too hasty to be minutely reliable; so that changes depending upon their authority need to be confirmed by continuance before they can be unreservedly accepted. The same qualification applies to M. Cruls's discovery of orbital revolution in three double stars within the precincts of the cluster (*Comptes rendus*, t. lxxxix. p. 435).

The stars about κ Crucis are famous for the loveliness of their varied hues. Blue and green, red and sulphur-coloured orbs shine together in a matchless sidereal picture, setting at the same time a problem in sidereal chromatics by no means easy to solve. There is no evidence of change of tint among them since Herschel's time, but there is some, tolerably conclusive, as to change of brightness.

Many irregular clusters seem to be throughout made up of star-streams and reticulations exactly similar to the inflected appendages of globular clusters. A collection (M 24) visible to the naked eye as a dim cloudlet near μ Sagittarii, and regarded by Sir John Herschel as intimately connected with, if not an actual part of, the Milky Way, was named by Father Secchi "Delle Caustiche," from the peculiar arrangement of its stars in rays, arches, caustic curves, and intertwined spirals. Closely adjacent to it, he noted a group of eleventh magnitude stars forming three spokes, as it were, and the nave of a wheel, the axis of which was occupied by a much brighter close pair (*Atti dell' Accad. Pont.*, t. vii. p. 72).

The same kind of radiated structure is apparent in a stellar swarm near the right foot of Castor (M 35), which, with Lassell's 24-inch mirror, showed as so "marvellously striking an object that no one could see it for the first time without an exclamation." A field 19' in diameter "is perfectly full of brilliant stars, unusually equal in magnitude and distribution over the whole area. Nothing but a sight of the object itself can convey an adequate idea of its exquisite beauty" (*Monthly Notices*, vol. xiv. p. 76). Admiral Smyth described it as "a gorgeous field of stars from the ninth to the sixteenth magnitudes, but with the centre of the mass less rich than the rest. From the small stars being inclined to form curves of three or four, and often with a large one at the root of the curve, it somewhat reminds one of the bursting of a sky-rocket" ("Cycle of Celestial Objects," p. 168, Chambers). A marvellously perfect photograph of this cluster, taken by the MM. Henry, March 10, 1886, exhibits not less than two thousand stars disposed in a roughly-indicated, eight-rayed figure, the branches often connected by drooping chains, and composed in detail of sinuous lines, or "fantastically crossing arcs" of stars (Secchi, *loc. cit.*).

About one hundred connected stars in Ophiuchus ("G. C." 4346) "run in lines and arches" (J. Herschel, Phil. Trans., vol. cxxiii. p. 460); a collection of eleventh magnitude ones in Sagittarius ("G. C." 4323) are scattered along "zigzag lines." The constituents of a large cluster near the Poop of Argo ("G. C." 1649) struck the elder

Herschel by their arrangement "chiefly in rows," by which he gained some insight into the mechanical complexities of such systems. Each row, he observed, while possessing its own centre of attraction, will at the same time attract all the others; nay, "there must be somewhere in all the rows together the seat of a preponderating clustering power which will act upon all the stars in the neighbourhood" (Phil. Trans., vol. civ. p. 269). Speculations, indeed, upon the dynamical relations of "stars in rows," are still premature; nor are they likely, for some time to come, to be accounted as "of the order of the day." But the continual recurrence in the heavens of this mode of stellar aggregation cannot fail to suggest the development of plans of systemic dissolution and recomposition on too grand a scale to be other than vaguely apprehended by us.

The more attentively clusters are studied, the more intricate their construction appears to be. That which challenged Herschel's notice is not singular in exhibiting the federative union of a number of subordinate groups. There is rarely evidence, in the conformation of irregular clusters, of their being governed from a single focus of attraction; there are frequent indications of the simultaneous ascendancy of several. A cluster in Sagittarius ("G. C." 4335) is distinctly bifid. It was remarked by Sir John Herschel at Feldhausen as "divided by a broad, vacant, straight band" ("Cape Observations," p. 116). The fission (as in many nebulæ), no longer in the inchoate state of a "dark lane," is complete. Admiral Smyth's stellar "flight of wild ducks," in Sobieski's Shield (M 11), is perhaps trifid. Father Secchi, at least, perceived in it a three-lobed central vacuity (*Atti dell' Accad. Pont.*, t. vii. p. 75). Sir John Herschel, on the other hand, succeeded by the use of high powers, in breaking up "this glorious object" "into five or six distinct groups with rifts or cracks between them" (Phil. Trans., vol. cxxiii. p. 462). M. Helmert's measures of two hundred of its components referred to a ninth magnitude star conspicuous among them ("Publicationen der Hamburger Sternwarte," No. 1, 1874) will eventually afford the means of detecting their relative displacements. Several of them appear to be variable.

The disruptive tendency indicated by the peculiarities of their distribution is equally marked in "a reticulated mass of small stars" in Cygnus ("G. C." 4511), described at Parsonstown as "a most gorgeous cluster, *full of holes*." The figure published by Lord Rosse shows a winding ribbon of stars inclosing three blank circular spaces, of symmetrically diminishing diameters.

Star-groupings of curiously definite forms are often met with. A triangular swarm ("G. C." 5055) occurs in the tail of Cetus; a rectangular area in Vulpecula ("G. C." 4498) is densely strewn with fine star-dust. Clusters shaped like open fans are tolerably numerous. One situated in Gemini would appear, according to Sir John Herschel, if removed to a sufficient distance, "as a fan-shaped nebula with a bright point like a star at the vertex." Another specimen of an "acutangular" cluster ("G. C." 4902) is bounded by "two principal lines of stars drawing to one" (Phil. Trans., vol. cxxiii. pp. 476, 503). It is 2′ in length, and is to be found in the constellation Cepheus. An oval annulus of stars in Cygnus, 4′ across ("G. C." 4701), centrally surrounds a ruddy ninth magnitude star. A similar elliptical group, with a double substituted for the red star, constitutes a quasi-nucleus for the great cluster in Perseus ("G. C." 512). This superb object, like the still richer group it immediately precedes, has probably galactic affinities. The two together form a telescopic pageant such as, in the wildest flights of imagination, Hipparchus could little have dreamed would one day be unrolled before the eyes of men, out of the "cloudy spot" in the sword-handle of Perseus which he was the first (it is said) to detect. Although the outliers of the two clusters can be brought within the same field of view, they are believed to be really disconnected. The following, and more considerable (known as χ Persei) was micrometrically investigated by Vogel in 1867-70, photographically by O. Lohse in 1884 (*Astr. Nach.*, No. 2650). The result of the comparison of 172 stars was to show their complete immobility in an interval certainly too short for the visible development of such tardy movements as were alone likely to be in progress. A rapid spectroscopic survey executed by Vogel with the Berlin 9-inch refractor, March 30, 1876 ("Der Sternhaufen χ Persei," p. 31), disclosed nothing remarkable in the light of any of the clustered stars, although several of them have been called red, "pale garnet," and even "ruby." Their comparative brilliancy suggests that this magnificent assemblage, as well as its neighbour, may be less exorbitantly distant from the earth than most other objects of its class.

Red and double stars often—we are at a loss to imagine for what reason—seem to dominate in clusters. Compound objects must of course, through the chances of optical juxtaposition, occur most freely where stars are most crowded; yet when they are marked out (as often happens) both by superiority of lustre and by distinction of place, some significance may be attached to their presence. Thus, each of the oblique arms of a "cruciform" group in Auriga ("G. C." 1119), photographed at Paris on January 28, 1887, carries a pair of conjoined stars brighter than the rest (Smyth, "Cycle," p. 140). A "superb cluster" in Monoceros ("G. C." 1637), standing on a background of sky "singularly dotted over with infinitely minute points," has a double star in its most compressed part (J. Herschel, Phil. Trans., vol. cxxiii. p 386). The central star in Præsepe is double; and there are many examples of more restricted groups gathered round a compound luminary.

Groups apparently ruled by a conspicuous ruddy star are met with in the constellations of the Swan ("G. C." 4676) and Auriga ("G. C." 1067). Another in Cygnus ("G. C." 4701) has already been mentioned.

The nebular affinities of stellar swarms are full of interest, but have as yet been very imperfectly investigated. The discoveries in the Pleiades, however, which may not prove to be the only cluster involved in cosmical fog-wreaths, show what can be done in this direction by the aid of photography. But since nebulæ thus situated are likely to be of the last degree of faintness, the stars probably replacing their original more brilliant knots, their existence can scarcely be made manifest otherwise than by prolonged exposures of plates of the highest sensitiveness. Visual detections of the kind will always be rare. Two rich clusters have nevertheless long been known to include each a nebula of the planetary kind. One in Argo ("G. C." 1801) has a central vacuity conspicuously occupied by a nebulous disk 40″ across; the other (M 46), not far from the head of Canis Major, displays well within its borders a fine annular nebula ("G. C." 1565). It is difficult, if not impossible, to believe either projected casually into such a very remarkable position.

The occurrence of *clusters within clusters* can just as little be set down to the account of chance. In one such instance, a large loose collection in Gemini ("G. C." 1490) involves a neat group of "six or seven stars close together, and well isolated from the rest" (Lord Rosse, Trans. R. Dublin Soc., vol. ii. p. 56). The companion example ("G. C." 1383) is found in the Milky Way, near Orion's right arm.

Researches into the mutual relations of clustered stars are still in their infancy. They will demand for their prosecution a reserve of patience as inexhaustible as the store of problems to be successively confronted. Before these come to an end, the human race itself will perhaps have become terrestrially extinct. But not, we may hope, before much has been attained that is well worth waiting and working for.

A. M. CLERKE.

THE COLOURING MATTER OF THE TESTA OF THE SEED OF RAPE (BRASSICA NAPUS).

