THURSDAY, OCTOBER 7, 1880

THE PLACE OF SCIENCE IN EDUCATION

THERE has been a great deal said and written on the subject of education during the past week. First of all we have the important address of Prof. Huxley at the opening of the Mason College, Birmingham, which we give in full on another page; then there is the brief but significant address of Sir Stafford Northcote at Tiverton; and lastly, the summary of Sir Charles Reed of the ten years' work of the London School Board. All this has furnished ample food for comment in the daily papers, and their misconceptions as to the real drift of Prof. Huxley's address must be amusing to those who know what science really means, and what are the opinions held by reputable men of science as to what constitutes sound and complete education. With regard to the institution which has been so generously founded and handsomely endowed by Sir Josiah Mason at Birmingham, it should be remembered that there was no intention to start it as a university. Its founder has had to push his way through life, and notwithstanding the unusual success of his career, he confesses that he has but little faith in the rule-of-thumb method, which was often his only guide. At every step, he admits, he was hampered and hindered by the want of scientific knowledge, by his ignorance of those exact methods, those laws and facts, which can only be satisfactorily acquired and utilised by a preliminary scientific training. Even at his advanced age the consciousness of this want is so strongly impressed upon him that, with true benevolence and rare generosity, he has founded the magnificent institution at Birmingham which was opened last Friday, in order that succeeding generations of boys may have a chance of equipping themselves at the outset with those weapons of precision, the want of which he who has fought successfully the battle of life had to deplore at every step. The Mason College at Birmingham is not a mere technical institute, as may be seen from our article in NATURE, vol. xxii. p. 514, in which the course of instruction provided is described. All departments of science are provided for, as well as certain special applications of some of them; the great principles and facts of these sciences first, and their special application afterwards. Wisely also the founder has provided for instruction in the English, French, and German languages; and even, as Prof. Max Müller stated in his brief but admirable address at the luncheon, for Greek and Latin. The deed of foundation makes ample provision for the widening of the programme, the extension of the subjects taught, and the adaptation of the institution to the times. Special reference is made to art, which will no doubt be added. At the same time the founder excludes from his programme "mere literary education." It is, we suppose, this exception—which looking at the programme of the College, seems to us somewhat vague—that has led the daily press to misconceive Prof. Huxley's address as a defence of science as a means of education, to the entire exclusion of literature. What Prof. Huxley maintains, as we read his address, and as we read his other utterances on the same point, is, that if a man is to have an education in only one aspect of things, then by all means let it be the scientific aspect; on the other side he can educate himself at his leisure, whereas, as Sir Josiah Mason forcibly testifies, when a man gets into the thick of the fight, it is all but impossible for him to make up for the want of scientific training in his youth. As a mental discipline and a means of culture science by itself is as good an implement as literature by itself, and probably a great deal better, as the former takes us into the very heart of nature in its widest sense, while the latter only deals with the outside of things. At the same time Prof. Huxley expressly states that exclusive training in either the one direction or the other is essentially lop-sided, and not to be encouraged; that it is essential to the completeness of a man's culture that it should have an æsthetic and literary, as well as a scientific side; and what other opinion could be held by one who himself seems familiar with "the best that has been said and thought" in all the languages of culture. We are much mistaken if Prof. Huxley would not endorse every word spoken by Prof. Max Müller, on the necessity for the study of the science of man, the science of thinking and of speaking, to a completely liberal education. The truth is that there is a widespread misconception as to what science really means; we have been so long accustomed to apply the term to certain groups of concrete facts, that we forget that it may be applied, and indeed is now frequently applied, to any branch of knowledge investigated on the method which has been so fruitful in the study of physical phenomena. Science indeed is merely the counterpart of sentiment; each of them has its proper place, and each of them is indispensable to the complete development of the human mind. To neglect training on either the one side or the other must produce an imperfect, a lop-sided result; but there is no reason why either should be neglected. Let the programme of elementary education only be developed in the direction so long advocated by Sir John Lubbock and those who think with him, and let the whole of the education of the country up to our colleges and universities be carried out on the same lines, and every side of the human constitution and every aspect of human learning will have fair play. Prof. Huxley did well to defend science as a method of mental discipline certainly equal to the old and merely literary methods which so long prevailed at our universities, and which have been so abused; but his address will be strangely misread if any idea of suppressing the old learning is attributed to him. It is interesting to notice that Sir Stafford Northcote, in his short address at Tiverton, followed the plan of that of Prof. Huxley, beginning by strenuously advocating the spread of scientific education in the country as the only means by which we can be able to cope with our neighbours, and concluding by maintaining that it would be a serious mistake to suppress literary training entirely. This is what we have all along maintained in these pages, and we are sure that Prof. Huxley is on our side. Science has had a hard fight to obtain a place in the education of the country, and she has not yet obtained the place she is entitled to; she will only have done so when in all our educational institutions she holds a position of perfect equality alongside of the subjects which until recently monopolised our schools and colleges, and we trust that when another decade's work of the London or any other School Board has to be summarised, the so-called extra subjects will have become an integral part of the elementary education of the country. Such institutions as that opened at Birmingham will greatly help on the cause of scientific education. The standard of teaching we are glad to see is high, the best science schools of the Continent being taken as models; and we trust the Mason College will never degenerate into a mere technical training-school. Under the liberal principles for its conduct laid down by the founder, it is capable of the widest development in every direction; whether it may form the nucleus of a Birmingham University remains to be seen. Its working will be watched with the greatest interest by all who have at heart the raising of the standard of education in the country.

