THURSDAY, JULY 30, 1885

THE UNIVERSITY OF LONDON

CONVOCATION met on Tuesday to consider the report and draft scheme submitted to it by Lord Justice Fry's Committee. After a somewhat lengthened debate the House adjourned till November 3, when no doubt their consideration will be resumed.

We do not think much is lost by the delay. As we pointed out last week, the scheme has at first sight an aspect of complexity. But this arises in great measure from the technical form and language with which it is necessary to invest provisions intended to receive legislative effect. We do not think the underlying principles are difficult to disentangle, but it could hardly be expected that such a body as Convocation would grasp them without considerable opportunity for explanation and discussion.

The particular date which the accident of circumstance determined for the meeting was in some respects unfortunate. Many of the medical graduates who might be expected to support the scheme were drawn away by the meeting of the British Medical Association at Cardiff. In November all the medical schools will be in full activity, the leading teachers in every faculty will be in town, and the preliminary ventilation which the scheme has now received, followed, as it will be, by the discussion and reflection of the vacation, will prepare Convocation for a definitive decision in the autumn.

What that decision should be there can hardly be any doubt in the mind of any reasonable person. The remarkable attention bestowed by the leading journals on a purely academic question goes far to prove that the ear of the public is ready to entertain any reasonable proposals for the development of real university work in London. It is for the graduates in Burlington Gardens to decide whether they will approach the task or leave it to some new organisation which may be created for the purpose. That the thing sooner or later in some shape or other will be done we have not ourselves a shadow of a doubt.

The Association for promoting a Teaching University for London has suspended to some extent its own efforts, pending the action of Convocation, to which in its first report it has given its cordial support. The Association and the Committee of Convocation do not, however, seek to attain their objects quite on the same lines, and the identification by some of the speakers on Tuesday of the views put out on behalf of the two perfectly distinct bodies introduced a certain amount of confusion into the debate which no doubt the present opportunity for further consideration will go far to remove.

Of the debate itself little is to be said. Lord Justice Fry's speech explanatory of the scheme had the quality of lucidity which every one expected from him. But more than this, he exhibited a largeness of view in contemplating the possible future of the University which might have been expected to carry with it a more enthusiastic sympathy from Convocation than it obtained. The criticisms which followed were mostly on points of detail, and, on the whole Convocation, without being adverse, evidently felt that it should like more time for reflection.

THE EVOLUTION OF THE PHANEROGAMS

L'Evolution du Règne Végétal. Les Phanerogames. Par MM. Marion et Saporta. (Bibliothèque Scientifique Internationale, 1885.)

SINCE the appearance of the first volume of this important work the views of the authors have been subjected to more than one attack, and they have turned aside to vindicate the correctness of their interpretation of the often obscure fossils upon which our knowledge of the earliest forms of plants is based. The wisdom of the delay is unquestionable, for it would have been useless to continue a work whose foundations had been shaken by adverse criticism. It is not to be expected that their views will even yet be universally acceptable, for the difficulties attending the study of fossil plants are such that its most experienced professors are still scarcely agreed upon some of the fundamental questions. It is well known that Prof. Williamson is opposed to the French school as to the gymnospermous nature of several groups of Carboniferous plants, and in addressing the British Association in 1883 (NATURE, September 20, 1884) he criticised in advance some of the main facts dwelt upon in this work. In contrast to the divergent views of English investigators, the greatest workers in France, including the honoured names of the late Adolphe Brongniart, and of MM. Grand'-Eury, B. Renault, Marion, and de Saporta, are in complete accord. Their work presents for the first time a complete outline of the evolution of the vegetable kingdom, and its importance and novelty are such as to demand a critical as well as friendly examination.

In the former volume it will be remembered (NATURE, May 26, 1881) the authors endeavoured to trace the development of vegetable life from the protoplasmic body, differentiated from animal life in no way other than through the conversion of a portion of its protoplasm into chlorophyll, to the heterosporous cryptogams. The present volumes prove that there is an almost direct passage from the latter to the far higher phanerogams.

There is no need to argue at the present day that if phanerogams were differentiated from cryptogams this must have taken place in very remote times; and it is equally certain that evolutionists will be disposed to anticipate that the initial differences between them must at first have been relatively imperceptible. An heterosporous cryptogam in which the microspores penetrate to a solitary macrospore in order to effect fertilisation, and in which the prothallus is enclosed and germination takes place *in situ*, is well on the road to become a phanerogam and, moreover, a gymnospermous one, if the macrosporangium be not protected by any leaf modified into a tegumentum. The change in the reproductive organs was accompanied and preceded by modifications in the vegetative organs, and the transformation is actually found to have progressed through three distinct stages—the *progymnospermous*, the *gymnospermous*, and the *metagymnospermous*.

The Progymnosperms are among the earliest plants

known, and already occupied an important position in Carboniferous floras. Though they are now completely extinct, the Cycads have to some extent preserved their characteristics. They retained many characteristics of the cryptogamic stock whence they originated, which are completely lost to remote descendants of the present day. As the earliest connecting links between Cryptogams and Phanerogams their morphology is peculiarly interesting, and the exquisite preservation of many of their silicified or calcareous stems permits the minutest details of this part of their structure to be studied.

That Cryptogams reached a far higher stage of development in the Palæozoic time than exists in any living representative is one of the few facts that has not been disputed. One of the best-known of these is Lepidodendron, a tree-like plant allied to the Lycopodiaceæ. Its structure has frequently been described, and presents nothing unusual to Cryptogams. But in Sigillaria, a plant strongly resembling it in nearly every other respect, we find a radiating vascular cylinder or woody zone in the cellular stem, with unmistakeable exogenous growth. It is richly supplied with medullary rays, and, Prof. Williamson allows, presents clear evidence of interruptions to growth, succeeded by periods of renewed vital activity. The same writer also describes the prosenchymatous and the parenchymatous structure investing the woody zone as a bark, and remarks that, although not divisible into three layers, the enormous development of the elongated prosenchymatous fibres or bast-tissue in the inner layers of the epidermis of the fossil stems is a manifest foreshadowing of the presence of that same tissue in the bark of living exogens, especially the Cycads. In Diploxylon there is a further development, the woody zone being made up of an inner or medullary vascular cylinder, either interrupted or continuous, composed of large scalariform vessels without definite order, and an outer cylinder of scalariform vessels of smaller size arranged in radiating fasciculi. There is no difference of opinion as to the exogenous nature of the woody zone, which bears a relatively small proportion to the diameter of the stem, and as to the presence of medulla or pith and bark; but while Adolphe Brongniart and our authors class Sigillaria in consequence as a low form of exogen, a progymnosperm, Prof. Williamson and some of the German authors prefer to regard it as a highly-developed Cryptogam. He possesses specimens which conclusively prove to him that the exogenous wood is undeveloped in the young stages, and that young stems of Sigillaria are indistinguishable from Lepidodendrons; but though there is a gradual passage from one to another, the typical Lepidodendron never produced a ligneous zone. Sir J. W. Dawson, who has done much to elucidate this subject, believes that even some Lepidodendrons are exogenous, and that all Sigillarias are so. The evidence goes to prove that unquestionable Lepidodendrons in youth gradually acquire the internal features, notably the exogenous ring, characteristic of Brongniart's gymnospermous family of Sigillariæ. So far as its bearing on evolution is concerned, the differences of opinion scarcely affect the question. Whether they are looked upon as Cryptogams with exogenous growth, or exogens with cryptogamic characters, they are equally valuable as connecting-links, and if we agree with Prof. Williamson that they pass direct into true Lycopodiaceæ, the chain only becomes so much the more direct and complete. During growth the woody or exogenous zone increased for a certain period, but this was quickly arrested by the absorption or destruction in some way of the Cambium layer. The subsequent increase in diameter took place mainly in the cortical system, and to it the growth and solidity of the stem was principally due. The exogenous element in the oldest known trees is thus seen to have been transitory and subordinate, for had it persisted indefinitely, the continued generation of fresh layers or new rings of growth would have produced true dicotyledonous stems. It is suggested that until seasons, or alternations of activity and repose, replaced the earlier uniformity of climate, an exogenous growth would have been of relatively little use to the plant.

Sir J. W. Dawson has observed specimens of Sigillarian stems possessing still more definite exogenous characters, and in Poroxylon M. Rénault finds that the wood is dotted with areolated punctæ similar to those distinguishing the spiral vessels of Cycads and Araucariæ. Still the structure of their stems agree in so many respects with those of the highest heterosporous Cryptogams, the Lepidodendrons, that the difference between them remains almost insensible. Moreover, the Sigillarias are not supposed to be in the direct line of the evolution of Gymnosperms, but an offshoot which was quickly extinguished, and even in the Carboniferous time exogenous trunks were growing side by side with them. The construction of their stems was greatly varied, and it is evident that their plan of growth was susceptible of very considerable modification and development. It is now universally acknowledged that some Stigmarias are the roots of Sigillaria, yet here again we find a remarkable divergence of opinion, for while our authors regard them as rhizomes capable of bearing leaves as well as roots, Prof. Williamson contends that they are merely roots with rootlets. The Stigmarian rhizomes were procumbent and vegetated in the soft mud, Sigillarian stems budding from them occasionally, erect and cylindric, and crowned with a mass of long and linear leaves whose scars, impressed upon the bark, give rise to complex and beautiful tesselated designs. To how great an extent their fruiting organs preserved their cryptogamic attributes is unfortunately even yet imperfectly known.

The next type of progymnospermous stems, that of Calamodendron, is more remarkable because more abnormal, for it possessed a hollow fistular stem with verticillate leaves, closely resembling in appearance a gigantic Equisetum. Here again there is an irreconcilable divergence between the views of the French authors and those of Prof. Williamson. The former separate Calamites from Camalodendron, believing them to have been confounded simply because the casts of the interior of the hollow stems of both accidentally present the same grooved and articulate aspect, though morphologically they completely differ. Calamites they maintain to be a Cryptogam whose thin walls presented within and without the same structure as those of Equisetum. Prof. Williamson urges that no such Calamite has ever been found, but that, however thin the walls of a specimen may be, they always show the Calamodendron structure if any is preserved, and that the points of agreement are too remark-

able to be a mere case of mimicry between a cryptogam and a gymnosperm. Our authors, however, lay stress on the fact that there are two very distinct types of articulated root, belonging respectively to the two genera in question, but although Prof. Williamson recognises them both, he does not specially comment on the fact. As to matters of fact relating to the structure of the Calamodendron stem, opinion does not differ, but the Professor, as in the case of Sigillaria, views them as Cryptogams of exogenous growth, without, however, admitting the close relationship to the Equisetaceæ advocated by Mr. Carruthers.

The stems of Calamodendron were filled in solid with pith or cellular parenchyma when young, but became hollow with age, the fistular interior of the stem consisting then of a linear series of oblong chambers, making an entire internode and separated from each other by transverse medullary diaphragms. The exogenous zone consisted of numerous woody wedges separated from each other by peculiar prolongations of the pith, to which Prof. Williamson assigns the name of primary medullary rays, while secondary medullary rays separated the constituent vascular laminæ of each wedge as in recent Exogens. These extended vertically from node to node, when they underwent a change. The apex or inner face of each wedge originates in a duct or canal. Investing this woody zone was a thick cellular cortical layer without vessels. The bark is very rarely preserved and is not exogenous in character, the tripartite division of existing Coniferæ not being present. The outer surface appears to have been smooth, and not fluted longitudinally, at the same time masking the articulations. Camalodendron thus possessed exogenous wood playing exactly the same *rôle* as in Sigillaria, surrounding the pith, and closely resembling the first year's shoot of a recent conifer; but it differed in the verticellate arrangement of its appendicular organs. The structure of the root hardly differs from that of the stem, this indicating, according to the authors, a peculiarly primitive type, and the rootlets grew from the nodes and were branching. Prof. Williamson states, on the other hand, that the root is adventitious and not a prolongation of the main axis. The leaves or branchlets were distributed on the trunk at regular distances on the line of the nodes, which were pretty close together, alternating regularly from one to another, so that the appearance resulting was that of a quincuncial arrangement, the more obvious on account of the concealment of the nodes by the bark. There is no direct proof, but the authors believe that the foliage known as Archæocolamites and Bornia, consisting of repeatedly dichotomosing acicular leaves arranged in verticels around nodes on slightly striated stems, really belongs to Calamodendron, in which case the male inflorescence was born in catkins something like those of the Taxeæ. Sir J. Dawson, however, states that he has found leaves like those of Asterophyllites attached to stems of Calamodendron. The fruiting organs are still very imperfectly known, but Prof. Williamson believes them to have been a heterosporous Strobilus like those of Lepidodendron. The authors, in conclusion, remark upon the resemblance between leaves of Bornia and those of Trichopitys and Bryon, which are true Salisburieæ, for, though the one is verticellate and the other spiral in disposition, the possibility of an easy transition from one to the other is exemplified in Calamodendron, and both modes occur together in existing Cupressineæ and the young Abietineæ.

Prof. Williamson believes that Calamites and Camalodendron are one and the same plant, and this a cryptogam. Against the exogenous wood he sets the cryptogamic bark, the Strobilus with Calamite structure full of spores, the adventitious roots and the verticellate arrangement of the leaves. It seems hardly possible, however, that such observers as A. Brongniart, M. Grand'-Eury, M. Rénault, and our authors can all be mistaken. In the former volume a graphic description was given of the growth of the Equisetum-like Calamites as they occur at St. Etienne. Prof. Williamson has not come across an undoubted Calamite, and very prudently disbelieves in their existence, but his evidence seems negative rather than positive, and we have already seen in several instances that coal-plants may have flourished in great numbers in one country and yet be exceedingly rare in another. The Carboniferous lasted over an immense period of time, and there appears less reason, as their plants become more completely known, to suppose that the forests were then composed of few types universally distributed. Development was proceeding actively, and it is quite conceivable that a gigantic primæval Cryptogam might take on phanerogamous characters without greatly modifying its external appearance.

Another remarkable cryptogam with exogenous wood is described by Prof. Williamson as Astromyelon. The stem was hollow, and except that it was not articulated, resembled that of Camalodendron. It appears that the stem and branches grew together under exactly the same relation as those observable in an ordinary exogenous tree, the latter not differing materially in their outward appearance from those of an ordinary pine. He appears to have felt hesitation in classing it, as he uses the expression "I am inclined to place" it among Cryptogams. Its affinities he considers to be with Marsilea, and we have thus—perhaps—in the coal-measures arborescent representatives of the Lycopodiaceæ in Lepidodendron, of Equisetaceæ in Camalodendron, and of Marsiliaceæ in Astromyelon, all of them having possessed rudimentary exogenous trunks.

J. STARKIE GARDNER

HARBOURS AND DOCKS

Harbours and Docks. By L. F. Vernon-Harcourt, M.A. (Oxford: Clarendon Press, 1885.)

IN the author's previous work on "Rivers and Canals" the science of hydraulic engineering received a valuable addition and the subject was treated, as far as it was necessary for inland works, in a masterly manner, fully upholding the author's high standing in his profession. We have now another work by the same author, in which the sequel to "Rivers and Canals" is given. In "Harbours and Docks," sea-works and kindred engineering subjects receive full consideration, the two books containing together an excellent collection of data on hydraulic engineering generally.

Of all the many branches of the engineering profession, that of hydraulic engineering pertaining to sea works and similar constructions trusts less to theory and more by far to practice than any other. The hydraulic engineer for

sea works has no convenient formulæ to guide him, but only previous experience and precedent. This is evident from the volume before us, for most of the sea works described are improvements on previous constructions.

The author commences with a description of the natural laws which govern the general movements of the sea, the causes and action of its waves, tides, currents, and consequent changes in the coast line, the knowledge of which is all important when any new works are projected; indeed, it is not too much to say that many sea-works have proved very expensive in their maintenance owing to ignorance of the above conditions when they were designed.

The author divides the various types of harbours into five classes—(1) estuary harbours; (2) harbours with back-water; (3) harbours partly sheltered by nature; (4) harbours protected solely by break-waters; (5) peculiar types of harbours with detached break-waters. After having given long and clear descriptions, with excellent illustrations of the several types, the author remarks with reference to the first three classes and their shelter from the sea:—"Some natural shelter exists in all the harbours referred to above, but it will be noticed that the amount of shelter varies considerably. Thus whilst at Cherbourg, Plymouth, Wick, Genoa, and Barcelona the entrance alone of a complete bay requires protection; at Holyhead, Table Bay, and Alexandria only a portion of the extensive bays in which the harbours are situated can be utilised, though the existence of the bay diminishes considerably the exposure; and lastly, at Dover, Newhaven, and Colombo projecting points of the coast, rather than regular bays, are taken advantage of for the site of a harbour." After discussing the last two classes of harbours, we have the conditions which govern the size and position of the entrances to harbours explained. We commend these chapters to the careful perusal of those who take an interest in the proposed harbours of refuge, for here will be found considerable information concerning the advantages of the several sites proposed.

Chapter V., and those following, until the end of Part I. of the book is reached, deal with perhaps the most important of all sea-works—viz. break-waters. The author classifies their several modes of construction into three classes—(1) mound of rubble and concrete blocks; (2) mound with superstructure; (3) upright wall. Under these heads we find all the principal break-waters, each being well described, the construction explained, and reason given for any special work.

It is interesting to follow the gradual increased use of Portland cement concrete in the place of natural stone, and, as the latest break-water, we may take the one at Newhaven now in construction. This break-water is practically one solid mass of cement concrete. It is built on the upright wall system, with concrete in bags deposited from hopper barges on the chalk bottom up to low-water, and concrete-in-mass above. The bags each contain about 104 tons of concrete, the concrete being mixed by a special machine consisting of a screw working in an inclined cylinder, the materials being added at one end, water being added during the transit, thoroughly mixed concrete coming out at the other end.

In Part I. of the volume is to be found every information with regard to sea-works generally; the descriptions and details of the construction of the Manora break-water, Madras harbour, and Alderney break-water among the many others, are extremely interesting, being as well written as they are good. Of the American break-waters described, those constructed in the large lakes, are, as may be expected, principally constructed of wood, some being bound together by means of iron ties. The form taken is generally crib-work, floated out to the site in sections, and filled with stone. Before leaving the subject of break-waters we will quote the author's opinion on floating break-waters; this is interesting at the present time on account of the late experiments at Eastbourne and other places. He says:—"Various schemes have been suggested from time to time for arresting waves by means of floating break-waters moored in position. It has been imagined that the undulation being on the surface might be stopped or reduced considerably by an obstacle at or near the surface, and thus the cost of building up a break-water from the bottom could be saved; though, in the case of large waves, the undulatory motion is not simply superficial, yet, undoubtedly, the power of the waves would greatly diminish if the upper portions could be arrested in their progress; and the gain in dispensing with a solid structure founded on the bottom of the sea would be very great." He then tells us of several forms tried which were not successful in reducing the waves, and in conclusion says:—"The force of waves is so great, as indicated by its effects in moving huge masses, that no fragile floating moored construction could possibly oppose an adequate resistance. The accumulated power of the wind, acting through the medium of the waves, cannot be evaded, but must be met; and this can only be effectually accomplished by a solid break-water." This part of the book concludes with a chapter on lighthouses, beacons, and buoys; the construction and cost of all the important lighthouses is given and admirably illustrated.

In Part II. "docks" receive very full consideration, Chapters XIX. and XX. dealing with sites, preliminary works for docks and dock walls; suffice it to say that all these are treated in such a way as to render it evident that the author is thoroughly master of his subject. In Chapters XXI. and XXII. the usual fittings pertaining to docks are discussed, their entrances and locks, dock-gates and caissons of all kinds thoroughly described, and their varied construction under different conditions explained. All the following chapters, which occupy the last 150 pages of the book, are taken up with a general, and in some cases a detailed, description of some of the more important English and foreign docks; it is needless to say that they are all thoroughly well treated, and the trade statistics are carefully given and useful comparative distinctions drawn.