THE testa of the seed of this species of Brassica is dark brown in colour, so dark often as to appear almost black. Being curious as to the chemical nature of the colour in this outer seed skin, I made several very simple experiments (which, however, have been thoroughly successful) with a view to elucidate the matter. After trying many solvents I was able to dissolve out the greater part of the colouring material by the use of that very common solvent, viz. a 25 per cent. solution of hydrochloric acid.

I put two or three hundreds of rape-seeds into a large test-tube (boiling-tube), covered them over completely with the dilute hydrochloric acid, and let the whole stand for three days.[1]

At the end of that time the solvent had acquired a very distinct pale brownish-violet (inclining to magenta) colour.

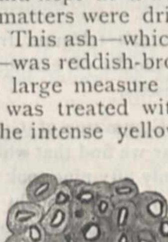
When a little of this dilute hydrochloric acid extract was mixed with as much *strong pure* hydrochloric acid, and gently heated, an intense yellow colour was developed, pointing to the very probable presence in the solution of iron in the ferric condition.

When potassium ferrocyanide was added to another portion, in a test-tube, of the original dilute HCl solution, a pale greenish-blue colour, which gradually darkened, was produced, and, after standing for about a day, the characteristic Prussian-blue precipitate indicative of ferric iron was observed to have settled to the bottom of the tube.

Potassium sulphocyanide confirmed the results obtained above, by giving, when added to the original solution, a well-marked blood-red coloration, showing the certain presence of a ferric compound in the liquid tested.

By these simple experiments I proved the presence of iron. I now wished to ascertain the nature of the iron compound in the testa which gave it its characteristic colour. I adopted the following simple method of investigation:—

I soaked for about a day a hundred or so of seeds. Then I took off the skins, which the soaking had rendered easily removable, placed them on a clean platinum foil, and heated to and kept at a white heat till all the water and organic matters were driven off, and nothing but ash remained. This ash—which was very small in quantity, of course—was reddish-brown in colour, and so was *undoubtedly*, in large measure at least, ferric oxide. When this red ash was treated with moderately strong hydrochloric acid, the intense yellow colour due to the



Section of testa of rape-seed showing thick corky cell-walls impregnated with hydrated (?) ferric oxide. (× 160).

production of ferric chloride was developed, and the potassium ferrocyanide and the sulphocyanide give the characteristic tests recorded above.

No doubt, then, was left in my mind by these experiments that the iron existed in the state of ferric oxide (most probably hydrated ferric oxide or limonite) in the testa of the rape-seed. I was next anxious to know how the ferric oxide was distributed in the corky tissue of the testa. It soon occurred to me that this was also a very simple matter to investigate. I embedded several testas in paraffin, and by means of my microtome cut several thin sections, mounted in water, and examined them with a medium microscopic power. The cell-cavities were entirely empty; the thick corky walls were quite red. There, then, in the walls, plainly enough, the ferric oxide was seen to be distributed.

How did the ferric oxide get into its place in these walls? This, I think, is the explanation. The iron was taken in from the soil, by the root hairs of the plant which produced the seeds, chiefly in the ferrous state, probably as ferrous carbonate or chloride. It was conveyed in the water stream through the parent plant to the seed, and there deposited as an accessory substance in the cell-walls of the testa amongst the corky matter while the process of wall-thickening was going on. It was afterwards, or during the process of deposition, oxidized and hydrated (?), and so the seed of *Brassica Napus* acquired its characteristic tough dark brown testa.

ALEXANDER JOHNSTONE.
Edinburgh University.

[1] I know now that it was not necessary to let the seeds remain in the acid so long. By a little gentle and judicious heating for about twenty minutes sufficient of the colouring substance would be extracted to enable one to determine its nature.

THE TAIL-BRISTLES OF A WEST INDIAN EARTHWORM.

I HAVE recently received from Mr. Reginald Windle a small collection of earthworms from Bermuda, among which is a new species showing a remarkable peculiarity of structure which I have not observed, or seen recorded, in any other earthworm.

The posterior extremity, for the length of about half an inch (the worm measures about three inches), is furnished with bristles, which, as in *Urochæta*, are disposed in an alternate fashion; the eight bristles on each segment do not correspond in position to those of the preceding or succeeding segments, but are placed so as to correspond to the intervals between them.

In my specimen the bristles at the end of the body were extremely conspicuous, and, when examined by a lens, appeared to end in a thickened head; the skin felt sticky when touched by the finger. When a portion of the body-wall was teased up in glycerine, and examined with a microscope, the bristles showed the very remarkable shape indicated in the accompanying woodcut (Fig. 1, *a*). The bristle is very large—compared with those upon the more anterior segments (*b*) and those of other

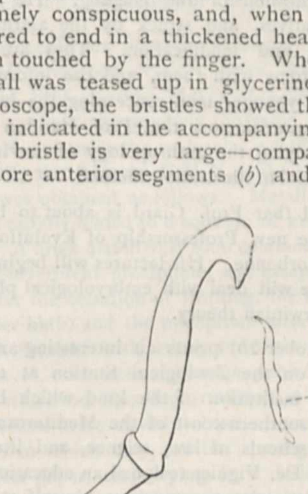


FIG. 1.—*a*, one of posterior setæ; *b*, seta from about middle of body. Both drawn to scale with *camera lucida*.

earthworms—and the free end is bent into a hook, the point of which lies in a direction nearly parallel to that of the shaft. The whole bristle is enormously thicker than those which are found upon the anterior segments, and of a deep yellow colour. At about the middle of the shaft, where a slight swelling is commonly met with in the bristles of other earthworms, is a thickened rim which suggests the attachment of powerful muscles. The hooked end of the bristles accounts for the "sticky" feeling of the skin, which I was first inclined to ascribe to a secretion of the cutaneous glands.

This curious modification of the posterior bristles has an evident relation to the habits of these creatures. All observers, from the time of Gilbert White onwards, have noticed that earthworms constantly, at night and in wet weather, lie outside their burrows with only the extreme end of the body fixed in the hole; when alarmed they dart back with great rapidity. Now it is quite clear that this movement depends upon the fact that the bristles at the posterior end hold that part of the body firm while the anterior part is being retracted. Probably the alternate arrangement of the bristles in *Urochæta* and in the Bermuda worm (which is a close ally of *Urochæta*, if not a species of the same genus) are useful to the worm in performing such rapid movements, inasmuch as they permit of a firmer hold of the ground. When these bristles become strong hooks, as in the Bermuda worm, the stability of the hinder end of the body must be enormously increased.

I have, however, no information as to the habits of these worms, so that I can only suggest a possible explanation of the presence of these remarkable hooks.

FRANK E. BEDDARD.

NOTES.

OUR readers will be glad to hear of the safety of Prof. A. C. Haddon, of the Royal College of Science, Dublin, who recently started for Torres Straits. He writes, under date September 9, reporting himself in good health, and well pleased with both the climate and his reception. If he is carrying out his original programme, he should be now busy among the islands in the middle of the Great Barrier Reef to the west side of the straits. His captures already embrace several new Actiniæ and some probably new Nudibranchs; and he is also at work upon the habits and placentation of the Dugong. He is much interested in the natives, and struck by the alarming rapidity of their decrease and modification. They are fast dying out, and their customs with them, and the information to be obtained from the younger men concerning the doings of their forefathers is so unsatisfactory that Prof. Haddon is losing no opportunity of studying the anthropology of the islanders and of collecting material in illustration thereof.

IT is understood that Prof. Giard is about to be appointed immediately to the new Professorship of Évolution des Êtres Organisés in the Sorbonne. His lectures will begin this month, and the first course will deal with embryological phenomena in relation to the Darwinian theory.

La Nature (October 20) prints an interesting article, by Dr. Camille Viguier, on the Zoological Station at the town of Algiers, the only institution of the kind which has yet been established on the southern coast of the Mediterranean. Eight years ago, when schools of law, science, and literature were formed at Algiers, Dr. Viguier resigned an educational office he held in France, in order to associate himself with the new Algerian schools, in the hope that he might be permitted to create a marine laboratory. This hope has been fulfilled, and, although the site has some disadvantages, he is, upon the whole, satisfied with the opportunities of research which have been provided for him. He calls especial attention to the fact that it is not necessary for naturalists to go to Algiers to profit by the institution. Those who write to him will receive, as soon as circumstances permit, and prepared in accordance with their directions, any animals that can be procured at Algiers.

THE Trustees of the British Museum have appointed Mr. Alfred Barton Rendle, late Assistant Demonstrator of Botany, Cambridge, an assistant in the Department of Botany at the Natural History Museum, in the vacancy occasioned by Mr. H. N. Ridley's taking the office of Director of the Botanical Gardens at Singapore.

MR. H. BURY, who has recently been elected to a Natural Science Fellowship at Trinity College, Cambridge, began the study of biology at Eton, and obtained a First Class in the Natural Science Tripos of 1885 (Part I.), having previously gained a Foundation Scholarship at Trinity College. He spent the winter of 1886–87 at the Naples Zoological Station, and the results of his work, which has added much to our knowledge of the development of Comatula, have been recently published in the Philosophical Transactions, with five illustrative plates. He returned to Naples at the beginning of the present year to study the larvæ of other Echinoderms, and his observations will be published in an early number of the *Quarterly Journal of Microscopical Science*.

THE Princess Louise will open the Durham College of Science, Newcastle, on Monday next, November 5, at 12 o'clock.

IT is reported from India that Mr. Griesbach, the geologist of the Indian Survey, sent for a time to Afghanistan at the request of the Ameer, has been compelled by the rebellion of Ishak Khan to postpone his geological exploration north of the Hindu Kush, and to remain at Cabul.