CHEMISTRY OF THE CARBON COMPOUNDS

Elements of Chemistry. By William Allen Miller, M.D., &c. Revised and in great part re-written by Henry E. Armstrong, Ph.D., F.R.S., and Charles E. Groves, F.C.S. Part III.—Chemistry of Carbon Compounds, or Organic Chemistry. Section I.—Hydrocarbons, Alcohols, Ethers, Aldehydes, and Paraffinoid Acids. Fifth edition. (London: Longmans, Green and Co., 1880.)

THE study of the laws governing the combinations of molecules containing carbon is of the very first importance to chemical science, inasmuch as this study so well illustrates and extends the general laws of molecular combinations, that is to say, the general laws of the science of chemistry.

An almost innumerable array of facts concerning carbon compounds is to be found in the ordinary text-books; papers in the chemical journals sometimes contain generalisations drawn from certain classes of those facts: the later supplements to Watts's "Dictionary" contain the more important of the comparatively recent generalisations; but there has undoubtedly existed for some time among students of chemistry a wish for a text-book in which the leading facts concerning the compounds of carbon should be clearly stated, the general properties of, and general relation between groups of these bodies should be indicated, and summaries of the evidence in favour of or against the generally adopted structural formulæ of the more important compounds should be presented to the student, in order that he might thus have in one text-book such a fair compendium of the present state of this branch of the science as should furnish him with suggestions for work, by showing him what is clearly known, where exact knowledge ceases, and where even analogy lends but little help.

The first part of such a text-book English chemistry now possesses; let us hope that the second part of this admirable book will soon follow, and be worthy of that now published.

In their preface the editors—had we not better say at once the authors?—write: "Notwithstanding the extraordinary increase in the number of the carbon compounds, their study is gradually becoming simplified as the possibility is extended of arranging them in series and of giving a general description of their chief properties applicable to all the members of the group."

There can be no hesitation in saying that the authors' work—more than any other text-book in the English language—will aid the advance of this, the only true method, of studying Organic Chemistry.

There are text-books of Organic Chemistry which tell the student that the structure of this or that compound "is represented by the following formula"; this book follows another and a better plan: the authors give a succinct and clear sketch of the evidence for and against all important structural formulæ, thus indicating the true value of these formulæ as condensed statements of chemical facts, and at the same time setting before the student examples of the application of the chemical method of inquiry.

The general principles underlying the formation of so-called structural formulæ are adverted to in more than one place by the authors.

These formulæ are based on the laws of "atom-linking," which again are deductions from the theory of quantivalence or valency, itself an outcome of the application of chemical methods of inquiry to the molecular theory of matter.