As a work on hydraulic engineering we can confidently recommend it to all those who are interested in the subject, feeling convinced that it will be found a most useful book. The author has produced, and students will profit by, a book well written, sound, and most useful in forwarding the science. Both volumes do credit to the publishers, the plates are good and well executed. These volumes ought to find a place in every technical library in the country.

OUR BOOK SHELF

Lehrbuch der vergleichenden Mikroskopischen Anatomie. Von Dr. Herman Fol. Erste Lieferung. (Leipzig, 1884.)

THE present volume is the first of a work which promises to be in many respects an important addition to the literature of microscopic anatomy. It describes in clear and concise language most of the commendable methods used by the author himself for examining and preparing microscopic specimens of animal tissues.

The methods of injecting vessels and cavities, the nature and preparation of the various materials and apparatus useful for injection, the theory and practice of the microscope and practice of the auxiliary apparatus are treated thoroughly, the theory and practice of drawing microscopic objects, the methods most useful for making micro-photographs, and for showing stereoscopically small objects, are fully described and illustrated, and will be found most useful and instructive reading. Next, the methods for examining living tissues, for fixing and hardening them, then the various ways for embedding and making sections, are minutely described. The last or seventh section is one of the most important ones, giving an excellent *résumé* of micro-chemical reactions, including the osmic acid gold and silver methods, and the methods of staining tissues with carmine, hæmatoxylin, and the various aniline dyes.

To each section is added a useful bibliographical summary. On the whole the book is an excellent guide for microscopists, both teachers and original workers.

E. KLEIN

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. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Unconscious Bias in Walking

THE results of some experiments recently made to ascertain the cause of the well-known phenomena of "unconscious bias in walking" will perhaps be of interest to your readers in connection with the various theories presented in the discussion of this subject in NATURE (vol. xxix. pp. 262, 286, 310, 356, 384, 452).

Within the past six months over 2500 anthropometric measurements have been made of students in the three higher classes of the Massachusetts Agricultural College, including the relative length and strength, muscular development, &c., of the limbs, and the bias in walking of forty-nine individuals has been carefully determined, with results as given in the following summary statement.

In making these measurements I have been assisted by Dr. F. Tuckerman, of this place, who will collate the data obtained in their relations to bilateral symmetry.

The tests to determine the bias in walking were made in the drill-hall of the College, a room with a hard smooth cement floor, well adapted to this purpose.

For convenience in recording the curves of divergence a meridian or base line was drawn through the middle of the floor lengthwise of the hall, and on each side of it lines of departure were marked 1 metre apart, while the latitude was indicated by transverse parallel lines every 2 metres.

In trials to determine the bias, the individual was placed on the meridian line 2 metres back of the first parallel, and after he had well fixed the bearings of the line, he was blindfolded and started at a rapid, but not hurried pace. If he crossed the first parallel of latitude on the meridian line, he was allowed to proceed, but if a marked divergence from this line was made he was stopped, and a new start was made in the right direction. Small sticks were laid down on each parallel of latitude at the point of crossing, by assistants conveniently placed for this purpose, and at the end of the course the line of march could be readily seen. In some cases irregularities in the curve indicated either a hesitating or constrained effort in walking, or errors in marking the precise point of transit.

In these cases the trials were repeated, until a reasonably true curve was obtained. A record was then made of the distance from the meridian line, to the right or the left of the point of crossing on each parallel of latitude.

From this record the curves made were plotted on a diagram, so that they could be readily compared and their peculiarities noted.

That the relative length and strength of the legs has no direct relation to the bias in walking will be readily seen from the following tabular statement:—

TABLE I.

No bias in 5 cases	In 2 the right leg is longest (One of these presented the greatest difference in length of legs, and the other more than the average of those with right leg longest)	In 1 the right leg is strongest In 1 strength of legs not tested
	In 3 the legs of equal length	In 1 the right leg is strongest In 2 the left leg is strongest (*a*)

Four are right-handed.

One uses right and left with equal dexterity (*a*). In pointing at a distant object with both eyes open, in three the right eye is dominant, in one the left eye is dominant, and in one both eyes are apparently used to determine the range.

TABLE II.

Bias to right in 14 cases	In 5 the right leg is longest	In 2 the right leg is strongest In 2 the left leg is strongest In 1 the strength of legs not tested
	In 4 the left leg is longest	In 3 the right leg is strongest (*a*) In 1 the left leg is strongest
	In 5 the legs are of equal length	In 2 the right leg is strongest (*a*) In 3 the left leg is strongest

All are right-handed.

In pointing at a distant object with both eyes open, in 12 the right eye is dominant, and in 2 the left eye is dominant, the latter in the groups marked (*a*).

TABLE III.

Bias to left in 30 cases	In 8 the right leg is longest	In 5 the right leg is strongest (*a*) (*b*) In 2 the left leg is strongest In 1 the legs of equal strength
	In 10 the left leg is longest	In 5 the right leg is strongest (*b*) In 4 the left leg is strongest (*b*) In 1 the legs of equal strength
	In 12 the legs of equal length	In 5 the right leg is strongest In 5 the left leg is strongest (*b*) In 2 the strength of legs not tested

One is left-handed (*a*). Twenty-five are right-handed. Four use right and left with nearly equal dexterity (*b*). In pointing with the finger at a distant object, with both eyes open, in 22 the right eye is dominant, in six the left eye is dominant, and in 2 both eyes are apparently used to determine the range.

The relative dexterity of the legs was tested in a number of cases, but a press of other duties prevented further experiments in this direction. From the tests made, however, it is obvious that there is no direct relation of the relative dexterity of the legs to the bias in walking.

From these experiments it is evident that the cause of the observed unconscious bias in walking is not to be found in the mechanical proportions, or relative strength, or dexterity (?) of the legs.

The application of well-established physiological principles will, however, furnish a ready explanation of the phenomena in question.

The co-ordination of the voluntary muscles is the exclusive prerogative of the nervous system and the senses are important factors in all movements involving a definite direction. The muscles of locomotion when called into action under ordinary conditions, as when walking in a straight line, are co-ordinated or brought into an orderly correlation, by impulses conveyed to the nervous centres through the afferent or sensory nerves, but when in the dark, or in a mist, or when one is blindfolded, the senses are not available as a guide to direction, the co-ordinating nervous mechanism is dormant, and a divergence from a right line is made to the right, or the left, from a lack of equilibrium in the action of the efferent or motor nerves.

In several of the trials, to determine the bias in walking, interruptions occurred before the course was completed, by the opening of the door at the side of the hall and the talking, in a low tone, of the visitors, which served as a guide in orientation, and the curve made before the interruption was suddenly corrected to a line parallel to the meridian.

In all of the trials the greatest care was taken to prevent the senses from gaining clues to the right direction.

Unconscious bias in walking is obviously the result of vital activities involving complex actions and reactions in the nervous system, which may be clearly defined in general terms, while the details of the obscure changes taking place in the nervous mechanism cannot, in the present state of our knowledge, be fully traced. Moreover, it is evident that the phenomena in question must be studied from the same stand-point of other biological processes which cannot be explained or expressed by purely physical or chemical conditions.

MANLY MILES

Massachusetts Agricultural College, Amherst, Mass., April 7

The Flora of Canada

THE review by Mr. J. G. Baker in your last number (p. 242) of the second part of Prof. Macoun's "Catalogue of Canadian Plants" prompts me to send you a few notes on some of the features of the flora of Canada, which I had an unusual opportunity of observing last autumn under the guidance of Prof. Macoun in the neighbourhood of Ottawa, and again in the magnificent railway trip given to members of the British Association by the Canadian Pacific Railway Company from Lake Superior to Kicking-Horse Pass in the Rocky Mountains.

Throughout Eastern Canada and the Eastern United States the European botanist is struck with the strange intermingling, in the wayside flora, of forms new and strange with those familiar by every roadside and in every hedge-bank in England. Away from human habitations the flora is almost altogether novel, but near houses, introduced purposely or accidentally, the English weeds are rivalling and even supplanting the native. I was particularly struck with noticing the vegetation of the grass lawn by the hotel on the Catskill Mountains at an elevation of about 3000 feet. It consisted almost entirely of the same species as you would expect to find in similar situations at a lower altitude in the old country: *Achillæa Millefolium*, *Daucus Carota*, *Plantago major*, *Chenopodium album*, *Cnicus lanceolatus*, &c., most or all of them importations. Elsewhere, in the east, you find docks, milfoil, thistles, shepherd's purse, jostling *Asters*, *Asclepiases*, *Amaranthuses*, *Solidagos*, and other peculiarly American weeds. Exactly the same thing is taking place with introduced animals. I was staying at a farmhouse in Ontario, not far from Niagara, and was told that the English house-sparrow made his appearance there about three years since, and is already as abundant as in England, and a terrible nuisance. Some English plants, however, like our daisy and primrose, seem to refuse to naturalise themselves to the American soil and climate.

Everywhere the lines of the railways are marked by the advent of the foreigner. As Prof. Asa Gray said at Montreal, even English weeds now travel by express train. It is most interesting, in travelling westwards over the vast continent, to note the gradual disappearance of European and the unrivalled supremacy of American types. But it is not only westwards that the tide of floral conquest makes its way. A fellow-traveller of our party had the good fortune to gather, near Port Arthur on Lake Superior, where we were detained twenty-four hours by stress of weather, a grass, *Beckmannia erucæformis*, 300 miles east of any locality previously recorded.

Although in the main the indigenous American flora is altogether different specifically from ours, yet there are exceptions. I am not now speaking of the Alpine flora of the Rocky Mountains, which agrees to a wonderful extent generically, and even specifically, with the flora of the Alps, Pyrenees, or Grampians. Covering the vast extent of ground from the eastern sea-board to the Rockies are a few species undoubtedly indigenous and absolutely identical with European and even English forms. I may mention three illustrations taken from widely-separated natural orders—*Potentilla fruticosa*, *Campanula rotundifolia*, and *Linaria vulgaris*. How to reconcile these facts with any theory accounting for the geographical distribution of species on the face of the earth it is difficult to say.

Even more interesting are those cases where American and European plants are regarded as belonging to the same species, but where there is a certain difference difficult to define, but recognisable at a glance. To take, again, three examples:—Among the most cosmopolitan of ferns are *Osmunda regalis* and *Pteris aquilina*. Abundant throughout Canada, there is yet, in both cases, a general habit by which they are at once distinguished from the English forms. Again, the American *Plantago major* is all but indistinguishable from the English wayside weed. And yet, it is said, American horses know the difference. Prof. Macoun is contemplating a visit to Europe next year, when one of his special objects will be to compile an account of these closely-allied but yet distinct eastern and western forms. It is possible that such a comparative list—and it could not be in better hands—may throw some light on some of the many still unsolved problems connected with the evolution and distribution of species.

ALFRED W. BENNETT

The Fauna of the Seashore

IN addition to the instances from the Molluscan class mentioned in the interesting letter from Mr. Arthur R. Hunt (NATURE, pp. 243-4), as illustrating—after Prof. Moseley's most valuable contribution—"the variety of method exhibited by the littoral fauna in resisting wave-currents," may be mentioned one of a higher class among the fishes—viz., the common smooth blenny (*Blennius pholis*).

No one who has hunted for this pretty little fish in rock-pools, or who has kept it in an aquarium, can have failed to notice its remarkable adaptation to the ever-varying environment of the littoral zone. The angular form of the head and smooth, mucous-covered body enable it readily to burrow within the smallest crevices of the rocks, to prevent its being washed ashore when the tide is coming in, and to prevent its being carried into deep water when the tide is going out, where it would readily fall a prey to rapacious fishes, as it has apparently little power to swim freely to a distance, not needing to do so in shallow water. Its peculiarly modified ventral fins, forming almost anterior limbs, enable it to cling securely not only to weeds and rocks, but even to perpendicular surfaces, for similar purposes to those above stated, while its beautifully-marked body—of splashed dark and light greens—seems to be a case of mimicry of the sea-weeds which afford it protection from its natural enemies among its own class and those of the higher Crustacea. An allied deep-sea genus (*Anharricas*, the wolf-fish), whose ancestor was probably a littoral blenny, has the ventral fins entirely wanting, and the head is round, for the obvious reasons that it does not need to cling to surfaces nor to burrow in crevices. This fish is, however, compensated by a formidable array of sharp teeth to protect it from its natural enemies. In the aquarium no fish, in my experience, is so readily tamed as the smooth blenny, so as to allow it to be handled, or exhibits such a high degree of piscine intelligence, arising doubtless from long education, both inherited and acquired; in the varying environment which is its habitat. A specimen now in my aquarium daily avails itself of the advantage of the dry ledge of the slope-backed tank "to get a mouthful of fresh air," while

at other times it usually takes refuge in an untenanted old shell of the common whelk (*Buccinum undatum*), where it is secure from the gobies and other fishes in the tank, and where it watches—as one can see its fellows do so at any time on the sea-coast in the middle of a rock-pool—expecting the return of the tide and prepared to adapt itself thereto. In "A Year at the Shore," pp. 215–16, Mr. P. H. Gosse, F.R.S., mentions, on the authority of Mr. Ross, of Topsham, the case of a blenny which for five months proved "a regular and correct tide-indicator," spending a portion of its time on the rock-work, and going back to the tank at the time of the return of the tide.

I quite agree with Mr. Arthur R. Hunt's idea that it would be a great gain if we could copy Nature a little closer, and have "working-models of the sea in some of our new aquariums."

Birmingham, July 22 W. R. HUGHES

Artificial Earthquakes

PROF. MILNE'S experiments with artificial earthquakes in Japan, noticed in NATURE of June 4 (p. 114), show that the vertical free surface-wave had the quickest rate of transit, and this was taken to account for the preliminary tremors of an earthquake. The normal wave travelled with a less velocity, and the transverse wave slowest of all. In the earthquakes which occur here from time to time there are generally, if not always, two distinct shocks felt, and it is possible that the second is the transverse wave following on after the swifter normal vibration. I have not heard that there are any seismographs in the Punjab, and in the alarm of the moment it is not easy to notice the direction of the motion without apparatus; fortunately our earthquakes do not leave any automatic record in the shape of fissures or fallen buildings. But Prof. Milne's experimental results are curiously confirmed by observations in Kashmir during the earthquakes of this month, which do not appear yet to have quite subsided. The Kashmir correspondent of the Lahore *Civil and Military Gazette* of to-day's date writes as follows:—"The more severe shocks seemed to be followed by others in a different direction, like cross waves. I noticed this in a boat which quivered all over during a severe earthquake, but rolled somewhat afterwards." T. C. LEWIS

Government College, Lahore, June 29

The Recent Earthquake in Switzerland

THE following is a table of events of the earthquake in Switzerland of June 20 last, compiled from numerous and interesting observations of the phenomenon, obligingly forwarded to me from all parts of the country.

The earthquake consisted of a series of shocks:—

1. *Preparatory Shocks.*—Very weak and ill-defined from midnight to 3 a.m.; at Neuchâtel and Chaud-de-Fonds.

2. *Great Shock*—At 5.16 on the morning of June 20; at the centre of the earthquake.

3. *Consecutive Shocks.*—At 7.26 a.m. June 22 at Neuchâtel; at 8.30 a.m. of June 22 at Yverdun, Payerne, Estavayer, Concise, Boudry, Neuchâtel; at 11 a.m. of June 23 at St. Imier; at 2.30 p.m. of June 23 at Neuchâtel; at 9.20 a.m. of June 24 at Yverdun (?)

The great shock had its centre near Yvonand and the central area may be defined by the triangle formed by Yverdun, Neuchâtel and Payerne. The shock was strong enough to alarm the inhabitants, to displace some articles of furniture and even to throw down a chimney at Payerne. I assign to the shock the strength of number 6 on the scale of intensity, of which number 10 would stand for the highest degree. The shock was felt more feebly in a vast territory extending as far at least as Geneva, Le Brassus, Le Locle, Bâle, Glaris, Thun, Saxon: that is, it traversed the whole plain of Western Switzerland from the Jura Alps. A subterranean noise was heard very distinctly in the whole central area and even a little beyond it.

The shock had very markedly the character of successive oscillations, horizontal or vertical, their direction differing according to the locality. Such is, indeed, the usual type of earthquakes, as has been shown by the study of them with registering instruments, and it is interesting to notice that the various observations of the earthquake of June 20 all perfectly concur in ascribing to it this character. F. A. FOREL

Morges

THE PITCHER PLANT

THE variety of the Pitcher Plant (*Sarracenia variolaris*) found in North America is carnivorous, being a feeder on various animal substances.

Mrs. Mary Treat, an American naturalist, made, a few years ago, several experiments upon the plants of this species to be found in Florida; and to the labours of this lady the writer has been indebted, in some measure, in the preparation of this paper.

The *Sarracenia* derives its name of "Pitcher Plant" from the fact of its possessing the following curious characteristics. The median nerve is prolonged beyond the leaves in the manner of a tendril, and terminates in a species of cup or urn. This cup is ordinarily three or four inches in depth, and one to one and a half inches in width. The orifice of the cup is covered with a lid, which opens and shuts at certain periods. At sunrise the cup is found filled with sweet, limpid water, at which time the lid is down. In the course of the day the lid opens, when nearly half the water is evaporated; but during the night this loss is made up, and the next morning the cup is again quite full, and the lid is shut.

About the middle of March the plants put forth their leaves, which are from six to twelve inches long, hollow, and shaped something like a trumpet, whilst the aperture at the apex is formed almost precisely in the same manner as those of the plants previously described. A broad wing extends along one side of the leaf, from the base to the opening at the top; this wing is bound, or edged with a purple cord, which extends likewise around the cup. This cord secretes a sweet fluid, and not only flying insects, but those also that crawl upon the ground, are attracted by it to the plants. Ants, especially, are very fond of this fluid, so that a line of aphides, extending from the base to the summit of a leaf, may frequently be observed slowly advancing towards the orifice of the cup, down which they disappear, never to return. Flying insects of every kind are equally drawn to the plant; and directly they taste the fluid they act very curiously. After feeding upon the secretions for two or three minutes they become quite stupid, unsteady on their feet, and whilst trying to pass their legs over their wings to clear them, they fall down.

It is of no use to liberate any of the smaller insects, every fly, removed from the leaf upon which it had been feeding, returned immediately it was at liberty to do so, and walked down the fatal cup as though drawn to it by a species of irresistible fascination.

It is not alone that flies and other small insects are overpowered by the fluid which exudes from the cord in question. Even large insects succumb to it, although of course not so quickly. Mrs. Treat says:—"A large cockroach was feeding on the secretion of a fresh leaf, which had caught but little or no prey. After feeding a short time the insect went down the tube so tight that I could not dislodge it, even when turning the leaf upside down and knocking it quite hard. It was late in the evening when I observed it enter; the next morning I cut the tube open; the cockroach was still alive, but it was covered with a secretion produced from the inner surface of the tube, and its legs fell off as I extricated it. From all appearance the terrible *Sarracenia* was eating its victim alive. And yet, perhaps, I should not say 'terrible,' for the plant seems to supply its victims with a Lethe-like draught before devouring them."

If only a few insects alight upon a leaf no unpleasant smell is perceptible during, or after, the process of digestion; but if a large number of them be caught, which is commonly the case, a most offensive odour emanates from the cup, although the putrid matter does not appear to injure in any manner the inner surface of the tube, food, even in this condition, being readily absorbed, and going to nourish the plant. In fact, it would seem tha

the *Sarracenia*, like some animals, can feed upon carrion and thrive upon it.