ACCORDING to *Allen's Indian Mail*, it is the intention of the Government of India to utilize the services of Mr. J. Duthie. Hitherto that gentleman has confined his botanical researches to Northern India, but it is now proposed that his sphere shall include not only the whole country but also regions beyond the Indian frontier. Accordingly he was sent with the Black Mountain Expedition.

THE British Consul at Costa Rica, in the course of his last annual report, states that a National Museum has been established at San José, and several valuable collections of Indian relics, birds, insects, plants, &c., have been presented or purchased. It is intended that in course of time it shall contain specimens of all the natural products of the country. A national publication and exchange office has also been opened, and all countries are invited to exchange periodicals and publications with Costa Rica.

ACCORDING to a Reuter's telegram from New York, dated October 29, two slight shocks of earthquake had occurred at New Bedford, Massachusetts.

IN the Report of the Committee of Council on Education in Scotland for the past year we find that while 1595 schools taught history and geography only fifty-nine took up elementary science. Strange to say, agriculture is not taught in any of the Scotch training colleges. In the secondary schools, what are called the University subjects—that is to say, Latin, Greek, and mathematics—are very well taught, particularly mathematics. The Technical Schools (Scotland) Act of 1887 has opened, says the Report, to School Boards a new field of operations in regard to a branch of education to which public attention has of late been very closely directed. Only very few schools appear to intend to take action under the Act, chiefly, no doubt, because the Boards are opposed to any increased expenditure. Technical instruction is already given in many of the higher schools. The Report recommends managers of schools in which it is proposed to give technical instruction to secure, if possible, the co-operation of local manufacturers, and to combine with other Boards as pointed out in the Act of 1887.

THE recent meeting of the Congress of American Physicians and Surgeons at Washington seems to have been a great success. It lasted three days, Dr. John Shaw Billings acting as President. *Science* considers that the meeting marked a new departure in national gatherings of American medical men. "It was a convention of specialists," says our American contemporary, "of men who have pursued their investigations, each in his own department, far beyond the point reached by the ordinary practising physician, even though his professional equipment be of the best. The papers that were read, therefore, presented the results of the most advanced scientific researches in the several departments, and the organization of the Congress is such as to insure in the future the maintenance of this high scientific standard. All opportunity for scheming medical politicians to gain prominence or office is carefully guarded against, and the only chance that any physician has to gain distinction through membership of the Congress is by presenting papers of such high order of excellence as to command the attention and secure the approval of the learned members of the medical profession to whom, as to the most competent critics, he submits his work."

AT one of the meetings of the Anatomical Society, during the session of the Medical Congress in Washington, Dr. Lamb, of the United States Army Medical Museum, spoke briefly of a singular phenomenon he had observed in his examination of human breast-bones. It was the occurrence, in a number of specimens, of an eighth rib, the cartilage that is usually found below the seventh rib being fully developed into a rib. Dr. Lamb first saw a specimen of this kind about ten years ago. While teaching, he had occasion to observe the subject he had before the class with great care, and was surprised on one occasion, on counting the ribs, to find that there were eight. He made no further investigation at the time, but recently he has given the subject more attention, and now he has in his own collection four specimens, while in the Army Medical Museum there are eight more. In all these cases the phenomenon occurs in Negroes, but one additional specimen is that of an Indian. *Science* says that Dr. Lamb has made a thorough search of anatomical literature for references to this peculiarity. In the English books there is only a single incidental reference to it, and in that case the author does not say that he has ever seen a specimen. In German books there are two references, one of them being the one already mentioned by the English authority. The French anatomists do not mention it at all; and only one American, Allen, makes any reference to it. Among the anatomists attending the Medical Congress. only two or three had seen specimens. Dr. Billings, in a circular he has sent out to anatomists and others, has requested that information on the subject be sent to the Army Medical Museum.

PART 4 of the Synchronous Weather Charts of the North Atlantic and the Adjacent Continents has been published by the Meteorological Council. It deals with the weather of each day from May 25 to September 3, 1883, and is the completion of the discussion undertaken for the thirteen months from August 1882, in connection with the international system of circumpolar meteorological observations. This last volume of the Atlantic Weather Charts is in every way equal in value to the previous parts issued, notices of which have been given in NATURE. Part 4 represents the weather of the summer season when the conditions over the Atlantic are necessarily quieter than they are in the winter. There is, however, much that is of general interest, and the broken weather so commonly experienced during an English summer is well pictured. Considerable play is shown in the behaviour of the high-pressure area usually situated in Mid-Atlantic, and the direct influence of its movement upon the weather over a very large area of both sea and land is very evident. At the beginning of June the high barometer holds a very central position, and extends across the Atlantic from coast to coast, the barometer reading as high as 30·6 inches. Several low-pressure areas are skirting to the northward, but they are pushed to a higher latitude than usual, and too far to the north to cause any serious disturbance of the weather in the neighbourhood of the British Islands. The high-pressure area, however, soon breaks up, and by June 7 there is no isobar over the Atlantic with a higher value than 30·2 inches, whilst the depressions embrace the whole area to the north of 40° N., and are more serious in character. These unsettled conditions continue till about June 20, when the high-pressure area regains its normal position; but there is somewhat similar play in the high-pressure system shown in July and August, although to a much less extent. The charts show a good instance of storm development in Mid-Atlantic on August 11, which ultimately caused a heavy gale in England on the 14th. A low-pressure area was also formed in 28° N. and 65° W. on August 20, which developed to a hurricane by the 22nd, and apparently reached our islands in a modified form on August 28. Good instances of the movement of depressions are also shown, some disturbances being traced across the Atlantic. An additional sheet is given containing the charts for September 1 to 3, in order to show the passage across the British Islands of a steep cyclonic system which was accompanied by severe gales. The depression apparently originated in 20° N. and 55° W. on August 21, and, after crossing the British Islands at the commencement of September, it passed over the North Sea, and subsequently disappeared.

THE First Annual Report of the Meteorological Society of Australasia, which was established chiefly by the labours of Mr. C. L. Wragge, shows that the Society is making good progress, and now numbers upwards of eighty subscribing members. There are twelve observing-stations established under the auspices of the Society, and it is proposed to establish others in Fiji and Norfolk Islands. The Council also propose to collect observations from ships, with the view of carrying out investigations similar to those undertaken by Dr. Meldrum at the Mauritius. Several papers of interest have been read by members during the past year, and an abstract of the climatological observations is published in the Proceedings of the Society.

TWO remarkable new polymers of methyl and ethyl cyanides, forming well-developed crystals, have been obtained in the laboratory of Prof. E. von Meyer at Leipzig. They possess percentage compositions precisely the same as those of CH_3CN and C_2H_5CN, but twice the molecular weight, and are therefore represented by the formulæ $C_4H_6N_2$ and $C_6H_{10}N_2$. The latter compound was obtained as follows. Metallic sodium, in small pieces, was rapidly added to a solution of ethyl cyanide in absolute ether. A brisk action very soon commenced with formation of a white pulverulent precipitate, and escape of gaseous ethane C_2H_6. After the cessation of frothing, the mixture was warmed upon a water-bath, and the precipitate afterwards separated by decantation, washed with ether, and thrown into water. Decomposition at once occurred, accompanied by the separation of an oil, which on standing solidified in magnificent tabular crystals. These were readily obtained pure by washing with cold water, in which they are but sparingly soluble, pressing between filter-paper, and drying in a desiccator. On analysis they were found to give the same numbers as ethyl cyanide. The latter compound, however, is a liquid boiling at 98° C., while the new substance is a solid melting at 47°–48°. It may be distilled without change, boiling at 257°–258°, 160° higher than ethyl cyanide. Vapour-density determinations show that it possesses twice the molecular weight of the latter compound, a result which was confirmed by determinations according to the new method of Raoult, described in these columns a short time ago. The cycle of chemical changes resulting in the production of this curious polymer have been fully worked out, and are briefly as follows. One atom of sodium appears to replace an atom of hydrogen in one molecule of C_2H_5CN, forming sodium cyan-ethyl, C_2H_4NaCN; a second atom of sodium at the same time seizes the CN of another molecule, leaving the C_2H_5 to combine with the displaced hydrogen to form ethane. Thus—

$$\begin{matrix} Na & C_2H_5CN \\ + & \\ Na & C_2H_5CN \end{matrix} = \begin{matrix} NaCN + C_2H_5H \\ \\ + C_2H_4NaCN. \end{matrix}$$

The sodium cyan-ethyl then combines with a third molecule of C_2H_5CN to form the sodium derivative $C_6H_9NaN_2$ of the new polymer; this unstable compound is finally decomposed in contact with water, with formation of caustic soda and the new polymer itself. The constitution of this singular compound was conclusively proved to be—

$$\begin{matrix} C_2H_5—C(NH) \\ | \\ CH(CH_3)CN. \end{matrix}$$

In a similar manner the methyl polymer was obtained by the action of sodium upon methyl cyanide, marsh-gas, CH_4, being evolved, and a white substance formed, which, on decomposition by water, yielded the polymer $C_4H_6N_2$ as an oil, eventually crystallizing in white needles melting at 52°–53° C.

THE British Consul at Barcelona, in a report to the Foreign Office on the agriculture of his district, says that a voracious caterpillar which made its appearance in myriads last year amongst the cork forests and stripped the trees completely of their foliage, is now attacked and devoured by another insect, a species of beetle, of a dark-green colour, and armed with a horn with which it cuts up the worms or caterpillars. Besides this deadly enemy, two others are at war with the caterpillar: a crab (*cangrejo*), and an insect, hitherto unknown, which destroys the bags containing the newly-laid eggs of the butterflies. There is very little doubt that the caterpillars will soon be completely exterminated.

A SCHOOL OF FORESTRY has been opened at Akhaltzik, in the Caucasian provinces. The scholars will be selected from the native forest-police actually in the service of the Russian Government. The increased demand made on the forest staff by the law which was passed last April, and which is in force in many districts since July, is the cause of the founding of this school. The officials hope that with an increased staff they will be able to check the devastation of Russian forests.