Although the volume before us is Part III. of a large work, the first part of which deals with chemical physics, it would nevertheless, we think, have been advisable to have given a brief sketch of the molecular theory of matter, and to have shortly stated—but more fully than is done on p. 42—the evidence on which is based the (chemically) all-essential difference between atom and molecule.

A little space might have been spared for an exposition of the laws of atom-linking, such as, but very much more condensed than, that in Lothar Meyer's "Modernen Theorieen."

In speaking of quantivalence, on p. 42, the authors do not explicitly state that it is the *atoms* of the elements which "are equivalent in combining or replacing power to one, two, three, four, five, or six monad atoms of hydrogen." Of course this is implied throughout the discussion which follows, but students sometimes fail clearly to grasp the difference between the old chemistry, which attempted, but failed, to determine equivalent weights of elements, and the new, which is so largely based on the equivalency of groups of atoms of the elements.

Frankland's "bond" explanation of valency is sketched, but so long as we have no definite physical conception of what a "bond" is, this explanation really explains nothing; such an expression as "two of the bonds neutralise each other" has no meaning, further than that the valency varies from a given number to two less than this number.

The authors give some examples of compounds, which seem to show that the valency of certain elementary atoms may vary from an odd to an even number; but they do not give examples which prove such a variation, *e.g.*, $MoCl_5$ and $MoCl_6$; WCl_5 and WCl_6; NO, NO_2, and NH_3.

The authors, probably wisely, do not very definitely express their opinion as to the exact meaning of a structural formula; they sometimes appear to regard these formulæ as real representations of the relative mode of arrangement of atoms in a molecule, sometimes only as condensed statements of facts of formation and decomposition. If the former view be adopted it becomes a question whether the "structure" represented by the formula is that of the molecule when unacted upon by the molecules of foreign bodies, or only when a certain disposition of its parts has been induced by the action of the molecules of another substance.

Facts are certainly known which are best explained by supposing that a change of some kind precedes that process of complete molecular decomposition usually called a chemical reaction; indeed almost the only feasible hypothesis of chemical action supposes that chemical change—that is, change among the parts of the molecule—may be proceeding without a permanent molecular decomposition taking place. In the section on "Aldehydrols" the authors apparently admit some such hypothesis as this; they do not regard the non-isolation of a compound as proof of the non-existence of that compound; they explain processes of chemical change by supposing the existence of unstable molecular configurations intermediate between more stable and isolable configurations.

Recent work in chemical physics appears to lend some countenance to the idea that structural formulæ may roughly represent the configuration of molecules just previous to their passage into phases of "absolute instability" rather than their configuration when in phases which are themselves "absolutely stable."

Quite recently a distinct advance has been made in molecular theories by the recognition of what might be called *atomic induction*, that is, the influence exerted by one part of a molecule in modifying the chemical function of another part, or other parts, of the same molecule. Illustrations of this "orientation" are to be found in the production of the substituted derivatives of benzene and of the phenols; the generalisations made in these cases are clearly stated by the authors.

A very valuable section on the Van't Hof Le-Bel hypothesis of isomerism is to be found from pp. 983 to 993. (There is evidently an omission of part of a sentence at the top of p. 993.) The authors suggest a slightly modified form of this hypothesis. The fundamental assumption is made in these hypotheses that chemical energy is entirely potential, and that it is wholly due to the arrangement of the parts of the molecules. It seems possible however that chemical energy may be partly potential and partly kinetic, and that if any means could be found for measuring the change of entropy as well as the change of total intrinsic energy of chemical systems in their passage from one standard state to another, some light might be thrown on the question of isomerism.

In their general classification of carbon compounds the authors have adopted a scheme founded on the chemical function of these compounds; they group together hydrocarbons, alcohols, aldehydes, &c. They do not fail to indicate how function is associated with "structure." But in each of these great groups of compounds a classification founded more upon genetic relations is adopted; they consider a group of hydrocarbons, then the haloid derivatives of these hydrocarbons, and so on.