In instances in which experiments have been made with fresh, raw beef or mutton, the meat has been covered in a few hours with the secretions of the leaves, and the blood extracted from it. There is, however, one difference between the digesting powers of the leaves when exercised upon insects or upon meat. Even if the bodies of insects have become putrid, the plant, as has already been stated, has no difficulty in assimilating them; but as regards meat, it is only when it is perfectly sweet that the secretions of the leaves will act upon it.

The Pitcher plant undoubtedly derives its principal nourishment from the insects it eats. It, too—unlike most other carnivorous plants, which, when the quantity of food with which they have to deal is in excess of their powers of digestion, succumb to the effort and die—appears to find it easy to devour any number of insects, small or large, the operation being with it simply a question of time. Flies, beetles, or even cockroaches, at the expiration of three or four days at most, disappear, nothing being left of them save their wings and other hard parts of their bodies.

The *Sarracenia* is, indeed, not only the most voracious of all known species of carnivorous plants, but the least fastidious as to the nature of the food upon which it feeds.

W. C. M.

THE ECLIPSES OF AUGUST, 1886

IT has been before stated in NATURE that the total solar eclipse of August 28-29 next year can be most favourably observed on the west coast of Africa near Benguela. In a recent number of *Science* Mr. Skinner supplies a valuable account of the local conditions, which we here reprint:—

"Benguela is about 400 miles south of the mouth of the Kongo, and about 200 miles south of the mouth of the Koanza. The climate of the lowlands bordering the coast near Benguela is fatally unhealthy for strangers, making it compulsory, on the score of prudence, for an observing party to penetrate the interior sufficiently to attain the mountainous highlands which lie not far inland.

"The American Board of Commissioners for Foreign Missions has for some three years occupied two mission stations in this region—viz. Bailundu, about 133 miles eastward from Benguela, and Bihe, about 70 miles south-east from Bailundu. Through the courtesy of Rev. Judson Smith, D.D., secretary of the American Board, and Mr. Frederick A. Walter, secretary of this west-central African Mission, I have received definite statements of some of the precautions necessary, and some of the difficulties to be encountered by an observing party locating in this region. I will give in brief the points with which Mr. Walter favours us.

"Dangers to the person from savages are not to be apprehended. The climate of Bailundu and vicinity is exceedingly salubrious. During a residence of nearly three years, Mr. Walter and his family have experienced no illness to be ascribed directly to the climate, but in every case to overwork, over-exposure to the sun, or want of proper food.

"The difficulties in reference to transportation are considerable. Transportation is done entirely by men; waggons and animals cannot be used. The gross weight for a carrier is from 65 to 70 lbs.; commonly it does not exceed 58 lbs. Packages, either bales or boxes, should be of about the following dimensions:—14 inches by 9 inches by 30 inches, or, if more convenient, 16 inches by 10 inches by 24 inches. No single package should exceed 18 inches in width by 10 inches in depth. Pieces not exceeding 60 lbs. in weight, though 8 or 10 feet long, can be carried by a single carrier.

"As to means of subsistence, an observing party must bring *all their supplies with them*, as it is essential to the health of newcomers that they should live on food to which they are accustomed. The time required for a round trip of a caravan from Bailundu to Benguela may be stated as one month to six weeks.

"Mr. Walter states that the chances for clear sky at the time of the eclipse are very favourable.

"It may be stated that the land rises very abruptly as one leaves the coast from Benguela, and in a few miles attains a very considerable altitude, and throughout these highlands the climate is very healthful."

INTERNATIONAL INVENTIONS EXHIBITION

SELF-ACTING or automatic machinery has made wonderful strides of late years, and its progress in the special department of watch-making cannot be more advantageously studied than in the beautiful display of machine tools now exhibited by the American Waltham Watch Company at South Kensington. We think that a few remarks with reference to the functions of these tools may be of service to the readers of NATURE when viewing the collection. The machine tools are all labelled, and can readily be identified.

(1) A screw-making machine.—This machine is engaged in producing watch jewel screws; the size of the screws may be appreciated when we state that it takes more than 8500 to weigh one ounce troy. Lengths of wire are transformed into these tiny screws in the following manner. The machine is fed with the wire through a hollow mandrel, the wire is seized and rotated rapidly, a movable cutter is brought against it, and immediately the body of the screw is turned. Two dies are at hand which attach themselves, and they cut the thread; on reaching the limit of their cut, they pull out the wire a distance, the thickness of the screw head, for hitherto the wire has only projected the length of the body of the screw through the mandrel head. The dies disengage themselves, and a second cutter cuts off the screw at its junction with the mandrel head. There is an alternating arm, the most conspicuous part of the machine: this takes possession of the screw as it is cut off, and, carrying it to a different part of the machine, holds the head against a small circular mill, where the notch is cut. The screw is now finished, and is discharged into a magazine by a kind of ram-rod. The machine turns out 4000 screws a day, and indeed the successive operations go on with so much rapidity, that it requires some practice to follow them. It is to be noticed that when the dies are cutting, the wire is stationary, and the machine then quickens its motion to save time. When the dies pull forwards, the chuck holding the wire opens simultaneously. Copious streams of oil are supplied to wash away the shavings, and the oil after being used once, escapes into reservoirs from whence it is automatically pumped up again. The different parts of the machine are regulated almost entirely by cams, the dies by a very elegant arrangement of opposing toothed sectors.

(2) A machine for cutting off dial feet—*i.e.* attachments. If this machine stood alone it would be interesting, but it is overshadowed by its neighbours.

(3) A machine for roughing out staves or pinions.—This is similar in some respects to the screw-making machine. Lengths of wire are fed through the mandrel, and a cutter shapes one end of the staff or pinion, giving it a male centre. It is then cut off, but the other end has to be shaped with its male centre too. Again we have an alternating arm, which carries the pinion away and places it in a very similar mandrel on the other side. So soon as it is gripped it begins to rotate; a cutter comes and shapes the unfinished end with its male centre. When done it is discharged into a magazine, as the tiny screws were.

(4) This is a machine for trueing down the staves or

pinions roughed out in (3). Like (2) this is a simpler machine, but worthy of attention. The roughed-out pinions are here turned true upon their own centres. Notice that when the tool has turned off the necessary amount it stops of itself, till started for a fresh piece.

(5) A pinion-polishing machine.—The polisher is driven to and fro by crank motion. After a sufficient number of rubs have been given the pinion turns automatically and presents a fresh face to the polisher, till all the leaves are done. The other side of the stand shows us a lathe requiring no special explanation.

(6) An automatic machine for cutting pinions.—In this is exhibited an elegant arrangement for bringing a succession of cutters into play. The principle, however, is very much better illustrated in the scape-wheel engine that follows; we therefore defer explanation.

Alongside of this machine is another for cutting the bevelled wheel teeth for keyless work.

(7) A scape wheel tooth-cutting engine. The scape wheels to the number of sixty are threaded upon a kind of split spindle, which passes through the spaces around their arms, and holds them firmly. The spindle with the wheels around it looks like a solid rod of brass, and the cutter acts transversely so as to scoop a groove through all the sixty at once. Owing to the peculiar shape of tooth and the degree of finish necessary, seven different cutters are required. The actions are as follow:—The spindle being placed in position, the first cutter operates. When it has made one groove the spindle turns; it makes another, and another, in all 15, which corresponds to the number of teeth. A sudden change now happens—the first cutter is diverted, and a second takes its place This cutter works through all the fifteen spaces, and then the next supersedes it, until all have had their turn and the wheel is finished. We understand that the whole sixty wheels are cut in about twenty minutes.

(8) Another polishing machine, of somewhat similar design to (5).

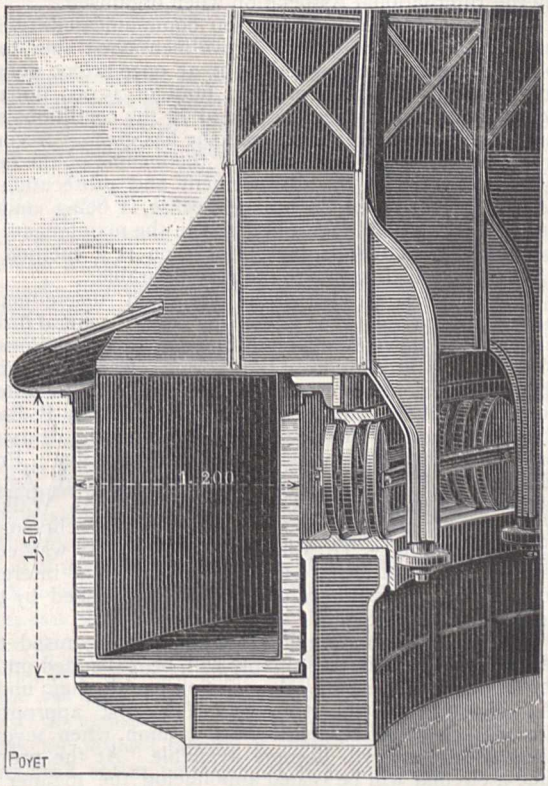
(9) On a counter opposite to the main stand is shown an interesting instrument for determining the strength of watch-balance springs. In this the differential principle is employed, the spring to be tested being measured against one of known force, and the number of degrees the latter is deflected registered. The springs are sorted into compartments corresponding to these numbers.

There are two other tools not working at present, but still of considerable interest. The first is supplementary to (9), which only gives the strength of the spring within certain limits. There is a normal balance with spring attached, and the balance and spring to be tested are mounted on an arm alongside of it. A lever sets both balances vibrating simultaneously, and it is easy to perceive in a few seconds whether their vibrations are synchronous or not. The other tool is automatic, and is for the purpose of drilling and tapping the screw-holes in compensation-balances. These holes are placed at irregular distances, as experience has suggested. By means of a divided plate the machine automatically finds these intervals. A very pretty feature will be noticed when the machine is drilling—viz. that the drill is withdrawn occasionally by the machine to free the cuttings, just as would be done by a workman.

HENRY DENT GARDNER

THE NICE FLOATING DOME

WE have already (NATURE, vol. xxxii. p. 62) referred to the floating dome for the great equatorial of the Nice Observatory of M. Bischoffsheim. We give now an illustration from *La Nature*, which shows the details of the annular floater. The entire dome is supported on the annular floater situated at its base. The floater, of hollow metal, swims in a circular caisson containing water holding saline matter in solution. When the dome is in the position of normal buoyancy, the only friction which opposes its movement of rotation is the friction inside a liquid body, and consequently is extremely feeble, notwithstanding the great weight of the moving mass. Experiments prove that one man can easily set the dome in motion with his hand. The floater of the dome is open above like an undecked boat; it has a rectangular section of 1·50 m. in height by 0 95 m. in breadth. Its walls are bound together by rivets of steel.



The annular caisson, which receives the floater and the liquid, has a rectangular transverse section; its height is 1·50 m., and breadth 1 20 m. The latter dimension thus exceeds the breadth of the floater by 0·25 m., which gives a lateral play of 0·125 m. in the inside and 0·125 m. at outside between the floater and the caisson. Finally, the caisson rests on thirty-six strong cast-iron supports, distributed at equal distances over the upper part of the mason-work of the tower.

A NEW ENDOWMENT FOR RESEARCH

IT is usually the case that private endowments for public purposes are made subject to narrowing restrictions, and then it too often ensues that with the lapse of time the very object of the gift is defeated by the restrictions—the letter kills the spirit. It must therefore be a matter of congratulation when a great public donation is left as free as compatible with the general object for which it is made. This is remarkably the case with a noble and munificent endowment established by Mrs. Elizabeth Thompson, of Stamford, Connecticut—an American lady well known for her public benefactions. Her long experience with churches and various charitable enterprises had led her to question whether the money spent in them achieves the greatest possible good. She finally reached the conviction that knowledge is the real source, the impelling power, of human progress, and it

became her desire, from motives of the highest philanthropy, to contribute to the promotion of science.

When the plan for the establishment of an International Scientific Association was brought forward at Montreal, and again at Philadelphia before the great National Associations, Mrs. Thompson considered that the proposed International Society would be the fittest body to assume the trust she wished to establish. Accordingly, she placed in my hands the sum of 5000 dollars (1500*l.*) as the nucleus of a fund to be controlled by the International Association when organised.

Not long since Mrs. Thompson communicated to me her desire to transfer the above-mentioned sum to a board of trustees and to add to it at once 20,000 dollars more, making a total permanent fund of 25,000 dollars. Mrs. Thompson has been as liberal in the conditions she has established as in the amount she has given. According to her letter of conveyance, "the income of the fund is to be devoted to the advancement and prosecution of scientific research in its broadest sense, it being understood that to provide for and assist in the maintenance of an International Scientific Association is a method of application which seems to me very desirable."

The trustees are left with very great discretionary powers, which are to be guided by certain general directions. It is above all expressly understood that the prime object is to contribute from the income towards defraying the cost of scientific researches. The Board of Trustees consists of five members: Chairman, Dr. Henry P. Bowditch, Professor of Physiology and Dean of the Harvard Medical School; Treasurers, Wm. Minot, jun.; Prof. Edward C. Pickering, Director of the Harvard Astronomical Observatory; General Francis A. Walker, President of the Massachusetts Institute of Technology; and the Secretary, Dr. Charles S. Minot. It was considered important to have as great a variety of interests represented as possible, and this is accomplished by the association of these gentlemen.

When the International Association is organised the income of the fund presumably will be expended under the direction of that new Association; until then, under the direction of the trustees. The first appropriation will probably be made next autumn, when several hundred dollars will become available. At the proper time a circular will be issued announcing the manner in which applications may be made. As it is desired to give the fund an international character, it is hoped that foreign journals will copy this notice.

In conclusion I wish to express my admiration for the wisdom shown by Mrs. Thompson. It is certainly very remarkable that a person not specially versed in science, nor directly interested in any of its branches of investigation should be induced by a desire to benefit her fellows, not to give for some temporary need, but, with exceptional insight, to give for the development of the very sources of progress. The same sound judgment governed her decision as to the conditions of her gift, for it is difficult to foresee any probability which will render this endowment futile. Very often a public gift has its object determined by the donor's personal interests. I believe Mrs. Thompson was governed solely by her convictions as to the application of her money which would do most good.

At their first meeting the trustees voted unanimously to call their trust "The Elizabeth Thompson Science Fund." CHARLES SEDGWICK MINOT

Boston, Mass., U.S.A.

NOTES

WE are informed by Dr. Armstrong that arrangements have been made for two discussions in the chemical section over which he will preside at the meeting of the British Association at Aberdeen. The one will be on the Determination of the Molecular Weights of Liquid and Solid Bodies, the other on Electrolysis. It is proposed to have a series of critical papers read which shall embody, as far as possible and desirable on such an occasion our knowledge of these subjects, and also indicate the directions in which investigation is specially required and may be most usefully carried on. These subjects have been chosen as being of general interest and of special importance to the chemist, and in the hope of inducing chemists and physicians to cooperate in attacking the many problems which await solution. Capt. Abney will open the first discussion with a paper on the spectroscopic method. Profs. Guthrie, Reinold, and Dilden, Mr. S. U. Pickering, Dr. Russell and Dr. Armstrong will also contribute papers. Professor Lodge will open the discussion on Electrolysis, and Prof. Schuster, Capt. Abney, and Mr. Shelford Bidwell have already consented to contribute papers on portions of this subject. Dr. Armstrong will be glad to hear from any other gentlemen who may wish to aid in forwarding what promises to be a useful departure.

A TELEPHONE has just been brought to this country from America which is absolutely independent of electricity, so that batteries, coils, and cells are quite dispensed with. This obviously greatly simplifies the working of the instrument, and in the "mechanical telephone," which was recently subjected to a severe test, simplicity and distinctness are claimed as its chief characteristics. The instrument consists of a diaphragm, or sounding-board made of strips of willow wood, which has been found by experiment to possess a remarkable sensitiveness to sound vibrations. These strips of wood are closely woven together and varnished. In the centre of the diaphragm a small disc of metal is placed, from which the wire proceeds to any point desired up to two miles. In recent trials the instrument freely answered to all demands upon it, the ticking of a watch, musical sounds, whispering, &c., being heard with great distinctness.

WE understand the Fishery Board for Scotland, in order to learn further what has been done in other countries for increasing the fish supply, has requested Prof. Cossar Ewart, when on the Continent during the autumn, to visit some of the principal fishing stations in Norway and Sweden. It will be remembered that Prof. Ewart, by visiting at his own expense Canada and the United States last autumn, was able to present to his Board a valuable report on the "Progress of Fish Culture in America." An equally interesting report on the Norwegian fisheries may be expected.

IN accordance with previous announcements the summer meeting of the Institution of Mechanical Engineers will be held at Lincoln on Tuesday, Aug. 4, and the following days of the week. The following papers have been offered for reading and discussion after the address of the President, Mr. Jeremiah Head:—Description of Dunbar and Ruston's steam navvy, by Mr. Joseph Ruston, M.P., of Lincoln; on recent adaptations of the Robey semi-portable engine, by Mr. John Richardson, of Lincoln; description of the Tripier spherical eccentric, by M. Louis Poillon, of Paris; on private installations of electric lighting, by Mr. Ralph H. C. Nevile, of Wellingore; on the iron industry of Frodingham, by Mr. George Dove, of Frodingham; description of an autographic test-recording apparatus, by Mr. J. Hartley Wicksteed, of Leeds. A formidable programme of excursions and visits to various works has been arranged.

WE referred a short time back to a proposed excursion by the Geologists' Association to Belgium, under the direction of MM. Dupont, Gosselet, Purves, and Renard. The monthly circular, giving full details of the arrangements, is now before us, from which we learn that during the six days of the excursion (August 10 to 15) visits will be made to the typical sections of Cambrian, Devonian, and Carboniferous rocks, including the

altered rocks of the Ardennes; the Devonian limestones of Roly, &c., which M. Dupont regards as true coral atolls; the grand section of Devonian and Carboniferous limestone along the Meuse; the Grotto of Han, and the Devonian limestones, &c., near Rochefort. The circular contains nine maps and cuts illustrating the geology of Southern Belgium, a table of geological formations, and a list of maps and books relating to the district. There are also full particulars as to routes, fares, &c. A pamphlet on "The Geology of Belgium and the French Ardennes," containing papers by Gosselet, Bonney, Rutot, Van den Broeck, and Topley, has also been prepared by the Association, and is published by Stanford. This gives a fuller account of the literature, and is illustrated by three maps and thirteen cuts.

On Saturday, July 25, a whole day meeting of the Essex Field Club was held at Witham and neighbourhood. The party, about sixty-five in number, was met at Witham Station by the Vicar, Canon Snell, and after being conducted over the church, an inspection was made of the ancient earthwork surrounding the railway station. A paper on this camp, which is believed to have been constructed by Edward I., was communicated by Mr. F. C. J. Spurrel, who had prepared for distribution a number of printed copies showing the plan of the entrenchments. After lunch at the "Spread Eagle," Witham, an ordinary meeting of the Club was held for the election and proposal of new members, Prof. R. Meldola, in the absence of the President, taking the chair. At the conclusion of the meeting brakes were in attendance, and the party proceeded to Black Notley, passing *en route* through the village of Cressing, where in former times the Knight Templars had a preceptory. The remains of the Temple, now a farmhouse, were inspected by the permission of the present owner, Mr. J. H. Shoolbridge, who had had excavations made in various parts of the grounds in order to expose some of the old brickwork foundations. In the churchyard of Black Notley, by the tomb of John Ray, Prof. G. S. Boulger gave an excellent account of the "Domestic Life of John Ray at Black Notley." Mr. E. A. Fitch followed with an equally interesting account of Ray's labours as an entomologist. The Rector of Black Notley, the Rev. J. Overton, was in attendance in order to conduct the party over the church. In the neighbouring school-room the Rev. F. W. Kenworthy, Vicar of Braintree, had arranged for exhibition a fine collection of flint implements, many of which had been found in the neighbourhood, and some of the palæolithic specimens being of special interest as having been found beneath the chalky boulder clay. After leaving the school-room a visit was paid to "Dewlands," the home of John Ray at Black Notley, by the permission of Mr. Mortier, the present occupier. Proceeding to Faulkbourn, the rector, the Rev. F. Spurrel, conducted the party over the church, and, by the invitation of Capt. Talbot, Faulkbourn Hall was next visited, although the length of the day's programme prevented the club from taking advantage of the hospitality of the owner. After a short ramble through the grounds and an inspection of the hall from the exterior, the party proceeded to Terling Place, where a most hospitable reception was given by Lord and Lady Rayleigh. In the course of the evening Lord Rayleigh addressed the meeting on some mechanical questions involved in the flight of birds, and some of the party were then conducted to the laboratory, where a number of experiments bearing upon his lordship's researches on sound, hydrodynamics, &c., had been arranged for exhibition. Amongst those present at the meeting were Mr. G. J. Symons, F.R.S., Prof. S. P. Thompson, Mr. E. B. Knobel, Sec. R.A.S., Dr. T. Taylor, &c. In carrying out the local arrangements much assistance had been rendered by Mr. W. D. Cansdale.