DR. A. JULIEN AND PROF. H. C. BOLTON have submitted to the New York Academy of Sciences a Report on the results of their researches on sonorous sands. They have collected samples from all parts of the world, and, on close examination, found that all sonorous sands are clean; that no dust or silt is found mixed with the sand; that the diameter of the angular or rounded grains ranges between 0·3 and 0·5 of a millimetre; and that the material may be siliceous, calcareous, or any other, provided its specific gravity is not very great. When these sands are moistened by rain or by the rising tide, and the moisture is evaporated, a film of condensed air is formed on the surface of each grain, which acts as an elastic cushion, and enables the sand to vibrate when disturbed. In sands mixed with silt or dust, these small particles prevent the formation of a continuous air-cushion, and therefore such sands are not sonorous. If this theory be correct, sonorous sand must become mute by the removal of the film of air. Experiments of the authors prove that by heating, rubbing, and shaking, the sand is "killed." All these operations tend to destroy the film of air condensed on the surfaces. On the other hand, samples of sonorous sand were exhibited which had been kept undisturbed for many years. They had retained their sonorousness, but, after having been rubbed for some time, became almost mute. The aim of the authors is now to make a sonorous sand.

MESSRS. A. C. MCCLURG AND CO., Chicago, have issued the fifth edition of "A Manual of the Vertebrate Animals of the Northern United States," by David Starr Jordan, President of the University of Indiana. The work has been wholly re-written, and the order of arrangement is reversed, the lowest forms being placed first.

WE have received the third edition of Mr. Milnes Marshall's well-known text-book "The Frog: an Introduction to Anatomy, Histology, and Embryology." The present edition, we are told in the preface, has been carefully revised, and an account of the development of the frog has been added.

MR. J. RUSSELL has put together a short account of the life and system of Pestalozzi. It is called "The Student's Pestalozzi," and is based on "L'Histoire de Pestalozzi," by Roger de Guimps. Messrs. Swan Sonnenschein and Co. are the publishers.

THE latest issue of the Proceedings and Transactions of the Nova Scotian Institute of Natural Science (vol. vii. Part 2) includes the following papers:—Glacial geology of Nova Scotia, by the Rev. D. Honeyman; list of Nova Scotian butterflies, by Arthur P. Silver; on the elementary treatment of the propagation of longitudinal waves, by Prof. J. G. Macgregor; Carboniferous flora, with attached spirorbes, by the Rev. D. Honeyman; fishes and fish development, by Harry Piers; Carboniferous of Cape Breton, by E. Gilpin, Jun.; Japanese magic mirror, by Harry Piers; museum meteorites, by the Rev. D. Honeyman; and Nova Scotian superficial geology, systematized and illustrated, by the Rev. D. Honeyman. There is also an appendix on birds of Nova Scotia, by Andrew Downs, edited by Harry Piers.

MESSRS. WILLIAM WESLEY AND SON have just issued No. 92 of their "Natural History and Scientific Book Circular," containing an important list of books on botany.

WE have received Mr. J. H. Steward's Catalogue (Part 5) of improved magic and dissolving-view lanterns and slides, with a complete catalogue of photographs for the magic lantern.

THE Calendar of the Huddersfield Technical School and Mechanics' Institute for the forty-eighth session, 1888–89, has been issued. From the report of the Governors for the session 1887–88 it appears that the institution has been making good progress "on every side." The buildings will soon have to be enlarged, and the Governors look forward to the hearty support and co-operation of the town and neighbourhood in this undertaking.

WE learn from *Science* that a manufacturing firm in New York has sent to the United States Department of Agriculture specimens of a new fibre they are making from the stalk of the cotton-plant. The samples received strongly resemble hemp, and seem to be adapted to all the uses hemp is put to. A few fibres of it twisted together in the hand show remarkable tensile strength, although no exact comparative tests with other fibres have yet been made. A collection of the fibres of hemp, flax, jute, ramie, &c., from all parts of the world is being made by the Department, and a new instrument has been invented by which it is expected that the tensile strength of each will be ascertained with great accuracy.

THE additions to the Zoological Society's Gardens during the past week include a Common Seal (*Phoca vitulina*) from British Seas, presented by Mr. Geo. Stevenson; a Tawny Owl (*Syrnium aluco*) from Ross-shire, presented by Mr. J. Weston; a Little Grebe (*Tachybaptes fluviatilis*), British, presented by Mr. Bibby; a Starred Tortoise (*Testudo stellata*) from Ceylon, presented by Mr. William Ford; an Alligator (*Alligator mississippiensis*) from Florida, presented by Mr. G. A. Ruck; a Puff Adder (*Vipera arietans*), an African Cobra (*Naia haje*) from North Africa, presented by Mr. Herbert E. White; a Macaque Monkey (*Macacus cynomolgus* ♂), a Larger Hill-Mynah (*Gracula inter-*

media) from India, three Red Deer (*Cervus elaphus* ♂ ♀ ♀), British, two White-tailed Gnus (*Connochætes gnu* ♂ ♀), bred in Holland; a Ruffed Lemur (*Lemur varius*) from Madagascar, deposited; a Red-crested Pochard (*Fuligula rufina* ♂) from India, purchased.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1888 NOVEMBER 4-10.

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

At Greenwich on November 4

Sun rises, 7h. 2m.; souths, 11h. 43m. 40·9s.; sets, 16h. 26m.: right asc. on meridian, 14h. 40·3m.; decl. 15° 36′ S. Sidereal Time at Sunset, 19h. 23m.

Moon (New on November 4, 0h., and at First Quarter November 10, 16h.) rises, 7h. 13m.; souths, 12h. 18m.; sets, 17h. 12m.: right asc. on meridian, 15h. 14·5m.; decl. 13° 20′ S.

Planet.	Rises.	Souths.	Sets.	Right asc. and declination on meridian.	
	h. m.	h. m.	h. m.	h. m.	° ′
Mercury..	6 16 ...	11 15 ...	16 14 ...	14 11·2 ...	12 29 S.
Venus ...	9 54 ...	13 47 ...	17 40 ...	16 44·3 ...	23 28 S.
Mars ...	12 0 ...	15 43 ...	19 26 ...	18 40·0 ...	24 41 S.
Jupiter ...	9 30 ...	13 36 ...	17 42 ...	16 32·6 ...	21 27 S.
Saturn ...	23 7* ...	6 34 ...	14 1 ...	9 29·6 ...	15 45 N.
Uranus ...	4 47 ...	10 15 ...	15 43 ...	13 11·7 ...	6 57 S.
Neptune..	17 19* ...	1 4 ...	8 49 ...	3 58·7 ...	18 46 N.

* Indicates that the rising is that of the preceding evening.

Occultation of Star by the Moon (visible at Greenwich).

Nov.	Star.	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image.
			h. m.	h. m.	° °
6 ...	B.A.C. 5954 ...	6 ...	18 13 ...	18 57 ...	75 348

Nov.	h.	
5 ...	19 ...	Jupiter in conjunction with and 3° 5′ south of the Moon.
6 ...	3 ...	Venus in conjunction with and 4° 28′ south of the Moon.
6 ...	22 ...	Mercury at least distance from the Sun.
8 ...	0 ...	Mars in conjunction with and 2° 35′ south of the Moon.
9 ...	18 ...	Mercury stationary.

Saturn, November 4.—Outer major axis of outer ring = 40″·7: outer minor axis of outer ring = 9″·7: southern surface visible.

Variable Stars.

Star.	R.A.	Decl.			h. m.
	h. m.	° ′			
U Cephei	0 52·4 ...	81 16 N. ...	Nov.	5,	1 49 *m*
			,,	10,	1 28 *m*
λ Tauri...	3 54·5 ...	12 10 N. ...	,,	7,	2 23 *m*
T Monocerotis ...	6 19·2 ...	7 9 N. ...	,,	6,	5 0 *m*
R Canis Majoris...	7 14·5 ...	16 12 N. ...	,,	8,	23 42 *m*
			,,	10,	2 58 *m*
R Ursæ Majoris ...	10 36·7 ...	69 22 N. ...	,,	7,	*M*
S Ophiuchi	16 27·8 ...	16 55 S. ...	,,	9,	*M*
U Ophiuchi	17 10·9 ...	1 20 N. ...	,,	6,	18 58 *m*
W Sagittarii ...	17 57·9 ...	29 35 S. ...	,,	7,	19 0 *m*
β Lyræ...	18 46·0 ...	33 14 N. ...	,,	5,	2 0 *m*
S Vulpeculæ ...	19 43·8 ...	27 1 N. ...	,,	8,	*M*
S Sagittæ	19 50·9 ...	16 20 N. ...	,,	8,	19 0 *m*
T Vulpeculæ ...	20 46·7 ...	27 50 N. ...	,,	8,	6 0 *m*
Y Cygni	20 47·6 ...	34 14 N. ...	,,	4,	3 0 *m*
			,,	7,	3 0 *m*
W Cygni	21 31·8 ...	44 53 N. ...	,,	10,	*m*
δ Cephei	22 25·0 ...	57 51 N. ...	,,	9,	1 0 *M*

M signifies maximum; *m* minimum.

Meteor-Showers.

	R.A.	Decl.	
Near γ Camelopardalis...	54° ...	71° N. ...	Swift.
The *Taurids*	60 ...	20 N. ...	Slow; bright.
	350 ...	52 N. ...	Rather slow.

GEOGRAPHICAL NOTES.