Most admirable tables are appended to all the more important groups; the usefulness of these tables may be illustrated by reference to that on pp. 458-459, wherein the ethylic alcohols are arranged in *really* homologous series.

The acids are classified into various sub-groups, and the dependence of the function of the "acid hydrogen" on the "structure" of the other part of the molecule is indicated.

In speaking of the higher aromatic or "benzenoid" hydrocarbons, the happy expression is used of a closed chain containing "*loops*," and it is pointed out that "the formation of each new loop in the chain of carbon atoms tends to reduce the combining power by two units."

The proof (p. 399) that the carbon atoms in the olefines are not arranged in a closed chain is noteworthy, and may be taken as typical of the authors' method of dealing with such questions; basing a generalisation on carefully collected facts, and then applying their generalisation boldly, but without dogmatism.

The nomenclature of the work before us is much more self-consistent than that adopted in any other treatise on organic chemistry. Certain new names are introduced: thus, the bodies supposed to exist in aqueous solutions of many aldehydes—substances characterised by the groups $CH(OH)_2$—are called *aldehydrols*. A systematic nomenclature for the carbohydrates is proposed: those of the composition $C_6H_{12}O_6$ have names ending in *ose*, glucose being the best known example of this class; those of the composition $C_{12}H_{22}O_{11}$, which like cane-sugar produce two molecules of glucose on inversion, have names ending in *on*, *e.g.*, saccharon; and those which on hydration give rise to the formation of a saccharon have names ending in *yn*, *e.g.*, amylin. As another instance of the authors' attempt to systematise nomenclature may be noted their rules for the use of the Greek letters α, β, &c., in distinguishing isomeric derivatives (pp. 861-2, *note*).

Finally, I would draw attention to the authors' manner of dealing with physical methods of solving chemical problems: the physical method is so described that one cannot forget that it is to be used by a chemist—there is not first a little physics, and then a little chemistry; the problem is clearly chemical, the method only is physical.

A suggestion made in the preface seems most admirable, it is that "Each chemical school" would do well to "make the preparation by its students of certain substances in a state of purity a part of the ordinary course of study, and to give notice that these particular compounds are at the disposal of experts for the determination of physical constants."

Is there any probability of a treatise being written on Inorganic Chemistry conceived in the same spirit and carried out, as far as possible, on general lines similar to those of this most excellent work by Armstrong and Groves?

M. M. PATTISON MUIR

OUR BOOK SHELF

An Elementary Treatise on Solid Geometry. By W. Steadman Aldis, M.A. (Cambridge: Deighton, Bell, and Co., 1880.)

THE term "elementary" diagnoses this handy book to solid geometry from the more thorough works on the same subject by Messrs. Salmon and Frost. It is, to our mind, exceedingly well adapted to the requirements of that large class of students who, whilst requiring an acquaintance with this branch of study, are unable, either through want of time or the requisite ability, to extend their reading into the more recondite parts discussed by the above-named writers. As a proof that Mr. Aldis's labours have been appreciated, we need only say that this edition, improved by the addition of hints for the solution of some of the examples, is the third.

Familiar Wild Flowers: Figured and described by F. Edward Hulme. 2nd Series. With Coloured Plates. (London: Cassell, Petter, Galpin, and Co.)

WE have already called attention to the appearance of the first volume of this series, and of the second we can speak in equally favourable terms. In selecting for illustration a hundred of our familiar wild flowers, all chosen in some way for their beauty, a certain amount of arbitrariness must be allowed; but in the present instance very little complaint will be made on this head by the majority of readers. The coloured lithographs are somewhat unequal in excellence, but, as a rule, are extremely good. The book is one well adapted to awaken or to foster in young people a love of the floral beauties of our fields and hedges, woods and ditches.

A New and Easy Method of Studying British Wild Flowers by Natural Analysis. By Frederick A. Messer. (London: D. Bogue, 1880.)