The British Medical Association is holding its annual meeting this week at Cardiff.

The annual meeting of the Belgian Royal Society of Public Medicine, to be held at Antwerp on August 26–30, will this year assume a somewhat international character. The Committee issue a special invitation to its foreign corresponding members, with a view to their taking part in the discussion of the main topic to be submitted to the meeting. That topic is thus formulated:—"What are, in the present state of epidemological science, the most practical international prophylactic measures to be taken, especially in Belgium, against pestilential malaria?'

The annual meeting of the National Fish Culture Association will take place on Thursday next under the presidency of the Marquis of Exeter, when reference will be made to the Indian and Colonial Exhibition to be held next year, at which the Association is to represent the Fisheries Department, in accordance with the request of the Royal Commissioners.

At the last meeting of the Seismological Society of Japan (reprinted in the *Japan Gazette*) Dr. Knott read a paper on earthquake frequencies. The writer's aim was to discover, if possible, some satisfactory reason for the winter maximum of frequency. Earthquake statistics show that, wherever there is a marked winter season there is a corresponding increase in seismic action. In searching for possible causes for this periodicity Dr. Knott left out of account purely terrestrial actions, due to the earth's cooling and shrinking, or to the unequal distribution of surface matter as displayed in the arrangement of continents and oceans, for, although these no doubt produce earthquakes, they cannot cause periodicity. This restricts us to such periodic stresses as may result from the tidal actions of the sun and moon, or from the meteorological changes which accompany the sequence of the season. The writer discusses each of these possible causes in turn. Earthquake statistics do not afford us any clear evidence of fortnightly or monthly periods, and on the whole he discards the tidal action of the sun and moon as incapable of explaining the annual period in earthquake frequency. Coming to meteorological causes, the seasonal changes of temperature cannot have any direct effect, as they are inappreciable at a depth of from 20 to 30 feet; storm depressions and wind generally may be left out of account, as the earth is sluggish in responding to short-lived stresses. The attempts that have from time to time been made to connect earthquakes with the indications of the barometer *at the locality* could hardly be expected to lead to any definite result, for we have no right to assume that the earthquake is caused by an external stress applied directly at the origin of the disturbance. We must consider the stresses over a large area inclosing the locality in question. Are there, then, any meteorological phenomena of the necessary period and sufficiently long-continued in their different phases to give rise to stresses to which the earth's crust could reasonably be expected to yield? There seems, Dr. Knott says, to be such a possible cause in the annual oscillations of barometric pressure over land and sea. In cold weather this pressure is high over the land and low over the sea; in warm weather this relation is just reversed. This gives rise to steep gradients, which of course are steepest just where land and sea meet. Japan, for instance, between Siberia and the Pacific, is under one of these steep gradients. This semi-annual see-saw of pressure is very marked in all temperate regions, the steepest gradients always occurring in the winter months. Then, so far as regards the winter excess of pressure, a much more powerful cause than barometric changes is to be found in the snow-fall. If we consider the great winter accumulation of snow in the higher latitudes, especially over continental areas, such as Siberia, we see that the magnitude of the shearing stresses along the region where the snow accumula-

tions cease—that is, along the littoral districts—must be considerable. In lower latitudes, however, this explanation fails us, and the effect of rainfall on account of its non-persistency can hardly be taken into account. Thus there seem only two possible meteorological phenomena which can be regarded as causing the annual periodicity of earthquakes—the snow-fall gradient and the barometric gradient. Of these the accumulations of winter snow over the land surfaces must be regarded as vastly the most potent. It must not be forgotten that in the case of a rigid mass like the earth a slight steady stress may be more effective than a short-lived shock.

On Thursday the 16th inst. the first annual meeting of the Manchester and District Association of Science and Art Teachers was held in the Manchester Technical School, Mr. W. Gee, agent of the Union of the Lancashire and Cheshire Institutes, presiding. The report showed that "the Committee have endeavoured to diffuse information regarding methods of teaching and apparatus used by good teachers, and that some of the meetings have been very successful." The principal papers of the year had been "On the Science Department's List of Apparatus," "The Honours Examination in Machine Drawing and Building Construction," "Diagram Making," "The Magic Lantern as applied to Science Teaching," and "The True Purposes and Right Pursuit of Art." Visits had also been made to inspect scientific works at the Cheetham College Library and the Manchester Free Reference Library, and also to the Manchester Telephonic Exchange. The officers were appointed for the new year, including the re-election of Prof. Sir Henry Roscoe as President. The chairman drew attention to the subordinate position still occupied by science at several of the public examinations, and it was understood that this subject would be considered by the executive.

At the half-yearly general meeting of the Scottish Meteorological Society on Monday the following business was transacted :—Report from the Council of the Society ; the proposed earthquake observations on Ben Nevis, by Prof. Ewing, Dundee ; methods of observing the temperature and humidity of the air (with experiments), by H. N. Dickson, Scottish Marine Station ; Prof. Crum Brown exhibited an anemometer for maximum wind-pressure.

A telegram from Calcutta, July 25, states that three shocks of earthquake have occurred in Runpur, Bengal Presidency, causing serious damage. A village near Nattore has sunk completely into the earth.

A telegram from Teneriffe announces that a shock of earthquake was felt there on the morning of July 22. No details have yet been received.

Mr. C. G. Rookwood prints some notes on American earthquakes in the June number of the *American Journal of Science*, the earthquakes being those which occurred in the preceding year in North and South America. The list contains fifty-four items, not counting the one of Nov. 13. They may be geographically classified thus :—

Canadian Provinces	...	...	...	5
New England	...	...	...	9
Atlantic States	...	...	...	5
Mississippi Valley	...	...	...	7
Pacific Coast	...	...	...	21
West Indies	...	...	...	2
Central America and Columbia	...	...		3
Peru	...	...	...	2
Uruguay	...	...	...	1
				55
Deduct for Aug. 10, counted twice	...			1
				54

By seasons they are classified thus :—Winter, 12 (Dec., 2; Jan., 8; Feb., 2) ; Spring, 15 (March, 8 ; April, 7 ; May, 0) ; Summer, 8 (June, 4 ; July, 0 ; Aug., 4) ; Autumn, 19 (Sept., 4 ; Oct., 5 ; Nov., 10; Spring and Summer together, 23; Autumn and Winter together, 31. The following localities were shaken on two or more days :—Los Angeles, Cal., Jan. 4, Jan. 16, Oct. 22 ; San Francisco, Jan. 25, March 15, 25, July 15, Nov. 12 ; Oakland, Cal., March 25, April 17, 20 ; Eureka, Cal., Jan. 27, April 6, 8, 11 ; Concord, N.H., Aug. 10, Nov. 12, 23. The only shocks causing much damage were Nov. 5, Panama ; Nov. 6, Colombia ; Nov. 22, Lima, and Aug. 10, Middle States.

We have received from Stonyhurst College Observatory the "Results of Meteorological and Magnetical Observations for 1884," by the Rev. S. J. Perry, F.R.S. The work done at this observatory becomes more and more valuable every year. Of the solar surface 281 drawings were made during the year and 88 complete measures of the chromosphere. The spectra of sunspots have been measured on 30 days, and the widening of 200 lines between B and D accurately measured.

A meeting of the Washington Philosophical Society not long ince took the form of a symposium, in which various members gave answers to the question : "What is a glacier?" The following are the various definitions given ; but it should be mentioned that there are explanations and suggestions in most cases which we have not space to reproduce in full. "An ice-body, originating from the consolidation of snow in regions where the secular accumulation exceeds the loss by melting and evaporation—*i.e.* above the snow-line—and flowing to regions where the loss exceeds supply—*i.e.* below the snow-line" (*Mr. Russell*) ; "A river of ice, possessed, like the aqueous river, of movement and plasticity" (*Mr. Emmons*) ; "A mass of ice with definite lateral limits, with motion in a different direction, and originating from the compacting of snow by pressure" (*Mr. W. H. Dall*) ; other members did not attempt such precision of expression. Mr. Chamberlin pointed out that hard-and-fast lines of demarcation do not prevail in nature, but rather gradations of character. The terms névé and glacier were probably used by guides and travellers for convenience. "There is an area of growth and an area of waste to every glacier ; superficially the area of growth coincides with the névé ; the area of waste is that of the glacier proper." Mr. McGee said that as glacier ice and névé ice belonged to a graduating series, the two phases can only be arbitrarily discriminated. "Perhaps the most satisfactory line of demarcation detectable is the snow-line, above which the superficial *débris* is buried by precipitation, and below which it is exposed by ablation."

We have to acknowledge the receipt of the third Biennial Report of the Central Station of the Java Weather Service, as well as of various quarterly reports and monthly bulletins issued by Dr. Hinrichs, the director. The appropriation for the work is very small, but there appears to be a large number of volunteer observers all over the State. In a foot-note to a list of these the director notices the death of one of his volunteers with the following epitaph :—"Died, June 10, 1882. He was a most painstaking observer, furnishing good reports in fine handwriting."

A few days ago a salmon weighing 28 lbs. was netted at Jomfruland, in the Christiania Fjord, which was marked under the left fin with a straight line and a Latin A. Probably the line was meant for an I, making the marking I A.

Mr. John Wheldon, of Great Queen Street, has sent us Part I. of his Catalogue of Botanical Works. It extends to 84 pages and contains 1306 entries.

In a paper read before the last meeting of the French Academy of Medicine M. Lagneau described his researches into the anæsthetics employed in Europe by physicians in the Middle Ages. That such were known is beyond any doubt. Abelard, speaking of the creation of Eve from a rib of Adam, speaks of the deep sleep which fell upon the latter as similar to that which physicians produce in patients upon whom they wish to operate. Pliny speaks of a stone of Memphis which, when crushed and treated with vinegar, renders any part to which it is applied insensible to pain; and many old authors speak of surgeons producing sleep in their patients before an operation by mixing with their food a decoction of the leaves or root of the mandragora, or some grains of the plant called "morion." Preparations of these two plants, as well as of other narcotics, were employed by surgeons down to the thirteenth and fourteenth centuries, but much less in subsequent times. Opium was also used for a similar purpose, while in the East the anæsthetic properties of hemp have been known from the earliest times. These were all taken into the stomach; but anæsthesia by inhalation was also known. Two different preparations were discovered in the thirteenth century: one by a Dominican of Rome, the other by a surgeon named Theodoric, who was also a preaching friar, and subsequently a bishop. Both of these were prepared from opium, henbane, mandragora, hemlock, and many other plants, and were inhaled from a sponge. It is, however, difficult to believe that preparations so little volatile could produce anæsthesia by simple inhalation. M. Perrin, who has studied ancient anæsthetics, has given the composition of a liquid which contains all the ingredients required for chloroform, and it is said that this was applied to witnesses or prisoners who were about to be tortured in the judicial tribunals of the Middle Ages. After inhaling it the unfortunate subject was plunged into a semi-comatose state, which diminished in a certain degree the pain of the torture. This liquid was always kept in a place adjoining the torture-chamber.

The additions to the Zoological Society's Gardens during the past week include a Leadbeater's Cockatoo (*Cacatua leadbeateri*) from Australia, presented by Mr. H. Grant; two Great Eagle Owls (*Bubo maximus*), European, presented by Mr. E. G. Carpenter; a Common Peafowl (*Pavo cristatus*) from India, presented by Miss Rowland; an Indian Shama (*Copsychus macrurus*) from India, deposited; an Axis Deer (*Cervus axis*), two Squirrel-like Phalangers (*Belideus sciureus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

Tuttle's Comet.—In No. 2674 of the *Astronomische Nachrichten*, published during the last week, are elements and an ephemeris of this comet, by Herr Johannes Rahts of Königsberg. The orbit has been deduced from the observations of 1858 and 1871–2, with perturbations by Mercury, Venus, the Earth, Mars, Jupiter, Saturn, and Uranus to July 11, 1885. Under such conditions it may be anticipated that Herr Rahts' ephemeris will closely represent the track of the comet. His elements are as follows:—

Perihelion passage, 1885, September 11·14265 G.M.T.

Longitude of perihelion	° ′ ″ 116 28 58·8	M. Eq. 1890·0
,, ascending node	269 42 1·5	
Inclination	54 19 45·5	
Angle of eccentricity	55 14 22·6	
Mean daily motion	257″·8648	
Log. semi-axis major	0·7590765	

Motion—direct.

Hence we have—

Eccentricity	0·8215436	Semi-axis major	5·7422
Perihelion distance	1·02475	,, minor	3·2739
Aphelion distance	10·4596	Semi-parameter	1·8666

Period of revolution, 13·76 years.

Tuttle's comet was first seen by Méchain at Paris on January 9, 1790, and was observed there till February 1. Parabolic elements calculated by Méchain did not lead to any suspicion of ellipticity of orbit. On January 4, 1858, Mr. Tuttle, of Cambridge, U.S., discovered a comet, which was independently detected by the late Prof. Bruhns a week afterwards, and its orbit was found to present so close a resemblance to that of the second comet of 1790 as to immediately lead to the comets being considered identical, the identity being established by Bruhns, who found that five revolutions had been completed between 1790 and 1858. The dates of perihelion passage in this interval were thus determined by Clausen after taking into account the perturbations produced by the planet Jupiter—

	G.M.T.		G.M.T.
1790, January	30·87	1830, December	6·64
1803, November	7·27	1844, June	28·96
1817, May	18·76	1858, February	23·52

The comet was not recognised at any one of the four intermediate returns.

From Herr Rahts's ephemeris we have the following positions during the absence of moonlight in August:—

At Greenwich Midnight

1885	R.A. h. m. s.	Decl. ° ′	Log. Dist. from earth	Intensity of light
August 6	7 13 27	+29 48·1	0·2853	0·39
7	7 16 51	29 12·7		
8	7 20 14	28 36·6	0·2816	
9	7 23 36	27 59·9		
10	7 26 56	27 22·7	0·2780	0·42
11	7 30 16	26 44·7		
12	7 33 35	26 6·3	0·2744	
13	7 36 54	25 27·3		
14	7 40 12	24 47·7	0·2708	0·46
15	7 43 28	24 7·4		
16	7 46 43	23 26·6	0·2674	
17	7 49 59	22 45·3		
18	7 53 13	22 3·5	0·2640	0·[illegible]
19	7 56 27	21 21·1		
20	7 59 40	20 38·0	0·2607	
21	8 2 53	19 54·5		
22	8 6 5	19 10·5	0·2575	0·[illegible]
23	8 9 16	18 25·9		
24	8 12 27	+17 40·8	0·2544	

The intensity of light when the comet was first observed at Marseilles at its last appearance, October 12, 1871, is taken as unity. On September 10 it will be 0·55, the comet rising two hours before the sum. It must always be faint at its present return, so much so probably as to render observation difficult.

The New Comet (Barnard, July 7).—From observations on July 9, 12, and 15 the following elements result:—

Perihelion passage, 1885, September, 20·6740 G.M.T.

Longitude of perihelion	° ′ 290 10·5
,, ascending node	93 27·1
Inclination	76 6·1
Log. perihelion distance	0·36549

Motion—direct

An orbit calculated by Dr. Holetschek, of Vienna, much resembles the above.

It would appear that the perihelion distance of this comet may prove to be greater than in the case of any other comet hitherto computed, excepting the extraordinary one of 1729, which did not approach the sun within four times the earth's mean distance.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, AUGUST 2–8

(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 August 2

Sun rises, 4h. 27m.; souths, 12h. 5m. 58·2s.; sets, 19h. 45m.; decl. on meridian, 17° 40′ N.: Sidereal Time at Sunset, 16h. 31m.

Moon (at Last Quarter on August 3) rises, 21h. 56m.*; souths, 4h. 29m.; sets, 11h. 13m.; decl. on meridian, 5° 34′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury ...	7 6	13 50	20 34	7 56 N.
Venus ...	6 41	13 42	20 44	11 14 N.
Mars ...	0 59	9 19	17 39	23 50 N.
Jupiter ...	7 5	13 57	20 49	9 21 N.
Saturn ...	1 20	9 30	17 40	22 30 N.

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

Occultation of Star by the Moon

August	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
6 ...	B.A.C. 1526 ...	6 ...	3 32 ...	3 56 ...	129 174

August	h.	
4 ...	21 ...	Mercury in conjunction with and 2° 32′ south of Jupiter.
5 ...	17 ...	Saturn in conjunction with and 0° 4′ south of μ Geminorum.
6 ...	3 ...	Mercury at greatest elongation from the Sun, 27° East.
6 ...	7 ...	Venus in conjunction with and 0° 26′ north of Jupiter.
6 ...	20 ...	Mars in conjunction with and 1° 20′ north of Saturn.
7 ...	8 ...	Mercury at greatest distance from the Sun.
7 ...	14 ...	Saturn in conjunction with and 4° 13′ north of the Moon.
7 ...	15 ...	Mars in conjunction with and 5° 33′ north of the Moon.
8 ...	17 ...	Mercury in conjunction with and 3° 42′ south of Venus.

GEOGRAPHICAL NOTES

LIEUTENANT PALAT, of the French Cavalry, has been despatched by the Ministers of Public Instruction and of Commerce on a mission to the Sahara, his point of departure being Senegal and his terminus Algeria. The advanced posts recently occupied by the French in the Senegal, and the presence of a gunboat on the Niger, are believed to render the present a favourable moment for such an expedition. At Timbuctoo Lieutenant Palat will appear as a French officer, but from this place to Algeria he will travel as a Moslem doctor. His mission, though of geographical interest, appears to be undertaken chiefly with the object of leading the trade of the Sahara to Senegal on one side and to Algeria on the other.

AT the meeting of the Paris Geographical Society on the 3rd inst. M. Lostalot, French Consul at Jeddah, described in detail the circumstances attending the murder of M. Huber; a letter was read from M. Teisserenc de Bort continuing his account of his expedition in the Sahara; M. Jules Girard discussed the changes of level on the coasts of Scandinavia, and M. Demanche read a paper on the half-breeds of Canada, with especial reference to the recent revolt.

THE Spanish Government has appointed a geological commission, of which Señor Abella y Casariego is the president, to investigate the Philippines. The commission will not confine itself to geology, but will also study the geography and topography of the archipelago; and it is instructed to prepare a map which will complete and correct existing ones.

THE last *Bulletin* of the Royal Geographical Society of Antwerp (June IX. 6th fascicule) contains a report of the proceedings at the reception of Mr. Revoil on his return from the Somali country, and an interesting reprint of the diary of a journey from Antwerp to Vienna and back in 1724, made by representatives of a commercial corporation at Ostend to obtain certain alterations in the letters patent granted by the Emperor Charles VI.