In some notes embodying the results of his own observations, contributed to the *Mittheilungen* of the Hamburg Geographical Society, Dr. H. Lindemann throws some light on the physical geography of the interior of Heligoland. He points out that the island is protected on the east from the action of the sea by a long and narrow sand-dune, about 1½ mile distant. The gradual disappearance of this British possession, Dr. Lindemann points out, is but partly due to the action of the sea. This is especially the case with the western side, where the strength of the waves is much greater. The chief factors in wearing down the island are the heavy rainfall, the variations in the weather, and the dissolving power of the frost; all these causes effect the disintegration of the stones and the denudation of the land. The results can be seen better at work on the eastern side of the island, for the strata and the inclination of the Oberland are towards the north-east, and all the water consequently flows that way. The eastern side is largely planted with potatoes, and the gradual disappearance of these potato-fields gives us a tolerably good basis on which to calculate the sinking of this side of the island. There is now nothing remaining of a potato-field which only eighty years ago measured 80 metres, and another field, 25 metres broad, has been reduced within the same period to 3 metres. In old maps we find an ancient cemetery on the eastern side of the Oberland, which had to be removed to its present position. These causes, but, above all, the direction in which the strata lie, produce the different aspect of the eastern and western sides. The eastern cliff is mostly uniform and perpendicular; the western side offers a splendid and varied example of the invasive powers of the sea, with its many inlets, caverns, and chiselled pillars now separated from the main rock. From a comparison with the measurements taken in 1845, Lindemann finds that the western cliff had receded about 7 feet in the last forty years, or at the rate of about 2 inches a year. The Unterland was joined to the dune by a stone jetty, called the Waal, as recently as the seventeenth century. This Waal formed a kind of semicircular harbour, open on the north and south sides. If we take Geern's map, we find the place of the old northern harbour occupied then by green pastures and meadows. But this has all been swept away; the sea carried most of the jetty towards the Unterland and the dune. The destruction of the breakwater had the effect upon the mainland that the Unterland, against which the masses of stone were driven, was gradually so greatly increased that new rows of houses could be built upon the beach.

It is stated that contracts have been entered into in America for the construction of two steamers intended for an expedition to the Antarctic regions, which is being organized by Mr. Henry Villard. The officers and scientific staff of the expedition will all be Americans and Germans, as the enterprise is stated to be in great part supported by Hamburg money. The expedition will start from New York, and its object will be mainly the exploration of the South Shetlands, South Orkneys, South Georgia, and the Poovel Islands. This expedition seems to be independent of that to be sent out by the German Government under the conduct of Dr. Neumayer.

Mr. Joseph Thomson has returned from Morocco in compliance with an urgent telegram from the British East African Company. Mr. Thomson will probably start immediately for Mombassa, and we have reason to believe will be intrusted with a very important mission to the interior.

PRELIMINARY NOTE ON THE ANATOMY AND PHYSIOLOGY OF PROTOPTERUS ANNECTENS.

Introduction.

Owing to the generosity of Prof. Wiedersheim, I have recently had the opportunity of making some observations on the structure and mode of life of *Protopterus*. Although I can at present only give a few brief notes on the subject, some points have already proved so interesting, that it has seemed worth while to give an abstract of my results up to the present time, leaving a detailed description until a later date.

I was fortunate enough to be present in Freiburg at the end of last June when a quantity of fresh material arrived. This was procured direct from the Gambia, owing, in the first instance, to the energy of Dr. J. Beard, who, assisted by a grant from the Royal Society, hoped by procuring Protopterus in sufficient numbers, and keeping them alive under suitable conditions, to be able to study their development. My thanks are therefore due to Dr. Beard, as well as to Prof. Wiedersheim, for the specimens I have made use of.

The clods of earth in which the animals were inclosed in their torpid state having been opened up, they were found to contain about one hundred living specimens, varying in length from about 8 to 80 cm. These were kept in a tank in the Botanical Garden, in water which stood at a temperature of 18° Réaumur. They were fed with water-snails, earth-worms, Entomostraca, and small fishes, the last of which they seemed to prefer. But the abundant nourishment with which they were supplied did not prevent them from killing one another, so that at the date of writing only a small proportion still remain alive. In order to prevent this cannibalism, we should have isolated them by means of wire-netting, had it not been thought that this would greatly lessen any chance of obtaining embryos. Their vitality is very remarkable : after having been bitten severely, and having consequently lost much blood, they will usually live for some days.

The structure of the "cocoon," and the position of the animal within it, have already been described by Wiedersheim,[1] and in this connection I have only one point to add with regard to the respiration of Protopterus during its torpid state. Although in one or two of the specimens we noticed a slight redness of the tail, I doubt very much whether, as Wiedersheim supposed, the tail serves as a respiratory organ during this period. A close examination of that part of the cocoon-membrane which closes the bottom of the earth-tube, and which overlies the animal's nose, showed that no additional respiratory apparatus was necessary. Looking at this membrane from the outer side, the small aperture described by Bartlett and Krauss can be plainly seen. On the inner side, the rim of this aperture is produced into a funnel-shaped tube, the free end of which lies between the lips of the animal. Consequently, by means of this pipe, the Protopterus can inhale and exhale air during its long sleep. On being removed from the cocoon, moreover, the lungs were always found to be greatly distended and full of air, bubbles of which were immediately given off into the tank in which the specimens were placed. In all probability the above-mentioned tube is produced by suction, when the secretion which gives rise to the cocoon is still soft. The curious squeak which Protopterus makes when set free from the cocoon has been noticed by other observers.

In addition to dissections, and sections of various individual parts, I have made a complete series of transverse sections—in all about 2100—of a small female specimen : these are extremely instructive.

Integument.—Each outer cell of the epidermis is provided with a cuticular cap, and the whole of the epidermis is closely packed with goblet cells, which are less numerous on the paired fins than on the body, where they are less than the diameter of a single one apart. Multicellular glands, very simular to those of Amphibia, are also present here and there throughout the body, and are particularly numerous on the snout. Nests of lymphatic tissue are present beneath the epidermis in some regions.

Muscles.—The chief point of interest I wish to mention concerning the muscles is that they, more particularly the great lateral muscles of the tail, serve as stores of nutriment for the animal during its torpid state. A similar phenomenon has been described by Miescher-Rüsch in the salmon during the spawning season.[2]

The muscular tissue in places shows histologically all stages of retrogressive metamorphosis, and owing to this process, the leucocytes are able to absorb its broken-down remnants, which can be plainly recognized within many of the leucocytes which simply swarm into the muscles in these regions. In some parts the muscle is completely eaten away, so that nothing but the perimysium is left.

Nervous System.—An account of the structure of the nerves, with their numerous spindle-shaped nuclei, and of the remarkable nerve-cells, I cannot give here, and I also reserve at present a description of certain of the cranial and spinal nerves, and of the nerve-supply of the fins. I must, however, mention that the pulmonary nerve crosses its fellow at the base of the lungs, and then runs along the dorsal surface of the lung of the other side.

[1] *Anat. Anzeiger*, II. Jahrgang, 1887 ; and Proc. Brit. Assoc., 1887.

[2] "Ueber das Leben des Rheinlachses im Süsswasser," *Archiv. f. Anat. u. Physiol.*, 1881.

A lateral nerve is situated on either side of the notochord, beneath the muscles, at the point where the dorso-lateral and ventro-lateral muscles meet. The spinal ganglia lie outside the canal. No trace of a sympathetic could be detected.

SENSORY ORGANS.—*Integumentary Sense-organs.*—These are very numerous in the head, and in the body they are not restricted to the main lateral line, but are present in regions above and below it also. They are situated within the epidermis, external to the scales. The moisture necessary for their persistence during the torpid period is produced by the gland-cells of the integument. A mass of lymphatic tissue is usually present directly beneath each : this may be concerned with its nutriment, for it is known that in Amphibians these organs are continually undergoing regeneration. I have been unable to discover any sensory organs in the integument of the paired fins, and the function of these curious filamentous appendages, with their large nerve-supply, is still problematical.

The pharynx is provided with sensory organs similar in structure to those of the integument.

Olfactory Organ.—The structure of the nose is very complicated. In the presence of accessory cavities, it resembles that of Amphibia, but in the folding of the epithelium it is more similar to that of fishes. The main cavity gives rise to dorsal and lateral extensions, the latter corresponding closely with the "pars maxillaris" of Amphibia. Posteriorly, the main cavity branches into a number of tubes, each with a small lumen ; these in transverse section resemble gland-tubes cut across. The olfactory cells are in some parts diffuse, in others arranged in groups, as in many fishes and Amphibians.

No special glands are present in connection with the nose, as one would naturally expect. But the moisture necessary for the olfactory cells is probably produced by the numerous goblet cells which are present in the epithelium of the mouth and that lining the anterior and posterior narial passages. This may explain the peculiar position of the anterior nostrils, which open beneath the upper lip.

Eye.—No gland is present within the orbit. The lens is globular and relatively large, filling up the greater part of the posterior chamber, so that there is little space left for the vitreous body. The sclerotic is fibrous, but a few cartilage cells can be recognized in those regions in which the eye-muscles are inserted. The choroid is rudimentary, and contains no pigment, and there is no iris or pupil, the pupillary membrane being continuous over the front of the lens. The epidermis thins out slightly over the eye, and in this region the goblet cells are smaller and less numerous. The dermal fibres are directly continued on the one hand into the representative of the cornea, and on the other into the sclerotic. Processes of the pigment cells of the retina can be seen passing between the rods and cones. No trace of a processus falciformis could be seen.

ALIMENTARY CANAL.—*Lips.*—No muscles are present in connection with the lips, as is stated to be the case by Ayers.[1] Beneath the epidermis they consist of a curious embryonic connective tissue very rich in nuclei, similar to that found in the snout and tongue.