THIS work indicates a very large amount of labour on the part of the author; whether the labour has been altogether well applied is another question. For the field botanist whose sole object is to determine the name of a wild flower it will no doubt be useful in assisting him to make out at least the order and genus, for beyond this it does not pretend to go. No botanist will be disposed to depreciate the value of field botany and of the study of critical species, which often leads to further study of some of the great questions connected with the life of plants. There is no doubt that species-botany had been exalted a quarter of a century ago to a far too prominent place by English workers, and had been much too exclusively followed, to the disregard of morphological and especially of physiological work. The inevitable reaction has set in, and is now perhaps at its height, when the number of botanists who have an accurate acquaintance with our British flora is extremely small. As an introductory work for those who are desirous of increasing this number, Mr. Messer's book may be recommended, always provided that the student does not imagine that it will materially help him in his study of the structural and genetic affinities of the different families of plants. The graphic illustrations are novel in design, and will no doubt help to impress the meaning of the technical terms on the beginner. Some few errors should not have been allowed to pass in a work bearing the date of the present year. Among these is the reference of *Selaginella selaginoides* to the genus *Lycopodium*, and the complete suppression of Selaginellaceæ as a British order of vascular cryptogams.

Manual of the Indigenous Grasses of New Zealand. By John Buchanan, F.L.S. (Wellington: James Hughes, 1880.)

THIS is one of those excellent manuals emanating from the Colonial Museum and Geological Survey Department of New Zealand under the admirable direction of Dr. Hector. The work is a reproduction in a handy form of the folio work ordered by the New Zealand Government in 1876, to be prepared "with nature-printed plates and descriptions of each species, and to be accompanied by an essay on the grasses and forage plants likely to prove useful in New Zealand." This explanation is extracted from the preface of the book before us, which preface has been written by Dr. Hector himself. We also learn from the same source that "the whole of the illustrations of the large edition were drawn from nature by Mr. John Buchanan. . . . The condition imposed—that the plates should be nature printed—rendered it necessary in the first instance to publish the work in folio, but, as this large size is both inconvenient and costly, only a small edition has been issued, and the present handy volume has been printed for more general distribution. The plates now given—sixty-four in number, and including eighty-seven different species and varieties of grasses—are reductions by the process of photo-lithography from the original folio plates, and depict the grasses as of one half the natural size of the original specimens."

There can be no doubt but that the book will be very valuable, not only to the botanist, but also to those who wish to know all about New Zealand grasses for their utility for fodder or for other purposes. The plan adopted in the book is to give under each genus a brief generic description and general distribution over the world, the names of the countries being given in capitals, so that they catch the eye at once; this is followed by the etymology of the generic name. The species are then separately enumerated, the generic and specific names standing first, followed by the common name, reference to the plate, synonyms, habit of the plant, time of flowering, specific description and distribution of the particular species, after which is a good account of the properties and uses of the grass, and a detailed reference to the figures. The book is extremely well printed, the plates are well done, and there are two capital indices, the first to genera and species, and the second to popular names. JOHN R. JACKSON

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 ensure the appearance even of communications containing interesting and novel facts.]

Geological Climates

IN NATURE, vol. xxii. p. 200 *et seq.*, there occurs an important statement by Mr. J. Starkie Gardner, to the effect that fossil remains not distinguishable from *Araucaria Cunninghami* had been found among the Eocene plant beds of Bournemouth, in the south of England.

After reading Mr. Gardner's paper, I availed myself of an opportunity of studying the leaflets of the living and dead specimens of this species of *Araucaria* in the Kew Gardens, including the original specimens in the Herbarium named by Mr. Cunningham, and agree with Mr. Gardner as to the difficulty of separating the *A. Cunninghami* from the Sequoias by leaflets alone when in the fossil condition.

Assuming Mr. Gardner's conclusion to be true, viz., that the Eocene Bournemouth tree was identical, or nearly so, with the living *A. Cunninghami*, a question arises as to climate which will prove insoluble to geologists of the school of Lyell and his followers, who assume that all physical causes during geological time have been pretty much the same as at the present time and times immediately preceding the present.