A CORRESPONDENT writes:—In your note on Mr. Grenfell's recent explorations in the Congo Basin you state that the northern bend of the Congo is found by him to be in 2° 11′ N. This had already been found by Stanley; *vide* the map in his recently-published book. You also note that the Mbangi River has been traced by him to a point in 4° 30′ N. lat., lying north-by-east (magnetic?) of its mouth in 0° 26′ to 0° 42′ S. lat. At this ultimate point its breadth is stated to be 673 yards. Now the breadth of the River Thames at Gravesend is considerably greater, and its source in a direct line from Gravesend westward is about 105 miles, the drainage area being, in round figures, 5000 square miles. Arguing from this we should conclude that the source of the Mbangi does not lie east of 20° E. long., and, applying the measurements to Stanley's map, the water-parting falls just on the line thereon suggested. The distance in a direct line from the ultimate point reached by Mr. Grenfell to the last known point on the Welle is 540 miles, and to the source of the Welle some 900 miles. Judging, then, from this preliminary note, it appears to be practically impossible for this river, of less than the third of a mile in breadth, to carry off the water of the Welle Basin; and Mr. Stanley's suggestion that the Biyere (wrongly called the Aruwimi) is the outlet of the Welle is rather strengthened than otherwise by this latest, and certainly not least important, contribution to our knowledge of the mighty Congo.

A SOMEWHAT amusing quarrel has arisen between the parishes of Kjelvik and Maasö about a point of considerable geographical interest—viz. the proprietorship of the North Cape. It is caused by the establishment on the celebrated promontory of a *restaurant*, the taxes of which are claimed by both parishes. The Cape has always been considered to form the boundary between the two, without it being stipulated to whom it actually belonged.

The Deutsche Seewarte has issued a chart of the ice in the Atlantic Ocean this spring, which, as it may be remembered, penetrated very far south and east in consequence of continuous northerly and north-westerly winds. Several icebergs appear even to have been found in the Gulf Stream. It seems from experience that, first towards the end of June the ice recedes northwards, while between the banks and the east coast of Newfoundland it remains longest, even after it has disappeared south and south-east of the banks.

FROM recent observations it would appear that during the last thirty years or so the elevation of the shores around the Baltic and the Gulf of Bothnia has gone on with greater rapidity than during the previous period of observation. The shore-marks by which the fact of the elevation has been ascertained were made about the year 1750, at the time of the dispute between Celsius, the celebrated Swedish astronomer, and a German man of science as to whether the level of the Baltic was rising or sinking, Celsius maintaining the latter view. Since the shore-marks were made it has been shown that a movement of elevation of the land has been going on around the island of Bornholm, the level of which remains constant. The rate of emergence is most rapid in the north. In the neighbourhood of the frontier of Finland it amounts to two metres, while in the south it is only a foot. The increased rate of emergence in recent times is clearly shown on the rock known as Stora Reppen, not far from Piteå. That rock in 1851 had emerged 94 cm. above its former level since the commencement of the observations, while in August, 1884, it had risen 50 cm. further.

THE Geographical Society of Australasia has, it is stated, completed arrangements for the exploration of New Guinea, and a fully-equipped expedition has started under the leadership of Capt. Everill.

THE HIGHER MATHEMATICS

PROF. G. MITTAG-LEFFLER, principal editor of the *Acta Mathematica*, forwards us the following communication, which will shortly appear in that journal:—

His Majesty Oscar II., wishing to give a fresh proof of his interest in the advancement of mathematical science, an interest already manifested by his graciously encouraging the publication of the journal *Acta Mathematica*, which is placed under his august protection, has resolved to award a prize, on January 21, 1889, the sixtieth anniversary of his birthday, to an important discovery in the field of higher mathematical analysis. This prize will consist of a gold medal of the eighteenth size bearing his Majesty's image and having a value of a thousand francs, together with a sum of two thousand five hundred crowns (1 crown = about 1 franc 40 centimes).

His Majesty has been pleased to entrust the task of carrying out his intentions to a commission of three members, Mr. Carl Weierstrass in Berlin, Mr. Charles Hermite in Paris, and the chief editor of this journal, Mr. Gösta Mittag-Leffler in Stock-

holm. The commissioners having presented a report of their work to his Majesty, he has graciously signified his approval of the following final propositions of theirs.

Having taken into consideration the questions which from different points of view equally engage the attention of analysts, and the solution of which would be of the greatest interest for the progress of science, the commission respectfully proposes to his Majesty to award the prize to the best memoir on one of the following subjects:—

1. A system being given of a number whatever of particles attracting one another mutually according to Newton's law, it is proposed, on the assumption that there never takes place an impact of two particles, to expand the coordinates of each particle in a series proceeding according to some known functions of time and converging uniformly for any space of time.

It seems that this problem, the solution of which will considerably enlarge our knowledge with regard to the system of the universe, might be solved by means of the analytical resources at our present disposition; this may at least be fairly supposed, because shortly before his death Lejeune-Dirichlet communicated to a friend of his, a mathematician, that he had discovered a method of integrating the differential equations of mechanics, and that he had succeeded, by applying this method, to demonstrate the stability of our planetary system in an absolutely strict manner. Unfortunately we know nothing about this method except that the starting-point for its discovery seems to have been the theory of infinitely small oscillations.[1] It may, however, be supposed almost with certainty that this method was not based on long and complicated calculations, but on the development of a simple fundamental idea, which one may reasonably hope to find again by means of earnest and persevering study.

However, in case no one should succeed in solving the proposed problem within the period of the competition, the prize might be awarded to a work in which some other problem of mechanics is treated in the indicated manner and completely solved.

(2) Mr. Fuchs has demonstrated in several of his memoirs[2] that there exist uniform functions of two variables which, by their mode of generation, are connected with the ultra-elliptical functions, but are more general than these, and which would probably acquire great importance for analysis, if their theory were further developed.

It is proposed to obtain in an explicit form those functions whose existence has been proved by Mr. Fuchs, in a sufficiently general case, so as to allow of an insight into and study of their most essential properties.

(3) A study of the functions defined by a sufficiently general differential equation of the first order, the first member of which is a rational integral function with respect to the variable, the function, and its first differential coefficient.

Mr. Briot and Mr. Bouquet have opened the way for such a study by their memoir on this subject (*Journal* de l'École polytechnique, cahier 36, pp. 133-198). But mathematicians acquainted with the results attained by these authors know also that their work has not by any means exhausted the difficult and important subject which they have first treated. It seems probable that, if fresh inquiries were to be undertaken in the same direction, they might lead to theorems of high interest for analysis.

(4) It is well known how much light has been thrown on the general theory of algebraic equations by the study of the special functions to which the division of the circle into equal parts and the division of the argument of the elliptic functions by a whole number lead up. That remarkable transcendant which is obtained by expressing the module of an elliptic function by the quotient of the periods leads likewise to the modulary equations, that have been the origin of entirely new notions and highly important results, as the solution of equations of the fifth degree.

[1] See p. 35 of the Panegyric on Lejeune-Dirichlet by Kummer, "Abhandlungen der K. Akademie der Wissenschaften zu Berlin," 1860.

[2] These memoirs are to be found in—(1) "Nachrichten von der K. Gesellschaft der Wissenschaften zu Göttingen," February, 1880, p. 170; (2) Borchardt's "Journal," Bd. 89, p. 251 (a translation of this memoir is to be found in the "Bulletin" of Mr. Darboux, 2me. série, t. iv.); (3) "Nachrichten von der K. Gesellschaft der Wissenschaften zu Göttingen," June, 1880, p. 445 (translated into French in the "Bulletin" of Mr. Darboux. 2me série, t. iv.); (4) Borchardt's "Journal," Bd. 90, p. 71 (also in the "Bulletin" of Mr. Darboux, 2me série, t. iv.); (5) "Abhandlungen der K. Gesellschaft der Wissenschaften zu Gottingen," 1881 ("Bulletin" of Mr. Darboux, t. v.); (6) "Sitzungsberichte der K. Akademie der Wissenschaften zu Berlin," 1883, i. p. 507; (7) The memoir of M. Fuchs published in Borchardt's "Journal," Bd. 76, p. 177, has also some bearings on the memoirs quoted.

But this transcendant is but the first term, a particular case and that the simplest one of an infinite series of new functions introduced into science by Mr. Poincaré under the name of "fonctions fuchsiennes," and *successfully* applied by him to the integration of lineary differential equations of any order. These functions, which accordingly have a *rôle* of manifest importance in analysis, have not as yet been considered from an algebraical point of view as the transcendant of the theory of elliptic functions of which they are the generalisation.

It is proposed to fill up this gap and to arrive at new equations analogous to the modulary equations by studying, though it were only in a particular case, the formation and properties of the algebraic relations that connect two "fonctions fuchsiennes" when they have a group in common.

In case none of the memoirs tendered for competition on any of the subjects proposed above should be deemed worthy of the prize, this may be adjudged to a memoir sent in for competition that contains a complete solution of an important question of the theory of functions other than those proposed by the Commission.

The memoirs offered for competition should be furnished with an epigraph and, besides, with the author's name and place of residence in a sealed cover, and directed to the chief editor of the *Acta Mathematica* before June 1, 1888.

The memoir to which his Majesty shall be pleased to award the prize as well as that or those memoirs which may be considered by the Commission worthy of an honorary mention, will be inserted in the *Acta Mathematica*, nor can any of them be previously published.

The memoirs may be written in any language that the author chooses, but as the members of the Commission belong to three different nations the author ought to subjoin a French translation to his original memoir, in case it is not written in French. If such a translation is not subjoined the author must allow the Commission to have one made for their own use.

THE EDITORS OF THE "ACTA MATHEMATICA"

DR. PERKIN ON THE COAL-TAR COLOURS[1]

TAKING a precedent from some of those who have occupied this chair before me, I have selected for my few remarks to-day the subject in relation to Technical Chemistry, with which I have been personally connected—namely, the colouring matters produced from coal-tar products, with some of the lessons its development appears to me to teach is in connection with industrial chemistry. Sir Frederick Abel, in his address in 1883, when speaking of the history of gunpowder, said that "It is one of the most remarkable features connected with the history of gunpowder, that until the last quarter of a century no radical changes should have been introduced into the manufacture and modes of applying this, the first known practically useful explosive agent." It appears to me that this is more or less true of all the older industries, which resulted simply from experiment and observation without any other basis to work from. They have had long histories in which little progress has been made, but of late years, owing to our advanced and rapidly increasing scientific knowledge, they are undergoing great, and in many cases radical, changes.

The coal-tar colour industry stands in a very different position to our older ones. It has a sharply-defined origin, and a very short history dating back only to 1856, and it is not yet twenty-nine years since the date of the first patent. It is an industry which has been founded on scientific discovery, and has developed side by side with it, being in fact a most important handmaid to research, which in its turn has repaid it by new discoveries. At the date of its introduction very little was known of the chemistry of colouring matters; they were always found difficult bodies to investigate, and when produced in reaction were generally regarded as secondary products, and every endeavour was made to get rid of them so that the other products associated with them might be examined; but now, owing to the very extended study which has been made of these bodies, on account of this industry, and the relationships which have been found to exist between the colour of the compounds and the chemical constitution, it is possible with more or less certainty to predict the colour a compound will have before it is produced, and the means which can be used to modify it.

[1] The President's address, Institute of Chemistry.

It will be impossible for me to give you but a very brief sketch of the history of this industry in the time at my disposal; anything like a complete account would fill volumes. On account of this I shall not be able to refer except casually to the coal-tar industry itself, the development of which is nearly entirely due to the one under consideration. Nor can I give a consecutive account of the coal-tar colours themselves, because the discovery of new series of colouring matters, and the progress of old ones, necessarily produce overlapping as it were, and renders such a course difficult and confusing. I therefore propose to take them according to the groups we now know them to belong to. I will therefore commence with that which contains the first colouring matter connected with this industry—mauvein and safranine group of compounds.

As I already mentioned, the coal-tar colour industry dates from 1856, the discovery of the aniline purple or mauve dye being made during the Easter vacation of that year, and the patent for its production taken out on the 26th of the following August. From the accounts I have already given elsewhere, I have mentioned how the discovery of this colouring matter was made during the prosecution of scientific research, which had for its object the artificial production of quinine, a subject which of late has very much occupied the attention of chemists, though it has not as yet been accomplished.

When commencing this industry, which was looked upon by many with considerable doubt as to its practicability, the difficulties encountered were very numerous on account of its unique character, but few of the processes having their representatives in other industries, the products were also very valuable, so that great care had to be employed with them. The success of the product tinctorially had not been proved on the large scale, so that it was necessary to proceed tentatively and not launch out too rapidly.

Aniline, as is well known, was at this period a rare body, originally obtained from indigo by Unverdorben in 1826, but for its production from benzene we are first indebted to the discovery of nitrobenzenein 1834 by Mitcherlich, and then to Zineri, who found that this substance when submitted to certain reducing agents produced a base which was eventually identified as aniline. It was not long before the date of this industry that a method of producing this base from nitrobenzene, with greater ease than by the process of Zinin, was discovered; and it is to Beauchaump we are indebted for this, who found that the reduction might be easily accomplished by means of iron filings and acetic acid. Had this discovery not been made, aniline could not have been produced sufficiently cheap to be used for the production of colouring matters. And it is interesting to note that this process of Beauchaump, slightly modified, is the one used to-day for the production not only of this base, but its homologues and analogous compounds.

It was not long before the difficulties of producing nitrobenzene were to a great extent overcome. Messrs. Simpson, Maule & Nicholson also began to experiment on the production of nitrobenzene, and after a time were able to produce it at a sufficiently low cost to be able to supply us with part of our requirements. I mention this in passing because it was the starting point of the history of the connection of this firm with artificial production of colouring matter, which they carried on so successfully afterwards.

After the mauve was discovered it was necessary to teach dyers how to use it. Being an organic base, it is opposite in properties to the vegetable colouring matter, and therefore the ordinary methods of application were not generally useful, and much time had to be spent in dyehouses and printworks in the early days of this product in reference to this subject, and at that time the question of fastness to light soap and bleaching liquor was much insisted on. Fortunately for the future of the coal-tar colour industry, although the mauve would not resist bleaching liquor well, it proved to be a very fast colour—the fastest purple yet produced, I believe—and thus its introduction became rapid. After this the love of brilliancy of colour which it had induced caused less attention to be given to the subject of fastness. I quite think that had this, the first coal-tar colouring matter, yielded colours as fugitive as some which have since been used, this industry would probably have been, to say the least, much delayed in its progress; so that it will be seen the mauve had to bear all the burdens of the difficulties incident on the inauguration of this industry, the future products being free from these impediments. The importance of this colouring matter after its success was established was quickly recognised in France, and its manufacture commenced there. This soon resulted in its importation into this country irrespective of patent rights. As, however, the foreign manufacturer employed responsible agents in this country, the law was without difficulty put into operation successfully—unfortunately, however, only to teach Continental manufacturers the lesson not to employ responsible agents in this country any longer, but, by means of correspondence or travellers, to deal directly with the consumers, and this *modus operandi* (practically, though perhaps not theoretically) enabled them to ignore the existence of patents, and import their products freely into this country. On this point I shall have to speak again further on. The mauve was first employed in silk dyeing in London, Mr. Thomas Keith & Sons, of Bethnal Green, being the first to use it. The second application was calico printing, Messrs. James Black & Co., of Glasgow, being the first to employ it largely for this purpose. It afterwards was extended to other trades.

With reference to the chemical history of this dye, although it had been submitted to analysis very soon after its discovery, its formula, or rather the formula of its principal constituent "mauvein," was not established until some time after it had become a commercial product, and was prepared in a crystalline condition. It was then shown to have the composition $C_{27}H_{24}N_4$ (*Proc. R. S.* xiii. 170).

It was found to be a very powerful base, decomposing ammonia salts with evolution of ammonia, and combining with carbonic acid to form a carbonate. Its ordinary salts are produced by its combination with one molecule of a mono-basic acid, its hydrochloride being $C_{27}H_{24}N_4HCl$.

In concentrated sulphuric acid it dissolves with a dirty green colour, changing to blue on slight dilution, and back to purple when thoroughly diluted; this is a distinctive reaction of this class of substance. Further researches have shown (*J. Chem. Soc.* xxxv. 717-732) that in the ordinary colouring matter there are two other compounds, one which is remarkable for its solubility, and from analysis appears to have the composition $C_{24}H_{20}N_4$; and the third, which has not been fully examined, possesses a redder shade of purple than the other.

The first product, or mauvein, is evidently a derivative of paratoluidine and aniline. The third of orthotoluidine and aniline, and the second of pure aniline. This has been called pseudo-mauvein. It might perhaps be better called phenol-mauvein.

When boiled with aniline mauvein yields an indigo-blue product, difficultly soluble in alcohol. This change takes place without formation of ammonia, and shows how different mauvein is in its character to rosaniline.

Runge found that aniline, when treated with dilute chloride of lime, yielded a blue- or violet- coloured solution, which soon underwent change. Some experiments on this, made in 1868 (*J. Chem. Soc.* xxii. 25-27), showed that the product which I termed "Runge's blue," was a peculiar compound, the salt of an organic base, which itself dissolved in alcohol with a reddish brown colour, the salts being blue. It is quite different from mauvein, and of no practical value; but what is interesting is that when exposed to heat, as by boiling a solution of one of its salts, it decomposes with formation of mauvein.

A beautiful colouring matter was obtained from mauvein by treating it with ethylic iodide. It gives shades of colour of a very red purple tint, and it was therefore called dahlia. It was mostly used in calico and delaine and other kinds of printing, but being costly, the production was never very large. This substance is a mono-ethylic derivative of mauvein, and all attempts to further ethylate this compound have proved fruitless. In properties it appears to be more like an ammonium compound than a replacement product.

Safranines.—In the preparation of mauvein, a colouring matter was obtained from the liquors, from which it was precipitated, producing beautiful crimson-red shades of colour on silk. The amount produced in this way was so small, however, that we are even not able to introduce it as a dye. But it was found that it could be produced by the oxidation of the mauve dye itself, and was then manufactured under the name of "aniline pink," but afterwards "safranine." This substance is evidently closely related to mauvein, as it gives the characteristic reaction with sulphuric acid I have already referred to.

The preparation of this from the mauve dye was, however, too costly to allow of its being brought into general use. However, new processes have been since discovered, by which this or other colouring matters of its class can be produced cheaply.

The first of these processes consisted in passing nitrous acid into commercial aniline, and then heating the mixture with arsenic acid, and then extracting the colouring matter produced. Hofmann examined this, and showed that it had the formula $C_{21}H_{20}N_4$ (*Ber.* vi. 526, 1872).

The examination of the product which was obtained by oxidising the mauve dye, I found to have the composition, $C_{20}H_{18}N_4$ (*J. Chem. Soc.* xxxv. 731), results which correspond with analyses published by Dale and Schorlemmer (*J. Chem. Soc.* xxxv. 682), obtained from the examination of a similar product. This substance, I found, was associated with that examined by Hofmann in a product prepared by Messrs. Guinon & Co., of Lyons.

Methods of a more synthetical nature have since then been discovered. O. Witt found that safranine could be obtained from orthoazotoluene and hydrochloride of toluene at 150-200° (*Ber.* x., 874, 1877). He then found that by oxidising a mixture of one part of paraphenylenediamine, and two parts of aniline, on the application of heat a safranine could be obtained which has the formula, $C_{18}H_{16}N_4$, and which is called phenosafranine.

The formation of this colouring matter by this and other processes has been studied by Nietzki (*Ber.* xvi. 464). He finds that the aniline in the reaction, in which paraphenylenediamine takes part, may be substituted by other primary monamines, or a mixture of these with dimethylaniline, and thus a large number of these dyes can be obtained.

Phenosafranine is now produced very largely, and in a pure crystallised condition, and is a very useful dyeing agent.