Tongue.—The tongue is covered with numerous filiform papillæ in older specimens, the histological structure of which I have not yet examined. None are present, however, in the sections of a younger specimen. Goblet cells are very numerous in the epithelium, which is folded so as to give rise to a number of simple gland-like sacs. No sense-organs can be seen in my sections. The extrinsic muscles are, on either side, (1) a large hyoglossus, and (2) a small band-like branchioglossus. There are no intrinsic muscles, the whole of the substance of the anterior part of the tongue beneath the epithelium consisting of the connective-tissue referred to above.

On the floor of the mouth, in front of the tongue, and between the two cusps of the mandibular teeth, is a curious tube-like epithelial organ which apparently opens by a small aperture near its posterior end into a median groove of the oral epithelium. This tube is lined by columnar epithelium with goblet cells.

Thyroid.—The thyroid is a small bilobed organ, situated between the connective-tissue and muscular portions of the tongue. Its epithelium is flat, and the tubules contain a colloid mass which stains deeply.

Thymus.—The well-developed thymus consists of adenoid connective-tissue with leucocytes, and lies on the dorsal side of

[1] "Beiträge z. Anat. u. Physiol. der Dipnoër," *Jen. Zeitschr. f. Naturwiss.*, Bd. 18, 1885.

the gill-arches. Black pigment is present in the anterior part of its inner portion.

Epithelium.—The epithelium lining the mouth consists of polygonal cells, apparently without cilia. In the pharynx, nests of simple glands, like those of the tongue, are present; and, as already mentioned, numerous sense-organs are to be found in the region of the gill-clefts. The epithelial cells of the stomach and intestine are columnar, but vary much in their form and proportions. Cilia could be detected here and there; in all probability they occur in isolated regions, as in the adult lamprey.

With the exception of the large liver, there is no trace of any gland in connection with the stomach and intestine, and digestion must be thus performed largely through the instrumentality of leucocytes.

Muscles of the Alimentary Canal.—The muscles of the walls of both stomach and intestine are only very slightly developed in torpid specimens, and are apparently broken up and separated by the lymphatic tissue to be described presently. They probably, therefore, undergo a similar degeneration to that observed in the caudal muscles.

Lymphatic Organs of the Stomach and Intestine.—The form of these organs has been described by Ayers (*loc. cit.*) I have not been able to verify his supposition that there are direct connections between them and the lumen of the intestine. A central part of the lymphatic organ running down the axis of the spiral valve can be distinguished from the rest by its more compact structure. Many of the leucocytes in these regions are full of fat-globules.

A large lymphatic body is present behind the cloaca and pelvis, and probably serves to protect the vent from the entrance of harmful substances.

Cloacal Cæcum.—The so-called "urinary bladder" opens into the cloaca between the rectum and the urinary and generative ducts. It has therefore much the position of the "rectal gland" of Selachians, and probably has nothing to do with the urinary bladder of other forms.

Lungs.—The cavity of the lungs is divided up by trabeculæ, which give the anterior unpaired portion a sponge-like appearance: a central lumen is present in the paired portion. A large lymphatic organ lies beneath the anterior unpaired part, the curious relations of which I hope to describe later, and will now only mention that the blood corpuscles migrate from it into the tissues of the lung.

Abdominal Pores.—As Ayers has shown, only one abdominal pore is usually present, and in my sections this ends blindly, and does not open into the cœlome. Probably its relations vary in different individuals.

Blood Corpuscles.—The chief peculiarity of the blood of Protopterus is the large size of the corpuscles, and the comparatively large proportion of the white in comparison with the red. The form of the latter resembles that of the red corpuscles of Amphibians. In length they measure from 0·040–0·046 mm., and in width 0·025–0·027 mm. The size of the white corpuscles varies greatly. The diameter of the largest, when not throwing out pseudopodia, may exceed the length of a red corpuscle. Two kinds may be distinguished, as follows:—(1) Large leucocytes of the ordinary form, the protoplasm of which is usually distinctly differentiated into a coarsely granular endoplasm and a hyaline ectoplasm. In specimens prepared for me by Dr. Goldmann, according to Dr. Ehrlich's method, the protoplasm and nucleus are coloured violet. (2) Leucocytes of various sizes, the largest being usually rather smaller than those described above. The granules in the protoplasm are finer, and in addition to the ordinary blunt pseudopodia, stiff filamentous processes are also formed. The protoplasm of these stains brownish-red by Ehrlich's method, and Dr. Goldmann informs me that a similar coloration occurs in human white corpuscles in cases of leukæmia. Prof. August Gruber was kind enough to make a careful examination of these corpuscles with me, and we were able to trace a gradual disintegration in those described under (2), until finally nothing but the greatly altered nucleus is left. It seems probable, therefore, that these leucocytes convey the nutriment from the alimentary canal (or muscles) into the blood, and there disintegrate.

Blood-vessels.—I have at present only one or two remarks to make on the arrangement of the blood-vessels. Hyrtl's description [1] of the vessels of Lepidosiren would answer equally well in most points to Protopterus. Peters [2] describes a single pulmonary artery, arising from the efferent branchial vessels on the left side. This soon branches into two, each branch running along the inner side of the corresponding lung. No mention, however, is made by Peters of the corresponding right vessel, which has precisely the arrangement described by Hyrtl in Lepidosiren. This right pulmonary artery also divides into two, one branch passing along the dorsal surface of each lung alongside the pulmonary branch of the vagus.

The caudal vein divides up into two renal-portals. These are said by Hyrtl to anastomose anteriorly with a paired azygos in Lepidosiren. I have been unable to find any such "azygos vein" in Protopterus. The two so-called "venæ cavæ posteriores" doubtless correspond to the posterior cardinals, though they are somewhat modified. No lymphatic vessels could be detected.

Urinary Organs.—The kidneys are closely invested everywhere except on their dorsal side, by lymphoid and fatty tissue, which posteriorly forms a large median mass, plugging the end of the cœlome. No nephrostomes are present, as was supposed by Ayers.

A quantity of pigmented tissue on the outer and lower borders of the kidneys may possibly represent the adrenals.

Generative Organs.—Concerning the structure of the female generative organs, I have, as yet, little to add to the descriptions of former observers. No accurate account of the male organs exists, and I am inclined to think that the descriptions which have been given up to the present time referred to immature females, the generative organs of which might easily be taken for those of a male.

I have been able to distinguish no essential differences in external form between males and females: the latter are by far the more abundant.

Each testis has much the form and relations of an immature ovary, and, like the ovary, is invested along its free edge and sides with lymphatic and fatty tissue. Along its ventral surface a slight groove can be distinguished, at the bottom of which the spermatic duct lies. Posteriorly, the two ducts come to the surface, unite, and open by a common aperture on a papilla into the cloaca, just as in the female. In transverse sections, the seminiferous tubules can be seen opening into the ducts; in ripe specimens, fully formed spermatozoa can be seen in their lumina. I have, up to the present time, found nothing which could correspond to the remnant of a Müllerian duct, and, as the ureter undoubtedly must represent the mesonephric duct, there remains no other explanation of the duct of the testis than to suppose it to be the homologue of the Müllerian duct.

The form of the spermatozoa is very curious: they are carrot-shaped, and each is provided with two long cilia. They are very small, the length of the carrot-shaped head being only about 1/25 mm.

Most of the above observations were made in the Anatomical Institute in Freiburg i/B, where I have profited much by the kind help and advice of Prof. Wiedersheim.

August 31, 1888. W. NEWTON PARKER.

A more detailed examination of a male specimen, in which the spermatozoa were not yet ripe, has shown that distinct rudiments of the anterior parts of the Müllerian ducts are present. Each has an abdominal aperture, similar in form and position to that of the oviduct, and extends backwards for a short distance, tapering off before the level of the kidneys is reached. In sexually mature individuals, all traces of the Müllerian ducts appear to have vanished.

The duct of the kidney must therefore, as in Elasmobranchs, represent a special collecting-tube developed in connection with the posterior mesonephric tubules. W. N. P.

University College, Cardiff, October 27.

[1] *Abhandlungen d. böhm. Gesell. d. Wiss.*, 1845.
[2] *Müll. Arch. f. Anat.*, 1845.

THE WHEAT CROP OF 1888.

SIR JOHN LAWES has communicated some interesting facts with regard to the wheat crop of the present year. It has been Sir John Lawes's endeavour for many years past to establish a statistical relation between the fluctuations of the yield of wheat upon his own well-known experimental field in Hertfordshire with the general average obtained over the United Kingdom. In order to do this he has selected certain plots and taken their average yields, and it is maintained that the result so obtained fairly represents the average yield over the United Kingdom.

This conclusion is based upon observations extending over upwards of forty years, and has been rather forced upon the attention of Sir John Lawes, than assumed in the first instance.

The central position of Hertfordshire (at least with regard to England), and the medium character of the soil and climate, afford some reason for expecting an average yield; and the various treatments to which the selected plots have been subjected also assist to secure an average and representative result. The selected plots are five in number, each of which has been similarly treated for the last forty-five years, and all of them have carried wheat every year during this long period. One of these plots has remained continuously unmanured and has yielded on an average 13 bushels per acre, which, strange to say, is one bushel above the official average crop of the United States of America. One has been continuously manured with fourteen tons of farm-yard manure per acre, and has yielded an average of $33\frac{3}{4}$ bushels during the last thirty-six years. The remaining three selected plots have been treated with artificial manures upon a uniform and undeviating plan, and have yielded on an average respectively $32\frac{3}{4}$, $36\frac{1}{2}$, and $36\frac{3}{4}$ bushels per acre taken also over a period of thirty-six years.

The mean average of all these five plots taken over this long period is $27\frac{3}{8}$ bushels, and it is this *mean* which corresponds with, or at least closely approximates to, the average yield of the United Kingdom. The average yield of these five selected plots for the present year is $27\frac{5}{8}$ bushels per acre, equal to $26\frac{7}{8}$ bushels when calculated as of 61 pounds each. The average yield arrived at on the same principle last year was $28\frac{3}{8}$ bushels per acre, showing a deficit this year as compared with last of $1\frac{1}{2}$ bushel per acre. Again, comparing the result obtained from the Rothamsted standard plots with what is considered the usual standard average of 28 bushels per acre, the deficiency for the present year would appear to amount to $1\frac{1}{8}$ bushel per acre only.

Sir John Lawes's general deduction that the selected plots at Rothamsted fairly represent in yield the average of the United Kingdom is certainly an assumption which might be objected to on scientific grounds. It is, however, as already pointed out, rather to be regarded as an ascertained fact than as a simple assumption, and from the evidence of a large number of years, the fluctuations of yield at Rothamsted may be regarded as a barometer, if we may so express it, of the parallel fluctuations throughout the United Kingdom.

Judged by the standard of the Rothamsted yields, the wheat crop of 1888 is only slightly below the received average of 28 bushels per acre.

It is well known to agriculturists that the harvest of 1879 was the worst which the present generation has witnessed, and during the dismal summer which has now ended, many persons expressed an opinion that the harvest of 1888 was likely to equal in badness that of 1879. This discouraging view has, however, happily been dispelled, and the harvest of 1888, although inferior in both quantity and quality to an average one, is not to be reckoned as disastrous.

One important feature of the harvest of 1888 is, however, its irregularity, and this has not only given rise to many conflicting opinions, but made it exceedingly difficult to arrive at the truth.

The opinion of Sir John Lawes is that upon farms where the condition of the land was defective, as well as upon all lands where there was an excess of artificial nitrogenous manure, there was less than the average produce; but that when the manurial conditions were more favourable there was more than an average produce. Thus the continuously unmanured plot yields only 10 bushels per acre instead of 13, the average of the preceding 36 years. The farmyard manure plot, on the other hand, yields 38 bushels, against an average of only $33\frac{3}{4}$ bushels. Lastly, the plot which receives an excessive amount of nitrogenous manures in the form of ammonia salts, as well as mineral substances, yields only $35\frac{1}{4}$ bushels, against its average of $36\frac{1}{2}$ bushels. The result thus generally indicated is supported by experiments made beyond the list of the usually selected plots, and is in these experiments still more pronounced.

The economic conclusion arrived at by Sir John Lawes after carefully passing this evidence in review is that "Taking the average population of the United Kingdom for the harvest year 1888–89 at rather over $37\frac{3}{4}$ millions, the estimated requirements for consumption, at 5·56 bushels per head, would be about $26\frac{2}{3}$ million quarters. The area under wheat is reported to have been 2,663,436 acres, or nearly 300,000 acres more than last year. This area, at $26\frac{7}{8}$ bushels per acre, would yield nearly 9 million quarters (8,947,480), and deducting 2 bushels per acre for seed, there would remain rather over $8\frac{1}{4}$ million quarters (8,281,621) available for consumption, and there would therefore be required about $18\frac{1}{3}$ million quarters (18,394,271) to be provided from stocks and import. It is admitted that the wheat crop not only of America, but of some other countries whence we derive supplies, will be below the average. But during the last two months of the past harvest year our imports were at the rate of 21 million quarters per annum, and there seems no reason to fear that there will be any difficulty in obtaining sufficient supplies."

ON THE INFLUENCE OF LIGHT UPON THE EXPLOSION OF NITROGEN IODIDE.[1]

THE statement of L. Gattermann in his recent paper (*Berichte d. deutsch. chem. Gesellsch.* xxi. 751; following up V. Meyer's paper in the same volume, p. 26) on nitrogen chloride, that its explosive decomposition may be brought about, or its susceptibility to explosion much increased, by exposure to bright light, has recalled to my mind the fact, which did not specially impress me at the time, that I myself undoubtedly observed the same relation several years ago in the case of nitrogen iodide.

In a paper on the preparation and composition of the latter substance, published in the first number of this *Journal* (April 1879), it was noted that on two occasions the product obtained with the composition NI_3 or N_2I_6 "exploded in some quantity *under water* with much violence and complete shattering of the vessel."

I remember distinctly that in one of these cases I had just carried to a window, through which the sun was shining, the beaker full of water at the bottom of which was the black sediment of iodide, and was gently stirring the liquid with a glass rod, holding the beaker up so as to look at it from below, when the rod touched the lower part of the side or the bottom of the vessel, and the explosion occurred.

In the other case the iodide was being washed with ice-cold water of ammonia, the vessel standing on a table exposed at the time to the direct rays of the sun. I do not remember with certainty what seemed to precipitate the explosion on this occasion, but I believe it was the pouring some fresh liquid, from the height of a few inches, on the black sediment of iodide which had just been partially drained by decantation.

Under ordinary circumstances nitrogen iodide, while *wet*, exhibits no extraordinary sensitiveness, and may be safely worked with, only becoming highly dangerous on drying, so that I have little doubt that bright sunshine was influential in bringing about these two explosions. J. W. MALLET.

University of Virginia, May 8, 1888.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. Hill, now Master of Downing College, having resigned the Demonstratorship of Anatomy, a senior demonstrator and two junior demonstrators at £100 and £50 stipends, and a University lecturer on advanced human anatomy are to be appointed, providing four teachers for the aggregate stipend, £250, formerly received by the Demonstrator. Starvation pay this, considering the limited opportunities in Cambridge for supplementing the income of an anatomist.

A grant of £80 from the Worts Fund is recommended to be made to Mr. M. C. Potter, to enable him to make botanical researches and to collect specimens in Ceylon during the coming winter.

The old Chemical Laboratory being now vacant, it is to be altered into a Pathological Laboratory for Prof. Roy.

The new scheme of examinerships in natural science was passed last week; the chief features being the appointment of two examiners each in elementary biology and chemistry, to take the 1st M.B., and the "specials" for the ordinary B.A. The stipends are rearranged, and in addition to a fixed amount a proportionate sum per candidate is allotted to the examiners, 5*s.* for Tripos candidates, 4*s.* for 2nd M.B. physiology and anatomy, and 2*s.* for the rest. Thus the examiners in anatomy and physiology, if 100 candidates

[1] Reprinted from the *American Chemical Journal*, vol. x. No. 4.

present themselves for the Tripos and 100 for 2nd M.B., will receive £75 each. The papers of all candidates in a subject are to be looked over by both examiners, who must be present at all oral examinations and at the final meeting of examiners.

The Harkness Scholarship in Geology and Palæontology, for women in their first or second term of residence, has been awarded to E. Macdonald, of Girton College.

H. F. Newall, M.A. of Trinity College, has been recognized as a teacher of physics, D. Carnegie, B.A. of Caius College, as a teacher of chemistry, and J. R. Vaizey, M.A. of Peterhouse, as a teacher of botany, for the purpose of giving certificates for M.B. degree.

At Jesus College, on December 11, there will be an examination for scholarships in natural science, the maximum value being £80. Notice must be given to the tutors before December 1. Chemistry is essential, and one of the following: physics, elementary biology, animal physiology. Christ's College examination will commence on the same date, and a candidate may be elected at either College.

At St. John's College the open scholarship examination on December 11 may include all the subjects of the Natural Sciences Tripos, but every candidate must show a competent knowledge of two of the following subjects: elementary physics, chemistry, and biology.

SCIENTIFIC SERIALS.

American Journal of Science, October.—On a young tortoise with two heads, by E. H. Harbour. An account is given of a two-headed *Chrysemys picta* recently found near New Haven, Connecticut, and presenting some interesting physiological features. They appear to be two independent organisms inclosed in a common carapace, with separate and even antagonistic instincts and impulses, as shown in their struggles to move in opposite directions, in their independent breathing, sleeping and feeding at different times, and so on. They were still alive and vigorous on September 4, fourteen weeks after capture.—The structure of Florida, by Lawrence C. Johnson. In this paper, which was read before the American Association for the Advancement of Science at New York last year, the peninsula is divided longitudinally into four regions plainly marked by surface indications: (1) the Gulf Hammock in the west; (2) a central plain, or region of sinks; (3) the High Hammocks, or lake region; (4) the eastern slope, draining to the St. John's River.—Analysis of a soil from Washington Territory, with some remarks on the utility of soil analysis, by Edward A. Schneider. The specimens here analyzed are from the Rockland Ridge near "The Dalles" on the Columbia River. From this study the author infers that the action of hydrochloric acid on soils is far from uniform; that plant roots probably derive their nutrition from the finest sediments of the soil; that hydrochloric acid powerfully corrodes both the finest and coarsest sediments; that fertility largely depends not only on the quantity of phosphoric acid, but also on the mode of its occurrence, and that consequently the fertility of a soil cannot be determined by chemical analysis alone.—On the Rosetown extension of the Cortlandt series, by J. F. Kemp. The discovery of this extension of the well-known Cortlandt series is accredited to Dr. N. L. Britton, and the Rosetown area, due west of Stony Point, is here definitely circumscribed.—The contact-metamorphism produced in the adjoining mica-schists and limestones by the massive rocks of the Cortlandt series near Peekskill, New York, by George H. Williams. In previous papers were described the principal types and some intermediate varieties forming the complicated group of this series. Here the author deals with the unusual contact-metamorphism which they have occasioned in the adjoining schists and limestones, concluding with a summary of the evidence in favour of the eruptive origin of the massive members of the series.—The sedentary habits of Platyceras, by C. R. Keyes. The sedentary habits of this group of Palæozoic Gastropods is inferred from the analogous habits of their modern congeners, and from their attachment to various species of Crinoids during life.—On edisonite, a fourth form of titanic acid, by W. E. Hidden. The specimen here described is from the Whistnant gold mine, Polk County, California. Its analysis shows it to be a nearly pure TiO_2, like rutile, but differing in its crystallization from the three previously known forms of that mineral.—On two new masses of meteoric iron, by George F. Kunz. The first of these specimens, from Linnville Mountain, North Carolina, closely resembles the Tazewell Claiborne, and Bear Creek (Colorado) meteorites in composition; the second, from Laramie County, Wyoming, approaches nearer to those of Rowton, Charlotte, and Jewel Hill.—Experiments on the effect of magnetic force on the equipotential lines of an electric current (continued), by E. H. Hall. An account is here given of the author's experiments with cobalt, nickel, and bismuth, together with a summary of results.—W. Spring gives a further account of his views regarding the compression of powdered solids, in reply to Mr. Hallock; and E. S. Dana contributes a short preliminary notice of beryllonite, a new mineral so named by him from the fact that it contains the rare element beryllium.