If we assume that all the safranines are strictly homologous compounds, the formula that Nietzki gives for phenosafranine would make the formula of that examined by Hofmann, and that examined by myself and Dale and Schorlemmer, to be incorrect, and that they should contain two hydrogens more than are assigned to them. This I cannot think is possible from all the analytical results we obtained.

The constitution of mauvein has not yet been established, and I have still experiments on this subject in hand. This may also be said of safranine, I think, although Nietzki has proposed a formula for it, in which nitrogen occupies a similar position to the metharacarbon in the rosaniline series.

Triphenylmethane Derivatives.—We must now go back again to the early days of this industry to consider the next class of compounds—viz., triphenylmethane derivatives.

The industrial success of the mauve dye caused aniline to become a very favourite body to experiment with, and the result was that in 1859, the discovery of that important colouring matter first known as fuchsine or magenta took place. Hofmann had observed in his experiments on the action of carbon tetrachloride on aniline in 1858, the formation of a red colouring matter, which consisted of this substance as a secondary product of the reaction, but it was M. Verquin who first discovered a process for the transformation of aniline into a red colouring matter of tinctorial value. This discovery of the compound marks a most important fresh departure in the history of coal-tar colours. As I mentioned, the mauve had paved the way for future colouring matters, and this new substance, which could be applied to fabrics by the same methods as the mauve, was most eagerly sought after owing to the brilliancy of its colour; and probably its manufacture was one of the most successful financially of all the aniline colours.

M. Verquin's process, which consisted in treating tin tetrachloride with commercial aniline, was soon superseded by better processes. The number of patents taken out for the production of this dye was very large, and all imaginable products were claimed as capable of producing it from aniline. The two most important, however, were those in which mercury nitrate and arsenic acid were used. The first of these processes, with which I had some experience, required much care to regulate the reaction and prevent deflagration. The next process with arsenic acid, known as medlocks, was by far the best, and was used very extensively until the last few years, the use of nitrobenzene as the oxidising agent being now mostly used in the place of arsenic aicd.

The manufacture of magenta, which at this period was often called roseine, was carried on chiefly in this country by Messrs. Sampson, Maule, & Nicholson, by the arsenic acid process. Mr. E. C. Nicholson and Dr. A. P. Price, of this firm, worked out the process with great success, and were the first to produce this colouring matter in a pure state. The beautiful display of the crystallised acetate, shown at the Exhibition of 1862, illustrated this fully.

It was with products supplied by Mr. Nicholson that Dr. Hofmann made his first researches on this colouring matter. He changed its name from roseine to *rosaniline*, and found that the base, when in combination with acids, had the formula $C_{20}H_{19}N_3$.

The important observation of Nicholson, and the critical experiments of Hofmann, on the necessity of using, not pure aniline, but a mixture of aniline and toluidine for the production of this substance, was made about this period.[1]

The next important step in this industry was the use of rosaniline itself as a source of new colouring matters. For this we are indebted to the experiments of two French chemists—viz., MM. Gerard and Delaire, who discovered that rosaniline salts, when heated with aniline, gave violet and blue colouring matters, which they called Violet Imperial and Bleu de Lyon. It is, however, to Mr. Nicholson that the credit of producing these bodies, in a practically pure state, belongs. This especially refers to the blue, the product known as opal blue, used by Dr. Hofmann in his investigations on the subject, being of great purity. Dr. Hofmann showed that these products were phenylated rosanilines, as is now well known, ammonia being given off in the reaction. And I may mention in passing that the manufacture of these blues is now carried on to such a large extent that the ammonia produced in this reaction is collected for the production of its sulphate or other salt.

One of the difficulties in the way of the new blue was its insolubility in water. Mr. Nicholson, however (in 1862), probably thinking of the method used to render indigo soluble, experimented upon the action of sulphuric acid in this compound, and he found that it was possible to obtain sulphonic acids from it. One of these, the sodium salt of which is known as "Nicholson's" or "alkali blue," is the monosulphonic acid, which is itself insoluble in water, but forms soluble salts, which can be applied to the goods, and then decomposed by acids. This compound has had much to do with the successful introduction of this colouring matter. The other product known as soluble blue is the sodium salt of trisulpho acid.

In the early part of 1864 the Hofmann violets were introduced. These, as is well known, are the ethylated rosanilines produced by acting upon rosaniline with ethyliodide. These colouring matters are more brilliant, though much more fugitive than mauvein; but by this time the desire for permanency was giving way very much to that of brilliancy; and these colouring matters were quickly taken up by dyers and calico printers.

About this time some colouring matters derived from phenol were introduced, and which, curiously, are found to belong to the class of substances now under consideration. These were brought forward by Messrs. Guinon, Marnas, and Bonnet, of Lyons. The first product was aurine, prepared from phenol by means of oxalic and sulphuric acid (Kolbe and Schavtt's process). The next was polvuine, obtained by acting upon aurine with ammonia. The third was azuline, prepared by heating aurine with aniline. This last was a blue dye, which has since been shown to consist chiefly of triphenylrosaniline.

Purple and violet derivatives were also obtained from rosaniline by a process of my own, in which brominated turpentine was employed. These were known as Britannia violets, and were much used.

Other coloured derivatives were also discovered; for example, by the action of aldehyde and sulphuric acid, a blue product was obtained, which, when treated with sodium hyposulphite or sulphuretted hydrogen water, yielded the well-known aldehyde green.

On examining the action of acetylchloride on Britannia violet, I obtained a peculiar green, which was used principally by calico printers, and very considerable quantities of acetylchloride were prepared for this purpose. The process was not published. This green was of a blue shade, and was obtained in a crystallised condition in combination with picric acid. The crystals had a golden metallic reflection.

Soon after this it was noticed that a green compound was produced in the preparation of the Hofmann violets, though generally only in small quantities. It was afterwards found that by making rosaniline react with an excess of methylic iodide that it could be produced practically. It was called iodine green; but the product now manufactured is a chloride. This colouring matter gave good candle-light greens. One of

[1] In my original patent it was shown that colouring matters could be obtained, not only from aniline, but also from toluidine xylidine and cumidine.

its peculiarities is that when heated it is converted into violet methyl-rosaniline, with loss of methyl-chloride.

A new method of producing rosaniline violet was proposed by Lauth, and patented by MM. Porrier and Chappat, in June, 1866. The process consisted in taking aniline, in which hydrogen had been replaced by an alcohol radical, and oxidising this instead of first preparing rosaniline, and then replacing the hydrogen in the colouring matter by the radical. The product proposed for this purpose was methyl-aniline.

Owing to the improved method of methylating aniline, which, I believe, was first proposed by Messrs. Gerard and Delaire (*Bull. Chem. Soc.* [2] vii. 360), this process has become a very important one, and large quantities of dimethyl-aniline are now used, the oxidation being effected by copper salts. The product, according to the reseaches of Otto Fischer, consists chiefly of pentamethylpararosaniline.

The most important advance in the production of green colouring matters of the triphenyl-methane series was the discovery of the benzaldehyde, Victoria or malachite green.

In 1877, Otto Fischer, whilst investigating the condensation products of tertiary aromatic bases (*Ber.* x$_2$, 1625), obtained by the action of benzaldehyde on dimethyl-aniline in presence of chloride of zinc, a colourless base of the formula $C_{23}H_{26}N_2$, the salts of which, when exposed to the air, rapidly oxidised to a fair blue-green dyestuff, which, he thought, would prove to be of complicated constitution. A little later (*Ber.* xi$_1$, 950) he showed that by oxidising this colourless base with some of the ordinary oxidising agents, this green could be more easily produced, and that it stood to the colourless compound in the same way as rosaniline does to leucaniline. Emil and Otto Fischer afterwards say (*Ber.* xii. 796) that the first experiments for the production of this green were made by the Badische Aniline und Soda Fabrik, in March, 1878. About this time Oscar Doebner (*Ber.* xi. 950) found that a green colouring matter was produced by heating benzaldehyde with benzyl trichloride and zinc chloride. This product has been found to be identical with that of Fischer's. This green colouring matter is now largely made from benzaldehyde, as this process is found to be the best. A similar compound is also prepared from diethyl-aniline, and is known as brilliant green. It is a beautifully crystalline body. It is rather curious that this produces shades of colour somewhat yellower than the green from dimethyl-aniline, whereas, being of a higher molecular weight, we should have expected it to be blue.

The principal difficulty which had to be contended with in the production of these colouring matters was the need of a supply of benzaldehyde The usual method of obtaining it from bitter almonds, which was the only one in use, was quite out of the question, so that other sources had to be looked for. The Badisches Aniline und Soda Fabrik, however, successfully overcame this difficulty. At first they experimented with the process of Lauth and Grimaux, which consists in the oxidation of benzyl-chloride, with an aqueous solution of lead nitrate; but the product made by this process was too dear. But they found that the decomposition of benzylidene-dichloride, by means of water, as observed by Cahours (*Ann. Chem. Suppl.* 2306) and Limprecht (*Ann. Chem.* 139, 316) gave them a means of producing this compound successfully, the reaction being as follows :—

$$C_6H_5CHCl_2 + OH_2 = C_6H_5.CHO + 2HCl.$$

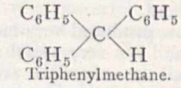
This process, which they have successfully employed since March, 1878, consists in the preparation of benzylidenedichloride from pure toluene, and in the subsequent treatment of this chlorinated body with milk of lime, at 100° C.

I have stated that the group of colouring matters under consideration are called triphenylmethane derivatives, and to show how this has been proved to be the case, I must now refer very briefly to some of the theoretical work which has led to this knowledge. The most important of this refers to rosaniline. I have already drawn attention to the work of Hofmann, which gave us the first knowledge of the composition of this colouring matter, and the further information that it contained hydrogen, which could be displaced by phenyl and alcohol radicals; but as to the matter of constitution, I think the experiments of Caro and Wanklyn were the first, as they showed the relation which existed between rosaniline and aurine, or rosolic acid, and, in fact, produced rosolic acid from rosaniline; but it is to the beautiful researches of Emil and Otto Fischer that we are indebted for a clear knowledge of the constitution of this class of colouring matter.

But to clear the ground before proceeding further, I must remind you that ordinary commercial rosaniline, or magenta, prepared from aniline and toluidines, is a mixture of colouring matters. This was first known by Mr. Nicholson, who found that for the production of the finest blues it was necessary to purify the base and separate one of these before phenylating; but it is only of later years that the difference between these bodies has been carefully studied and explained. The base examined by Hofmann contained C_{20}, and is the chief constituent of commercial rosaniline. The other contains C_{19}, and is now called pararosaniline, because it is produced from aniline and paratoluidine. Similarly, in commercial aurine, two compounds are found, one containing C_{20}, now called rosolic acid, and one containing C_{19}, now called aurine; and these latter can be produced from the corresponding rosanilines; and Dale and Schorlemmer have also shown that aurine can be also converted into pararosaniline, by the action of ammonia (*J. Chem. Soc.*, xxxii. 121).

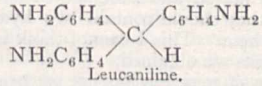
Emil and Otto Fischer, however, by submitting the leuco compound of commercial rosaniline to the diazo reaction, obtained the hydrocarbon $C_{20}H_{18}$, and from rosaniline prepared from paratoluidine and aniline, the hydrocarbon $C_{19}H_{16}$.

And this latter hydrocarbon was found to be identical with Kekule's triphenylmethane—



Triphenylmethane.

On nitrating this hydrocarbon they obtained a trinitro derivative, which, when reduced, gave the tri-amido body,

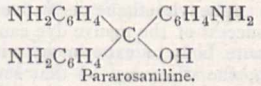


Leucaniline.

which is paraleucaniline, and by carefully heating its hydrochloride to 150–160°, it was converted into pararosaniline.

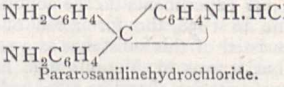
Also they found that by oxidising trinitrotriphenylmethane they obtained trinitrotriphenylcarbinol, and this when reduced gave pararosaniline direct.

From these results the constitution of the base is evidently—



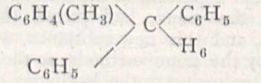
Pararosaniline.

The salts– the hydrochloride, for example—being

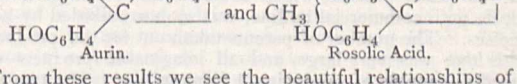


Pararosanilinehydrochloride.

Similar results were obtained from the hydrocarbon from rosaniline; it is tolyldiphenylmethane :—

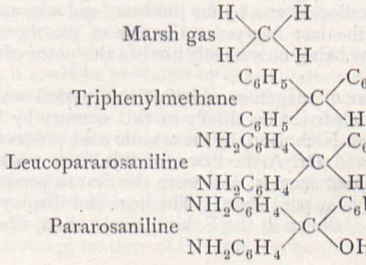


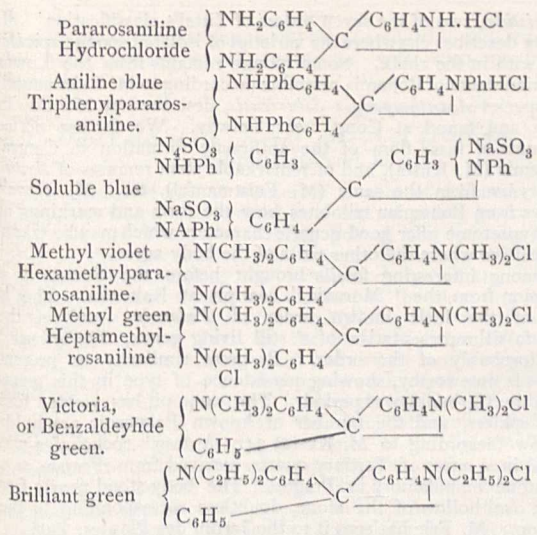
The rosolic acid and aurine corresponding to the rosanilines are constituted in an analogous manner :—



Aurin. Rosolic Acid.

From these results we see the beautiful relationships of the various colouring matters of this series to each other, and by it obtain information which is of practical value, as well as theoretical. From the following formulæ of a few of these products their relationships are seen :—





The effect of replacing hydrogen by hydrocarbon radicals in rosaniline is seen to result in the shade of colour becoming blue for each hydrogen replaced—the effects of those of high molecular weight, such as phenyl, being to produce the bluest shades; thus triphenylrosaniline is blue, whilst hexamethylrosaniline is blue-violet, notwithstanding it contains six hydrogens replaced.

After all the replacements possible have been effected, as in hexamethylrosaniline, the result of the combination of the products with halogen compounds of methyl is very interesting. The particular group to which this is attached becomes of the nature of an ammonium, and the colour changes to green—*i.e.*, methyl green—and this, like other ammonium compounds, when heated, dissociates, with loss of the halogen compound of methyl, and then hexamethylrosaniline is reproduced. Again, if this ammonium group be replaced by phenyl, we also get a green—*i.e.*, Victoria green.

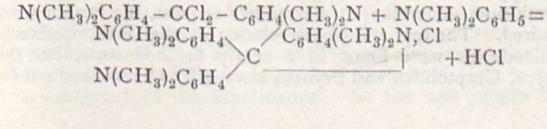
The structure of some of these bodies has been proved by another most beautiful synthetical process, which has lately come into use—a process which enables us now not only to say that we employ the volatile products of the distillation of coal, but also the coke itself; as carbonic oxide, in combination with chlorine, is one of the important agents—*i.e.*, phosgene or carbonoxychloride is used. This product was discovered in 1812 by J. Davey.

In 1876 W. Michler gave an account of his researches on the synthesis of aromatic ketones by means of phosgene (*Ber.* ix. 716), in which he showed by the action of this substance on dimethylaniline that a tetramethylised diamidobenzophenone was contained. This substance has, therefore, the constitution—

$$N(CH_3)_2C_6H_4 - CO - C_6H_4(CH_3)_2N.$$

The formation of this product takes place in two phases, but I need not enter into that now.

The first experiments to turn Michler's synthetically prepared tetramethylated diamidobenzophene to practical account were made by Dr. A. Kern, in the works of Bindschedler, at Basle. Dr. Kern proved that an agent like phosgene might be produced on a larger scale, and he invented a process to convert Michler's ketone base into methyl purple. This process was derived from the ketone synthesis of triphenylmethane from benzhydrol and benzene, and consisted in preparing the tetramethyldiamidobenzhydrol, and condensing the latter with dimethylaniline; thus the leuco base of hexamethylrosaniline was obtained, and then oxidised with lead peroxide. This process, which was too costly for practical purposes, has been superseded by one discovered by Dr. Caro, who has found that this ketone base can be made to form condensation products with dimethylaniline and other products directly, by the use of phosphorus trichloride—this substance converting it first into a chloride, which then reacts on the dimethylaniline, thus—



And this reaction takes place quantitatively, the body being so pure that it readily crystallises from water in prisms, like potassium permanganate, only with very much more brilliant lustre. These contain water of crystallisation. The condensation can also be effected with phosgene gas. The colouring matter obtained by this means is bluer than that obtained from dimethylaniline by oxidation, which consists chiefly of the pentamethyl compound.[1]

Diethylene can also be made into a ketone with phosgene or carbon oxychloride, and this product condensed with diethylaniline yields hexaethylpararosaniline.

Instead of dimethylaniline, dimethyl-α-naphthylamine can be used, and in this case a beautiful blue colouring matter is obtained, and if α-phenylnaphthylamine, the Victoria blue is produced, and by varying the reaction in this kind of way a great variety of colouring matter can be synthetically prepared.

With ammonias this ketone condenses to form the new yellow colouring matter, auramine, with aniline phenylauramine. With quinoline it produces a green very similar to Victoria or benzaldehyde green. I must not, however, spend any more time over this interesting part of the subject, but may say here again we have pure scientific research, conducted for its own sake, bearing fruit. The discovery of W. Michler, which remained for seven years a matter of theoretical interest, now comes forward as a matter of practical value.

(*To be continued.*)

THE DEVONIAN SYSTEM OF RUSSIA

M. P. VENUKOFF has recently given a general sketch of the Devonian rocks of Russia. As is well known, these rocks, so largely developed in Russia, contain such a peculiar fauna that geologists have been puzzled to establish a parallel between them and the different subdivisions of the Devonian system of Western Europe. Two great areas of Devonian strata are known in Russia: that of the north-west and that of the central basin. From Esthonia and Livonia the former extends north-eastwards to Lake Onega and perhaps even to the White Sea, and southwards through Pskor and Vitebsk to Moghiber. In Smolensk only traces of Devonian rocks have been found; but further south-east a great tract of these rocks runs through Tula, Orel, Voronesh, Ryazan, and Tamboff.

Prof. Grewinck, in his "Geologie von Livonia und Kurland" in 1861, and again in 1879, and Prof. Barbot de Marny, in the Russian *Mining Journal* of 1878, attempted to classify the Russian Devonian deposits; not to mention the earlier English work of Murchison, followed by those of Pander, Pacht, Helmersen, and Kutorga, and recently by those of MM. Stuckenberg, Inostrantseff, and Romanovsky. The mixed characters of the fauna have thus always presented great difficulties in the way of satisfactory correlation.

The recent monograph by M. Tschernyskev (*Mem.* Geol. Committee, i., 3) shows how rich a field remains to be explored before our knowledge of the Devonian fauna of Russia in any measure approaches completion.