THE *American Meteorological Journal* for September contains:—(1) An article by Prof. J. E. Curtis on suction anemometers. Two different forms of such instruments have been proposed, corresponding to two distinct ways in which a moving fluid produces a diminution of pressure. In the first the suction is produced by the wind blowing through a horizontal tube, having a contracted section; in the second the suction is produced in a vertical tube, by the wind blowing across its mouth. The second form alone has come into limited use, under the name of the Hagemann anemometer. The author points out that these instruments are not more generally used partly because there is a feeling of uncertainty as to the definite relation of the suction to the wind's velocity. The paper deals almost exclusively with their history and theory. (2) An account by Mrs. J. N. Brodhead of her experience of the great cyclone at Calcutta, on October 5, 1864. (3) An article by Prof. H. A. Hazen on the advantages of Mount Washington as a meteorological station. No individual station has had its observations discussed more thoroughly, and one of the most important investigations has been the use of the observations in determining a proper reduction of barometric readings at great altitudes to sea-level, by Lieut. Dunwoody.

Bulletin de l'Académie des Sciences de St. Pétersbourg, vol. xxxii. No. 3.—On the determination of constants of the ellipsoid of the earth by means of geodetical measurements, by A. Bonsdorff. This paper contains new formulæ for the calculation of the eccentricity.—On the formation of meteoric currents from the disintegration of comets, by Dr. C. Charlier, being a mathematical inquiry into the orbits of meteorites.—On the aberration of fixed stars, by M. Nyrén. After having calculated it on the ground of observations of two stars, the Comes and the Polaris, M. Nyrén obtains very nearly the same numerical values as those formerly found for the same stars by W. Struve.—On a new method for determining the focal distance of a system of lenses for different rays of light, by Dr. Hasselberg.—Some remarks on the fables of Phædrus, by A. Nauck.—A note by Dr. W. Radloff on grave-inscriptions in Semiryetchensk.—On the phenyl-angelic acid, by A. Gernet.—The approximate elements and ephemerides of Encke's comet for 1888, from May 12 to August 28, by O. Backlund and B. Seraphinoff.—The tale of the Princess Bentres compared with the tale of the Emperor Zenon and his two daughters, by Dr. O. Lemin. (All in German.)

No. 4.—Diagnoses of new Asiatic plants, by Dr. C. J. Maximowicz, being the seventh instalment (in Latin, with four plates) of a capital work about new plants brought by Przewalski, Potanin, Taschiro, and several others, from Central Asia, Japan, &c.—On the "hyperelementary" terms in the theory of perturbations, a mathematical inquiry, by O. Backlund (in German).

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 22.—M. Daubrée in the chair.—On lameness caused by pain, by M. Marey. By means of his photo-chronograph the author studies the character of the peculiar limping action instinctively caused by the desire to diminish the pain of a sore foot in walking. From the standpoint of the mechanical laws regulating the pressure of the foot on the ground, the three cases are considered in which this pressure is either equal to, greater, or less than, the weight of the body.—A paper follows by the same author, in which the swimming action of the eel is studied and illustrated by the same photo-chronographic process. The eel was 0·30 m. long, reduced by its squirming action to 0·29 m., and its rate of progress was shown to be 0·019 m. in 0·1 second, or about

0·19 m. per second.—Elements and ephemeris of Barnard's comet, by M. E. Viennet. The comet here in question was discovered on September 2, 1888, by Mr. Barnard, at the Lick Observatory, California, and noticed two days afterwards by Mr. Brooks, of the Geneva (U.S.) Observatory. The observations on which these elements are calculated were taken on September 5 and 18, and October 1, the first at Besançon, the two others at Hamburg.—On some errors affecting the observations of transits, by M. Gonnessiat. The sources of error here discussed are the magnitude of the stars on the one hand, and their position on the other. In the latter case, the absolute error is shown to decrease rapidly to within about 2° of the Pole, after which it becomes pretty constant. Hence in determining the instrumental constants, the stars nearest the Pole should be preferred.—Reflected images on the spheroidal surface of the Lake of Geneva, by M. F. A. Forel. M. Riccò's recent note (*Comptes rendus*, cviii. p. 590) showed the deformation of the image of the sun reflected by the spheroidal marine surface. The observations now taken by M. Forel on the Lake of Geneva fully confirm the interpretation of the Sicilian astronomer. Attention is called to the fact that the theoretical demonstration of the probability of such deformations was first given by M. Ch. Dufour, of Morges. This new demontration of the rotundity of the globe is now no longer theoretical, but is borne out by the direct observation of the phenomenon.—On the intersection of two algebraic curves in a single point, by M. G. B. Guccia. Several geometricians have long been engaged on the inquiry into the number I. of the intersections of two curves, $\phi = 0$, $\psi = 0$, merged in a single point, P. Prof. Cayley and M. Halphen have given general solutions of this extremely delicate problem, and M. Guccia has now been incidentally led to a new general expression of the number I., which presents considerable interest thanks to its great simplicity as well as the numerous and easy applications of which it is capable.—On the combination of benzoic aldehyde with the polyatomic alcohols, by M. Maquenne. In a recent note on the valency of perseite the author described, under the name of *dibenzoic acetal of perseite*, a new compound analogous to that obtained by M. Meunier with mannite and benzoic aldehyde. He now shows that in the acetals derived from a polyvalent alcohol each molecule of aldehyde necessarily saturates two alcoholic functions. If the number of the latter is odd, the aldehyde will always leave at least one free, whence it results that the elementary composition of these acetals, in passing from any polyatomic alcohol to its next homologue, differs sufficiently for them to be at once distinguished by analysis. Here is therefore a new means of determining whether an alcohol is of odd or even atomicity.—Action of hypophosphorous acid on benzoic aldehyde; formation of a dioxyphosphinic acid, by M. J. Ville. M. W. Fossek has obtained acid crystallized products corresponding to the general formula—

$$R{-}CH{,}OH{-}PO(OH)_2,$$

which he calls oxyphosphinic acids. But no chemist had hitherto determined the existence of dioxyphosphinic acids. M. Ville, however, has now obtained a compound belonging to this new class of acids. The process, as here described, consists in making hypophosphorous acid act on benzoic aldehyde. It may be designated by the name of dioxybenzylene-phosphinic acid, its constitution being expressed by the formula—

$$\begin{array}{c} C_6H_5{-}CH\ .\ OH \\ | \\ PO\ .\ OH \\ | \\ C_6H_5{-}CH\ .\ OH. \end{array}$$

—M. G. Denigès describes the action of the hypobromite of soda on some aromatic nitrogenous derivatives, and the differential reaction between the hippuric and benzoic acids.

BERLIN.

Physical Society, October 19.—Prof. von Helmholtz, President, in the chair.—Dr. König gave an account of experiments which he had made with Ottomar Anschütz on the instantaneous photography of projectiles. After exhibiting and explaining the instantaneous photographs which Anschütz had made during the last few months, such as those of the funeral procession of the late Emperor Frederick, of episodes at the manœuvres, of wild beasts at the Zoological Gardens in Breslau, of the several positions of a soldier marching on parade, and of a lady dancing, he described the arrangements necessary for photographing a cannon-ball travelling at the rate of 400 metres per second. The cannon-ball was projected in front of a white screen illuminated by direct sunlight, occupying in its passage $\frac{1}{80}$ second: during this time four negatives were taken. The firing of the cannon, the momentary exposure of the plate, and the recording of time on the chronograph were provided for by electric currents. The experiments were made at Magdeburg at the Grüson rampart, and had to be completed in one day. Only one successful picture of the projectile was obtained, but the possibility of such experiments, and of the accurate determination of the several time intervals, were sufficiently indicated.—Dr. Budde spoke on the mechanics of forces acting on rigid bodies. As one outcome of this address may be mentioned a proposal of Dr. Budde's with respect to the nomenclature of conjugate forces. Ordinarily, of two conjugate forces only the second one is spoken of as conjugate, while no special name is given to the first. The speaker therefore proposed to call the first of two conjugate forces "male" and the second "female," and introduced this nomenclature into his address with very marked furtherance of its clearness.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Studies from the Morphological Laboratory in the University of Cambridge, vol. iv. Parts 1 and 2 (C. J. Clay).—Life of Sir William Siemens: Wm. Pole (Murray).—Die Gletscher der Ostalpen: Dr. E. Richter (Englehorn, Stuttgart).—Force and Energy: Grant Allen (Longmans).—Theoretical Mechanics: J. E. Taylor (Longmans).—Elementary Theory of the Tides: T. K. Abbott (Longmans).—Elemente der Paläontologie, 1 Hälfte: Dr. G. Steinmann and Dr. L. Döderlein (Engelmann, Leipzig).—*Challenger* Report, Zoology, vol. xxvii. (Eyre and Spottiswoode).—The Book of the Lantern: T. C. Hepworth (Wyman).—The Gold Fields of Victoria; Reports of the Commissioners for Quarter ended June 30, 1888 (Sydney).—The British Farmer and his Competitors: W. E. Bear (Cassell).

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