M. Venukoff, in his *résumé* of the present condition of the problem, gives a brief account of all that is known as to the Russian Devonian system in each separate government, followed with an analysis of the work done by previous geologists. He then presents a detailed exposition of his own observations and conclusions in North-West and Central Russia; giving long lists of fossils which comprise the rich collections recently made by M. Antonowitsch. In the north-western basin three stratigraphical series have long been known: the lower sandstones, the middle limestones and dolomites, and the upper sandstones. The lower member contains only fishes and small *Lingulæ*, though on the Oyat the ichthyolites are accompanied with *Rhynchonella livonica*, *Streptorhynchus crenistria*, *Avicula rostrata*, *Isocardia*, and numerous *Algæ*. The fauna of the limestones is mostly that of deeper water, but even among these strata there occur occasionally—as at Lake Ilmen—beds of sandstone with shallow-water forms (the fishes *Coccosteus*, *Asterolepis*, *Osteolepis*, and the little *Lingula bicarinata*, Kut.). On the whole the middle limestones of Pskov and Novgorod may be sub-divided into four stages or zones characterised, the first, by *Rhynchonella Meyendorfii*, *Rh. livonica*, *Spirifera muralis*, *Atrypa reticularis*, *Orthis striatula*, and *Strophalosia product-*

[1] See Patents, Caro, 4428, September, 1883; 4850, March 13, 1884; and 5038, March 18, 1884.

oides; the second, by the same fossils, but without *Rh. Meyendorfii*, and with two additional species of *Spirifera* (*S. disjuncta* and *S. lenticula*); the third has yielded only these two Spirifers, and *Str. productoides*, while the fourth contains also *Atrypa reticularis* and *Orthis striatula*. Among the Devonian rocks of Central Russia, which consist only of limestones, M. Venukoff tries to establish the following four subdivisions: the Voronesh marls and limestones characterised by the presence of *Spirifera Anosoffi*, together with *Atrypa reticularis*, *Strophalosia productoides*, several Orthoceratites and Corals, the Elets beds, where *Sp. disjuncta*, and a variety of *Sp. Archiaci* replace *Sp. Anosoffi*, the other leading fossils being: *Rhynchonella livonica*, *Athyris concentrica*, *Productus subaculeatus*, *P. membranus*, *Strophalosia productoides*, *Streptorhynchus crenistria* (*umbraculum*), *Pleurotomaria*, *Euomphalus*, &c. The intermediate beds between these two groups are especially rich in corals (*Aulopora serpens*, *Cyathophyllum ceratites*, *Syringopora abdita*, *S. tabulata*, species of *Stromatopora*, &c.). The Elets beds are covered with a series of limestones characterised by the presence of *Arca oreliana*, and these last are followed by the well-known group of Murævuya (in Ryazan) which constitutes a passage between the Devonian and Carboniferous systems. The correlation of the subdivisions of the deposits of the Devonian groups of North-Western with those of Central Russia, and of both with those of Western Europe, is beset with difficulties. Still it appears that the limestones of Elets and Voronesh, as also those of the Duna (especially since M. Antonowitsch's researches), are comparable with the *Stringocephalus* group of the Eifel and Nassau; some resemblance may also be traced between the Elets and Voronesh limestones and the higher parts of the Middle and Lower members of the Upper Devonian system of England. They may likewise represent the "Frasnien" subdivision of the Upper Devonian series of the Boulonnais. Regarding the Lower Devonian Sandstones of Russia, Murchison's correlation of them with the [Lower] Old Red Sandstone of Caithness and Elgin remains unshaken. The break between these sandstones and the Silurian deposits which they cover seems also to be confirmed. As to the Devonian rocks of Poland, it appears from M. Mikhalsky's researches (*Izvestia* of the Geol. Committee, 1883) that the Lower, Middle, and Upper Devonian divisions of Western Europe are found there, the Upper being akin to the *Rhynchonella cuboides* group of the Eifel. Again, on the other side of the country the discovery on the eastern slope of the Ural of a *Clymenia* closely akin to the *C. annulata* and the *C. spinosa* (*Izvestia*, 1884, 4) is a fresh confirmation of the likeness of the Ural Devonian rocks to those of Western Europe. According to M. Tschernyshev the limestones of the western slope of the Middle Ural chain belong to the Lower Devonian, those of the Byelaya River (*Izvestia*, 1885, 3) belonging to its lower subdivisions.

SCIENCE IN BOHEMIA

THE Royal Bohemian Society of Sciences celebrated, on December 6 of last year, the hundredth year of its public existence. Occasion has been taken to issue some special publications, comprising a historical sketch of the Society and a *résumé* of the principal researches, a list of all papers, and another of members, since the commencement. The Society originated in a private one for study of science and history started in 1770 under the presidency of Ignaz von Born, who was not only an able scientist of the time, but an ardent freemason (as were many of his fellows). It is a curious fact, throwing light on the aims of this Society, that its publications were all in German, not in Latin, the usual scientific medium in Bohemia at that time. No one thought of using Bohemian for science. *Now* a considerable portion of papers appear in Bohemian, not always accompanied by a German *résumé*, through which some are rendered more accessible to the average linguist here.

Of the various scientific work recorded in the *Abhandlungen* and *Sitzungsberichte* for 1883–84 we may first notice that on fossil forms. The sponges of the Bohemian chalk formation, as represented in the Prague Museum, are being gone through by M. Pocta. In the new method of studying such remains, special weight is attached to inner structure, the outer form being regarded as of secondary importance; and following this course M. Pocta contributes the first two portions of a careful and finely-illustrated monograph dealing with the *Hexactinellidæ* and *Lithistidæ*, two of the seven orders of Zittel's classification. M. Pocta describes elsewhere the varieties of isolated sponge spicules met with in the chalk. Some sponge remains from the Lower Silurian strata of Bohemia resemble (according to M. Feistmantel) the species *Acanthospongia Siluriensis*, described by MacCoy in 1846, and found at Cong, near Galway. We further notice accounts of fossil flora of the anthracite formation in Central Bohemia (M. Kusta), and of remarkable stem remains of *Araucaroxylon* from the same (M. Feistmantel), &c. M. Novak shows from Bohemian trilobites how the form and markings of the hypostome offer good generic characters which may be taken as decisive where the other parts of the body agree.

Among interesting fossils brought before the Society is a scorpion from the "Moravia" coal-pit at Rakonitz. This is one of the little known order of *Pedopalpi*, and is the first fossil representative of a still living genus, *Thelyphonus*, and probably of the order. Its great similarity to present forms is noteworthy, showing persistence of type in this genus from the Carboniferous period. The same pit has yielded four new spiders, and the number of known Palæozoic arachnida is now (according to M. Kusta) 34. A fossil cockchafer was found in a mass of Tertiary quartz received from France at a millstone manufactory in Prague. The body stood nearly free in an oval hollow of the stone, doubtless corresponding to the cocoon. M. Fric has sent it to the Jardin des Plantes, Paris.

From a chemical examination of the dark colouring matter of ebony, M. Belohoubek concludes that it is to be regarded as coal, and the case is a striking one, as being that of carbonisation of plant material occurring physiologically in a living plant. The author not having sufficient young ebony could not exactly determine the mother-substance. M. Celakovosky finds in certain anamorphoses of the ovulum of *Raphanus sativus*, L., and in abnormal leaves of *Croton*, evidence in support of the foliolar theory of the ovulum. M. Palacky furnishes two instalments of his valuable, though necessarily incomplete and tentative sketch of the geographical distribution of plants. The formation of serial buds is studied by M. Velenovsky. M. Hansgirg extends the knowledge of Bohemian algæ (imperfectly studied hitherto), and there are yearly reports on the additions to Bohemian botany.

The organs of excretion of *Hirudineæ* are to be regarded (according to M. Vijdovsky) as modified "segmental organs" of the *Oligochæta*; as the former worms may be considered as Oligochæta degenerate through parasitism. The same author furnishes an account of the freshwater sponges of Bohemia; he finds five well-characterised species with some varieties belonging to the three sub-genera, *Eusponzilla*, *Ephydatia*, and *Trochospongilla*. Of freshwater Bryozoa M. Kafka finds in Bohemia thirteen species, two of them new. M. Bayer shows how widely apart *Pelobates* and *Bombinator* are in the structure of their skeleton, and offers a new classification of the Anoura.

Considering the nature of steel-hardening from the electrical standpoint, in connection with the corresponding behaviour of some silver alloys, MM. Strouhal and Barus arrive at the result that neither the mechanical nor the chemical hypothesis as to steel hardening suffices alone to explain the phenomena, and, while the proportion of carbon is the principal factor for determining the behaviour of steel, this behaviour must be explained by a combination of chemical and mechanical influences. The authors offer a definition of steel on the basis of the electrical behaviour of iron with increasing proportion of carbon. M. Kolacek makes a contribution to the theory of the Gramme machine. M. Seydler investigates the application of the principle of energy to the pondero-motive and electro-motive actions of the electric current, also the theory of tension of electrostatic phenomena from the standpoint of the theory of elasticity. There are various papers in mathematics, crystallography, &c., which we must not stop to notice. Tables of rainfall at different stations of Bohemia are furnished by M. Stodnicka.

To this brief account, indicating some directions of recent Bohemian science, we will add a word about the great work of Barrande. That eminent geologist, who died on October 5, 1883, left his collections, &c., to the Bohemian Museum; he also left directions and funds for the completion of his "Système Silurien du Centre de la Bohème," of which twenty-two volumes had appeared between 1852 and 1881. Drs. Waagen and Novak now undertake, at Barrande's request, the further work required. The text and plates relating to the Gasteropods and Echinoderms were found in a nearly finished state, but the Polyps, Graptoliths, and Bryozoa have still to be worked out for

the most part. Four volumes will thus be added to this remarkable work, making in all twenty-six, with 2000 plates of illustrations.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

THE Bristol Merchant Venturers' School of Science, Technology, and Commerce, erected at a cost of nearly 50,000*l.*, to replace the old Trade and Mining School, was formally dedicated by the merchants to the city on Saturday, when their handsome gift, including the complete charge of the school, estimated at 1000*l.* a year, was received by the Mayor on behalf of the citizens. After the Trade and Mining School was handed over to the Colston Trust by the Endowed Schools Commissioners, this science school, which had already won a very distinguished position in the country, made such rapid progress that the building was soon found inadequate for the 500 scholars attending it, and the Merchant Venturers, who constituted the chief part of the governing body known as the Colston Trust, determined to build a new school on the plan of the newest and best equipped English and foreign school, with the best-known methods and appliances for science and art instruction. Finding that the Colston Trust funds assigned for the purpose were inadequate to the demand of such a large building, they undertook the entire charge, so that the scholastic institution will henceforth be known as the Bristol Merchant Venturers' School. Sir Frederick Bramwell, C.E., Chairman of the Council of the City Guilds Institution for the Advancement of Technical Education, the Mayor and High Sheriff of Bristol, the Bishop of Gloucester and Bristol, Mr. Samuel Morley, M.P., Mr. Lewis Fry, M.P., Col. Donnelly, Capt. Abney, and others took part in the inaugural ceremony, which was prefaced by a luncheon given by the master of the Society, Mr. R. W. Butterworth, at the Merchant Venturers' Hall. After the luncheon the party repaired to the new schools, and the opening ceremony took place in the examination hall. The Master (Mr. Butterworth) presided, and in opening the proceedings gave a history of the growth of the old Trade School and its development into the present great establishment. The Master then called upon Sir Frederick Bramwell to declare the building open. Sir Frederick Bramwell said he thought that he might safely say that almost by universal agreement the training to be given in schools such as that was held to be a training that ought to be given, and was a national benefit and blessing. That meeting, he said, was not to initiate something new, for, as had been said, the work had gone on for thirty years; it was not to mark a birth, but to mark progress; not the full development, or anything like it, but a stage—for they would hope that not many years would elapse before an audience as numerous and as earnest as that he saw before him would meet in Bristol to celebrate some further marked step in the development of technical education in the city. What was the object in giving this technical education? The primary object was to enable men and women to earn their living better than they could otherwise do. The primary object of such education was to teach men engaged in industrial pursuits to conduct them in a manner which would redound to their happiness and material prosperity, and this would redound to the prosperity and welfare of the whole nation. A man instructed as he would be there would be enabled to carry on his industry in a totally different manner from those who had to begin the battle of life fifty years ago. At that time they had to profit by what could be taught them derived from experience, but without understanding the principle on which the things depended. They should remember the great things which for the first sixty years of this century were done by men who had not the advantage of technical education. But when a man had that advantage he was enabled to look at the experience of the past in a totally different manner, because he knew the principles on which that experience was based, and knew when it was applicable or inapplicable. Whatever his determination, the Englishman was badly weighted in his struggle with his foreign competitor if the latter had the means of applying science to his industry when the former had not. In London they were doing good work of this sort, one of the branches being technological examination, and during the past three years the number of those that came up more than doubled—from 1900 to 3900. That increase did not arise from the governing body relaxing the examination; on the contrary, they thought it right to add to he stringency of the examination. So the best judges of all, the very men whom they wished to instruct, themselves proved that they valued this instruction. It could not be said that this was a question where they were endeavouring to force on an unwilling people the advantages of education the value of which they did not recognise; and thus they had the encouragement arising from appreciation of their efforts.

MR. ARTHUR SMITHELLS, B.Sc. (London), assistant lecturer and demonstrator in chemistry at the Owens College, Manchester, has been elected to the Professorship of Chemistry at the Yorkshire College, Leeds, rendered vacant by the appointment of Dr. Thorpe to the Chair of Chemistry in the Royal School of Mines and Normal School of Science, South Kensington.

SCIENTIFIC SERIALS

Journal of Franklin Institute, No. 713, May.—Prof. C. F. Himes, actinism. A lecture delivered at the Philadelphia Electrical Exhibition, giving a succinct account of modern investigations.—F. E. Ives, isochromatic photography. Describes his blue-myrtle chlorophyll process.—C. J. Hexamer, fire hazards in textile mills. Deals with relative risks of cotton, wool, and shoddy of various qualities.—W. B. Le Van, economy in the use of high-pressure steam. Describes a new high-pressure boiler.—Prof. Pliny E. Chase, further experiments in weather forecast. Of interest to meteorologists.—Prof. E. J. Houston, glimpses of the International Electrical Exhibition, No. 7, Drawbaugh's telephonic inventions. Description and drawings of the instruments of this notorious person.

No. 714, June.—Dr. Persifor Frazer, the World's Industrial and Cotton Centennial exposition. Gossip about the New Orleans Exhibition.—Prof. J. Burkitt Webb, a simple form of draught gauge; a simple instrument for measuring the decrease of pressure in a flue directly by scales.—Dr. Werner Siemens, on the electromotive action of illuminated selenium, discovered by Mr. Fritts. In this communication, which is translated from the German, Dr. Siemens describes as being entirely new and scientifically of the most far-reaching importance, the phenomena discovered by Mr. Fritts, which were, at Philadelphia, condemned by Prof. Rowland as unworthy of being brought before the Physics section of the American Association. Dr. Siemens agrees with Mr. Fritts that in his experiments there is a direct conversion of the energy of light into electrical energy.—E. L. Corthell, the Tehuantepec Ship Railway.—Prof. E. J. Houston, facsimile telegraphy.—Appended to this number are the reports of the examiners of the Philadelphia Electrical Exhibition on electric arc lamps, and on carbons for arc lamps.

Annalen der Physik und Chemie, xxiv. No. 4, April.—Prof. F. Melde, experimental researches in acoustics. Gives account of new experiments with a phonic wheel and other electromagnetic means of exciting vibrations.—G. Tammann, on the vapour-pressure of salt solutions. Gives many hundreds of determinations of lowering of pressure of aqueous vapour by addition of some soluble salt. The author concludes that for a given salt the product of the relative pressure-reduction into the volume of the solution relatively to that of the water it contains is a constant. Exceptions are attributed to polymerisation.—Prof. W. von Bezold, on current-figures in liquids. The method consists in observing the forms which result from putting aniline dyes (such as are used for ink in hectograph) upon the liquids. The present paper deals with the internal currents set up by differences of temperature produced by surrounding with a ring of ice, &c. The figures are curious and instructive.—Prof. E. Kittler, on measurement of strength of currents. Describes the method of taking strength of currents by measuring potential when the current is passed through a known resistance.—Prof. G. Quincke, electrical researches, No. xi. This series deals with the constants of electromagnetic rotation. For sodium light, Quincke finds the constant for bisulphide of carbon to be 4·409′ at 21° C. Becquerel found 4·630′ at 0°, and Lord Rayleigh and Mrs. Sidgwick found 4·2002′ at 18°. Quincke gives tables of statistical results for other liquids, agreeing in the main with those of Perkin and of Becquerel.—A. Gockel, on the relation of the Peltier-heat to the efficiency of galvanic elements. A discussion of the work of Braun, Chaperon, Czapsky, Bouty, and others, with redeterminations.—W. Herman Schultze, on the reaction between two mutually perpendicular magnetic distributions. Very careful experiments confirm Siemens's result that longitudinal magnetism

diminished by a transverse magnetisation.—A. König and Fr. Richarz, a new method of determining the constant of gravitation.—Leo Arons, interference fringes in the spectrum. Fringes are observed to intrude; which the author eventually traces to the films between the two lenses of the achromatic telescopes.—Robert Weber, the electrical siren. An interesting apparatus producing tones in a receiving telephone by interrupting the circuit by a rotating cylinder having series of electric contacts around its periphery.

xxv. May.—Prof. L. Lorenz, determination of the electric resistance of mercury columns in absolute electro-magnetic measure. The result of the author's method is that the true value of the ohm is represented by a mercury column of 1 square millimetre section and 105·93 centimetres in length.—Franz Stenger, contributions to the electric conductivity of gases.—Hans Jahn, on the validity of Joule's law for electrolytes. The careful experiments establish the validity to a very close degree.—R. Lamprecht, on flexible conductors under magnetic influence. A mathematical discussion.—J. J. Balmer, note on the spectrum lines of hydrogen. The wave-lengths of twelve observed lines are found to agree with the formula $\lambda = N(m^2/m^2 - 4)$, where N is a coefficient, and m and n whole numbers. For hydrogen, $N = 3645 \times 10^{-8}$ cm.—Dr. Fr. Vogel, change of refraction in glass and calc-spar with temperature. The author finds, with Fizeau, a diminution in the difference between the two indices of calc-spar nearly proportional to the elevation of temperature.—Prof. W. Voigt, the optical properties of very thin metal films. Rediscusses Quincke's results.—Julius Elster and Hans Geitel, note on a sensitive Doubler. This is nothing else than a Thomson's water-dropper.—Elster and Geitel, remarks on the electric processes in storm-clouds. The authors regard thunder-clouds as acting as the water-dropping doubler does, in raising at the expense of the kinetic energy of the falling drops the electric potential of the mass placed under electric influence.—Elster and Geitel, on the development of electricity during formation of rain.—Dr. H. Kayser, on lightning photographs.—Prof. G. F. Fitzgerald, on the memoir of Prof. Kundt on the electromagnetic rotation of the plane of polarisation of light by iron, cobalt, and nickel.—Hanichi Muraoka, on the magic Japanese mirror.—K. Exner, remark on the velocity of light in quartz.

Rendiconti del Reale Istituto Lombardo, June 11.—Further remarks on the functions that satisfy the differential equation $\Delta^2 u = 0$, by Prof. Giulio Ascoli.—On the resolution of certain modular equations, a complement to the author's paper on the transformation and division of the elliptical functions, by G. Morera.—Inversion of the movement of the pupil in the case of a person affected by progressive analysis, by Prof. A. Raggi.—On certain physiological functions of the lower organisms: a contribution to the morphology of the Metazooi, by Prof. Leopoldo Maggi.—Reply to the recent objections advanced against a science of penal jurisprudence, by E. A. Buccellati.—Some recent studies on the origin of the Institutions of Justinian, by Prof. C. Ferrini.

THE largest space in the *Nuovo Giornale Botanico Italiano* for July is occupied by a paper by Sig. C. Massolongo, on the Hepaticæ gathered by Dr. Spegazzini in Terra del Fuego in 1882, an important contribution to Hepaticology. Ninety-five species are described, a considerable number of them new, including, also, one new genus, *Pigafettoa*. The paper is illustrated by no less than seventeen plates. The kindred Bryology claims also a paper by Sig. Venturi, on the Italian representatives of the section *Harpidium* of *Hypnum*. Sig. Piccone gives a list of marine and freshwater Algæ observed by him on or near the Ligurian coast, many of them being new to the district. The only papers in this number not concerned with Cryptogamy are teratological—by Sig. Terracciano on a quadrilocular capsule of *Agave*; and by Prof. Caruel on Viridescence in *Verbascum*.

IN the *Journal of Botany* for July, Mr. W. H. Beeby describes and figures the recently-discovered *Sparganium neglectum* from Surrey, for which he claims the rank of a good species. With the exception of a teratological note on Peloria in *Habenaria bifolia* by Mr. H. N. Ridley, all the other papers in this number are descriptive and topographical:—New ferns from Brazil, by J. G. Baker; additions to the British lichen-flora, by Rev. J. M. Crombie; Notes on the flora of Ceylon, by Dr. Trimen; on the flora of the Philippine Islands, by R. A. Rolfe; on Dovedale plants, by Rev. W. N. Purchas.—Dr. Buchanan White records one more addition to the Flowering plants of Great Britain, *Schænus ferrugineus*, from Perthshire.

SOCIETIES AND ACADEMIES

LONDON

Geological Society, June 24.—Prof. T. G. Bonney, F.R.S., President, in the chair.—John MacDonald Cameron, Matthew Heckels, and Robert H. Williams, were elected Fellows of the Society.—The following communications were read:—Supplementary notes on the deep boring at Richmond, Surrey, by Prof. John W. Judd, F.R.S., Sec.G.S., and Collett Homersham, F.G.S. Since the author's former communication to the Society on the subject, this boring, in spite of the strenuous efforts made by the Richmond Vestry, and the contractors, Messrs. Docwra and Co., has had to be abandoned, after reaching a total depth of 1447 feet from the surface. This depth is 145 feet greater than that of any other well in the London Basin, and, reckoning from Ordnance datum, reaches a lower level by 312 feet than any other well in the district. Before the termination of the work temperature-observations were obtained, which generally confirm those previously arrived at. The strata in which the boring terminated consisted of the red and variegated sandstones and marls previously described, which were proved to the depth of 208 feet. Although it was demonstrated that these beds have a dip of about 30°, complicated in places by much false-bedding, no conclusive evidence could be obtained concerning their geological age. They may be referred either to some part of the Poikilitic series, or to the Carboniferous (for similar strata have been found intercalated in the Carboniferous series at Gayton, near Northampton), or they may be regarded as of Old Red Sandstone age. Some interesting additional observations have been made since the reading of the former paper, on the Cretaceous rocks passed through in this well. Mr. W. Hill, F.G.S., of Hitchin, has found the exact analogue of the curious conglomerated chalk met with at a depth of 704 feet at Richmond. His observations entirely confirm the conclusion that we have at this depth the "Melbourne rock" with the zone of *Belemnites plenus* in a *remanié* condition at its base. Some new facts concerning the state of preservation of the fossils in the Chalk Marl are also recorded. With respect to the conclusions arrived at by the author concerning the distribution of the Jurassic rocks on the south side of the London Basin, an important piece of confirmatory evidence has been supplied by a deep boring made at the Dockyard-Extension Works at Chatham. This section, for the details of which the authors are indebted to the officers of the Geological Survey, shows that under the Chalk and Gault, with normal characters and thickness, there lie 41 feet of sandy strata of Neocomian age, and that these are directly underlain by blue clays of Middle Oxfordian age, as is proved by the numerous fossils which they have yielded. We have now, therefore, direct evidence of the existence and position of strata of Lower, Middle, and Upper Oolite age, respectively, beneath the Cretaceous rocks of the south-east of England.—On the igneous and associated rocks of the Breidden Hills in East Montgomeryshire and West Shropshire, by W. W. Watts, F.G.S. The author, in this paper, described the succession of rocks in the small tract near the Breidden Hills situated between Welshpool and Shrewsbury. The Cambrian rocks are: (1) Criggion shales, dark and barren, much penetrated by intrusive diabases and about 2700 feet thick. (2) Andesitic lavas and ashes, followed by conglomerates of the same materials. (3) Ashy grits and shales containing *Climacograpsus antiquus? C. bicornis? C. scharenbergi*, *Cryptograpsus tricornis*, *Diplograpsus foliaceus*, *Leptograpsus flaccidus? Beyrichia complicata*, *Trinucleus concentricus*, *Orthis testudinaria*, *Bellerophon bilobatus*. The rocks are thus of Bala age, the fossils indicating that the ashy grits and shales are on the horizon of the top of the Glenkiln or bottom of the Hartfell series. These are followed by Silurian strata. (1) *Pentamerus* beds. Soft sandstones and mudstones yielding *Pentamerus globosus? P. oblongus*, *P. undatus*, *Leptæna transversalis*, *Strophomena rhomboidalis*, *Petraia subduplicata*. (2) purple shales, unfossiliferous. (3) Lower Wenlock shale, with *Monograptus vomerinus? Cryptograpsus*, sp., *M. priodon*, var. *Flemingi*. These graduate into (4) Upper Wenlock shale, with *M. priodon*, *M. vomerinus? M. basilicus*, *M. nilssoni*, *M. rœmeri*. (5) Lower Ludlow shale. *M. colonus*, *M. nilssoni*, *M. salweyi*, *M. lintwardenensis*. The paper concluded with microscopical descriptions of the igneous rocks, of which there are two sets: (1) An older set interbedded with the Cambrian and consisting of andesites bearing a large percentage of a mineral allied to enstatite, together with augite and a small quantity of hornblende and mica. These are

chiefly lavas, but some few are perhaps intrusive rocks and dykes. (2) Intrusive rocks of a diabase type, generally, however, containing a variety of enstatites identical with that in the andesites. These are intrusive in the Cambrian rocks, and from their relations appear to be most probably of post-Silurian age.—Note on the Zoological position of the genus *Microchœrus*, Wood, and its apparent identity with *Hyopsodus*, Leidy, by R. Lydekker, B.A., F.G.S.—Observations on some imperfectly known Madreporaria from the Cretaceous formation of England, by R. F. Tomes, F.G.S.—Correlations of the "Curiosity-Shop" beds, Canterbury, New Zealand, by Capt. F. W. Hutton, F.G.S. The "Curiosity Shop" is a locality on the River Rakaia in the Canterbury Plains, and has been thus named on account of the numerous fossils found in some calcareous sandstones cut through by the river. The section exposed consists of (1) river-gravels; (2) loose grey quartz sands; (3) soft calcareous sandstone with glauconite, passing downwards into tufaceous clay; (4) calcareous sandstone without glauconite; (5) loose grey or yellowish brown sands. By Mr. McKay, of the Geological Survey, No. 2 had been referred to the Pareora series (Miocene?), No. 3 to the Upper Eocene series, and Nos. 4 and 5 to the Cretaceo-Tertiary series. The author, who was inclined to class all these beds in a single series, pointed out that the only difference between the fossils found in Nos 3 and 4, the most important fossiliferous beds, consisted in the presence of a greater number of forms in No. 3, all found in No. 4 being identical with those in the overlying bed. He then gave a complete list of the species of Vertebrata, Mollusca, Brachiopoda, Echinodermata, Bryozoa, and Cœlenterata, from the locality, 48 in all, and compared them with those from the Weka Pass stone, 26 in number, and the Ototara fossils from Oamaru, to show that a large proportion were identical. He gave reasons for not agreeing with the views of Dr. Hestor and Mr. McKay, who held that unconformity exists between the beds referred by them at the Curiosity Shop, in the Weka Pass district, and north of Otago, to the Upper Eocene and Cretaceo-Tertiary series respectively, and showed, both from palæontological and stratigraphical data, that all these rocks must be included in one system, the Oamaru system of Dr. von Haast and himself.—On the fossil flora of Sagor in Carniola, by Constantin, Baron von Ettingshausen, F.C.G.S. The author in this paper gave the principal results of his examination of the fossil flora of Sagor, consisting of 170 genera and 387 species, of which a list was appended. The plants were obtained from fourteen different localities, some of the most important species from each of which were mentioned; in one of these localities the flora underlying the brown coal of the district belonged to the uppermost Eocene, whilst the remaining stations were assigned to the lowest stage of the Miocene system. The great diversity of the fossil plants showed that the Tertiary flora of this and other localities must be considered the origin of all the living floras of the globe; for in the fossil flora of Sagor are found plants representative of forms now found in Australia, North America, and Mexico, California, Chili, India and the East Indian Islands, Europe, Africa, Norfolk Island, and New Zealand. Examples of all these were cited.

Edinburgh

Royal Society, July 6.—Sheriff Forbes Irvine, Vice-President, in the chair.—Dr. R. W. Felkin, F.R.G.S., gave an account of the For tribe, one of the Negro races of Central Africa.—The Astronomer-Royal for Scotland communicated a paper, by Dr. Daniel Draper, on bisulphide of carbon prisms, and also exhibited some stereoscopic photographs.—Drs. Woodhead and Hare, in a paper on the vital relations of micro-organisms to tissue-elements, endeavoured to classify as far as possible the actions of micro-organisms on tissues. They pointed out that the reaction of the tissue-elements themselves had latterly been too much lost sight of, and that a more careful study of the normal cell-life history must in time be the means of throwing considerable light on the subject under discussion. They insisted very strongly on the digestive action of micro-organisms.—Thomas Andrews, F.C.S., submitted a paper on the resistance, during recrystallisation, of fused salts of the halogens, compared with some others and glass.—Prof. Turner gave an account of a specimen of Sowerby's whale (*Mesoplodon bidens*), recently obtained from Shetland, calling special attention to the great complexity of the stomach, the contents of which seemed to indicate that the animal fed upon fish.—Mr. W. E. Hoyle laid before the meeting the second part of the Preliminary Report on the *Challenger* Cephalopoda.

Paris

Academy of Sciences, July 20.—M. Bouley, President, in the chair.—Observations of the small planets made with the large meridian at the Observatory of Paris during the first quarter of the year 1885, communicated by M. Lœwy.—Note on the movement of rotation of the earth around its centre of gravity, by M. Tisserand.—On various propositions relating to the movement of a solid body around a fixed point, by M. G. Darboux.—A spectroscopic study of substances rendered phosphorescent by the action of light or by electric discharges, by M. Edm. Becquerel.—On the metaphosphate of thorium, by M. L. Troost. This substance, obtained by the reaction of the chloride of anhydrous thorium on an excess of metaphosphoric acid in solution, takes the form of crystals insoluble in water and easily separated from metaphosphoric acid. Its analysis yielded metaphosphoric acid 52·45; thorine 47·64.—Researches on the duration of excitability in the excito-motor regions of the brain proper after death, by M. Vulpian.—Observations on the fauna of the island of Great Comoro, to the north-west of Madagascar, by MM. Milne-Edwards and E. Oustalet. From a careful study of the mammals and birds of this island the authors conclude that it is not a geographical dependence on Madagascar, that it never was attached to that region, and that its fauna has borrowed from the surrounding lands.—Note on the intermediary orbit of the moon, by M. Hugo Gyldén.—On the vaso-motor action of suggestion on hysterial subjects in a state of somnambulism, by M. Dumontpallier. From experiments made on two women subject to hysteria in the hospital de la Pitié it appears that, under certain conditions, suggestion may produce a vaso-motor modification characterised by a considerable increase of temperature in any region determined at pleasure. This result opens the way to a series of fresh experiments of the same order, and renders possible a physiological interpretation of phenomena, the reality of which science had hitherto regarded as somewhat doubtful.—Observations of Barnard's new comet made at the Observatory of Nice (Gautier's equatorial), by M. Charlois.—On the sixteen systems of planes of the regular convex icosahedral, by M. E. Héward.—On the capillary constants of the saline solutions, by M. A. Chervet.—Note on the production of the lowest temperatures, by M. K. Olszewski.—Experiments on the regulation of the charges and discharges in electric accumulators, by MM. Crova and Garbe.—Note on the electric resistance of alcohol, by M. G. Foussereau.—Heats of formation for some phtalates, by M. Colson.—Remarks on some phenomena of oxidation and reduction produced by the microscopic organisms of the soil, by M. A. Müntz.—On the variation of the physical properties in the series of chloro-acetic derived substances, by M. L. Henry.—On the existence of glycogene in the yeast of beer, by M. Léo Errera.—On the existence of a nervous system and of an organ of sense in *Rhabdocœles acœles*, *Convolvula Schultzii*, and other members of the same group, by M. Yves Delage.—Note on the analytical and comparative morphology of the mandible in the hymenopteræ, by M. Joannes Chatin.—The Coregoni of the Swiss lakes (*C. dispersus*, *C. balleus*, &c); their marine origin, classification, reproductive processes and gradual adaptation to their changed surroundings, by M. V. Tatis.—Note on the tertiary basin of Grenada, by MM. M. Bertrand and W. Kilian.—A contribution to the study of antiseptics; action of the antiseptics on the higher organisms (continued); phenic acid and resorcine, by MM. A. Mairet, Pilatte and Combemale.—Experiments made on the body of a criminal recently guillotined at Troyes, by MM. P. Regnard and P. Loye. These experiments mainly confirm those already observed on animals, and tend to reassure those who suspect the persistence of conscious life after decapitation.—Observations on the foregoing experiments, by M. Paul Bert.—On the photographic determination of the trajectory of a point in the human body during the movements of locomotion, by M. J. L. Soret.—Note on the theory of the perception of colours, by M. Aug. Charpentier.—A formal denial of the reports regarding the appearance of cholera in Hérault was made by M. Colson on the authority of a letter from Dr. Boissier, local medical inspector.

Berlin

Physical Society, June 12.—Dr. Lummer communicated his further observations on the interference-phenomena produced by glasses parallel to the same plane. If monochromatic light fell from a luminous surface on a glass plate of moderate thickness, differences of phase arose by reflection on the anterior and

posterior surface, in the beams of light falling under different angles. These differences of phase, as the speaker demonstrated by showing the course of the single bundles of rays produced on the retina of an eye focussed for parallel rays, a system of coloured and dark concentric rings, similar to Newton's rings of colour. This system of rings appeared, however, only when the plates were exactly parallel, at least to as great a degree of precision as that of the rays which enter the pupillary aperture by reflection from any point. These rings might therefore be utilised as a test of the parallelism of the glasses. Deviations of 0·2 wave-length caused no disturbance in the rings, but differences in the thickness of the glass amounting to 0·5 λ certainly gave rise to such disturbance. Bringing the glass before the eye, which was always accommodated to infinitude, considerably large spaces of the glass might be tested in reference to their parallelism. Any thinning or any thickening of the glass would be at once marked by displacements in the ring-systems and their wandering from the interior to the outside, or from the outside to the interior. The speaker compared his method of observing the interference phenomena, and testing the parallelism of the glass surfaces with that of Fizeau, and brought out the differences of the two, as also the advantages of his method.—Dr. Kayser gave a report of two works quite recently published on spectrum analysis, which seemed to make an important advance in the theory of spectral lines. It had formerly been attempted in vain to find harmonic relations, such as those existing among the upper tones of a sounding body, among the lines shown by the spectrum of a metal vapour, but the attempt to find such simple relations was abandoned after the question had been discussed by Prof. Schuster. Lately, however, Herr Balmer, in calculating the wave-lengths of the hydrogen lines, as given by Angström, had found a relation between these lines, expressed by the formula $h = \frac{m^2}{m^2 - 4} \cdot C$, when C had the value of 3645·6 millionths of a millimetre. In place of m let there be put in turn the numbers 3, 4, 5, 6, then were obtained Ångström's undulatory lengths of the four visible hydrogen lines. If the calculation were carried still further, and for m were placed the values 7, 8, &c., on to 16, then were obtained values for hydrogen lines which coincided very well with the wave-lengths of the lines which Dr. Huggins had found in the ultra-violet spectrum of the white stars, and had recognised as the invisible hydrogen lines. The longest among these ultra-violet hydrogen lines had been photographed by Prof. Vogel in the spectrum of a glowing hydrogen tube. This relation between the hydrogen lines had now received an increased significance from an investigation by Prof. Cornu, in which he had found a perfectly determinate proportionality in the lines of the ultra-violet spectrum of aluminium and of thallium to the ultra-violet hydrogen lines. Like the hydrogen lines, the pairs of lines of the two metals referred to advanced so much nearer to one another, and became so much paler the more one approached the more refrangible end of the spectrum; and if any line of the aluminium or the thallium spectrum was made to coincide with the corresponding line of the hydrogen, then did all the remaining lines coincide. This relation obtained both for the first and for the second lines of the pairs of lines in the metal spectra.—Prof. von Helmholtz drew the attention of the Society to an investigation of Dr. Wernicke, which will shortly be published, of great importance for the theory of the reflection of light. The experiments had reference to the reflection of thin plates in which each ray divided into two, one being reflected, the other refracted and again reflected by the posterior surface, in addition, still further secondary refractions and reflections came into account. The difference of phase in the reflected rays, on monochromatic light being applied, was observed through their interference phenomena. According to the theoretical development given by Dr. Wernicke, without any hypothetical assumption whatsoever, the difference of phase depended on the sine of the angle of incidence, on the cosine of the angle of refraction, and on three constants. By examining a large series of solid bodies—transparent crystals as well as metal films—Dr. Wernicke found in the case of incidences which were approximate to the angle of polarisation that, if the plane of polarisation were parallel to the plane of incidence, the three constants became zero. If, on the other hand, the plane of polarisation was perpendicular to the plane of incidence, the constants had a definite value. This experimental result was in agreement with Fresnel's theory of reflection. According to Naumann's theory the constants must become zero in the case of perpendicular polarisation planes and have a definite value in case of parallel direction. According to Ketteler's theory the constants could never become zero.

STOCKHOLM

Academy of Sciences, June 10.—The following papers were presented for insertion in the *Transactions* of the Academy: Contributions to the physiological anatomy of the algæ, by Herr N. Wille.—On Japanese cephalopoda, by Herr A. Appellöf, B.A.—On the determination of the amount of electromotive power of the voltaic arc, by Prof. E. Edlund.—Contribution to the question of the action of fluidity upon the electric conducting power of electrolytes, by Dr. S. Arrhenius.—Researches on the electric spark in fluids, by Dr. C. A. Mebius.—On the conformation of the hypostoma in some Scandinavian Asaphids, by Prof. W. Brögger.—On an Inoceramus from Queensland, by Prof. B. Lundgren.—A catalogue of the Silurian crustacea of Gothland, I. Trilobites and Merostoma, by Prof. G. Lindström.—On intermediate orbits, which at a given moment with a contact of the third order, join with the real orbits, by Prof. Gyldén.—On alcohol in beer, by Prof. Hamberg.—On marine vertebrates from the northernmost part of the province of Tromsö and West Finmark, by Dr. C. Aurivillius.—On rhodonite from Pajsberg and Langbau, by Hen. G. Flink.—On the crystallographic constituents of godolinite, by Hen. F. Eichstedt.—Crystallographic researches on the rarer metals, by Hen. C. Morton.—On some combinations derived from dicyanphenylhydracin, by Dr. J. J. A. Bladén.—On melanism and combinations of melam, by Dr. P. Claesson.—Some speculations and experiments on filtration in its bearing upon the processes of transudation in the animal body, by Drs. R. Tigerstedt and C. G. Santesson.—Prof. Smitt reported on the International Ornithological Congress in Vienna of last year.—Prof. Wittrock exhibited the first fasciculus of the fodder-herbs of Sweden, edited by Drs. Jönsson and Whalsted, and gave an account of a report on a botanical expedition to Norrland and Norway, for the purpose of studying the morphology and phylogeny of the Hierarsia, by D. S. Almquist.

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