The Moreton Bay Pine (*A. Cunninghami*) is found, as the name imports, on the shores of Moreton Bay, on the east coast of Australia, and has a range of 900 miles, from 14° S. lat. to 29° 30′ S. lat. along that coast. It does not extend more than eighty miles inland, where, instead of being 130 feet in height, which it is on the coast, it becomes a dwarf tree, and farther inland it entirely disappears.

This tree therefore becomes a most delicate self-registering thermometer, indicating to us precisely (after the well-known manner of plants) the exact conditions of the Eocene climate that existed in Bournemouth during the earlier Tertiary period. I propose to examine the evidence given by this thermometer, and to invite my *uniformitarian* friends to explain how this evidence can exist in conformity with their views.

The climate of the northern limit of the Moreton Bay Pine is as follows (as regards heat):—

Mean (January).	Mean (July).	Mean (Annual).
82°·0 F.	71°·0 F.	76°·5 F.

The climate of the southern limit is—

Mean (January).	Mean (July).	Mean (Annual).
72°·5 F.	57°·5 F.	65°·0 F.

The mean of both being—

Mean (January).	Mean (July).	Mean (Annual).
77°·25 F.	64°·25 F.	70°·75 F.

The present mean annual temperature of Bournemouth is only 50°·4 F., which is 20°·35 F. below its mean annual temperature in the Eocene period.

I want to know how Lyell and his followers propose to give to Bournemouth, from present existing forces and causes, this additional 20° F. of heat. If geologists really wish to earn the respect of their fellow-workers in more exact branches of knowledge, they must condescend to consider *quantitative* as well as *qualitative* questions, and enter into numerical details. To enable them to do so I lay down the two following statements:—

1. Of all places now existing on the same parallel of latitude as Bournemouth the highest mean temperature is in 20° W. long. (in the Atlantic), where the temperature is 53°·1 F., or only 2°·7 F. above that of Bournemouth.

Of all places on the same parallel the lowest mean temperature is found at 80° W. long. (on the borders of Labrador and Canada), where it is 29°·3 F., which is 21°·1 F. below that of Bournemouth, and 2°·7 F. below the freezing point of water.

Existing forces and circumstances might therefore benefit Bournemouth to the extent of 2°·7 F. degrees, or might injure it to the extent of 21°·1 F.; but how is Bournemouth to gain the 20° of heat necessary for the flourishing of the *Araucaria Cunninghami* on its Eocene sea-shore swamps, if existing causes only were at work?

2. The place in the northern hemisphere which is now most closely allied in climate to Moreton Bay, or to Bournemouth in Eocene times, is the central part of the Gulf of California, in Western Sub-tropical America.

Again, I ask geologists of the *uniformitarian* school to show me how they propose to convert the climate of Bournemouth into the present climate of the Gulf of California or that of Moreton Bay by mere transposition of land and water, without shifting the position of the earth's axis, which is an inadmissible hypothesis?

Trinity College, Dublin, September 25, 1880 SAML. HAUGHTON

The Naini Tal Landslip

FOR the purpose of making a thorough inquiry into the details of the causes that led to the above lamentable disaster an able geologist would undoubtedly be required, as was suggested in your leader last week. I think, however, that to any one who, like myself, has resided even but temporarily at Naini Tal, the main cause of the recent slip must be sufficiently obvious without the aid of the geologist.

From the account of the particular buildings overwhelmed it is plain that the slip took place close to where an almost equally bad one occurred some years ago (in the winter of 1865, I believe), viz., just above the Victoria Hotel, on the shoulder uniting the two peaks of Cheena and Lyria Kauta.

The foot of this shoulder forms the northern border of the Tal, or lake, for which the station is justly famed; the strata composing it, as far as I can remember, dip *with* the slope of the hill southwards towards the lake. Moreover, it faces the direction from which the rain mostly comes. The conditions for the production of a landslip in the direction of the lake are thus amply fulfilled.

Though landslips are not at all infrequent from this hill (one occurred near Cheena when I was there, killing two natives), it is from its sunny aspect and *comparatively* gentle slope decidedly the favourite, the station being mainly built on its slopes or at its foot.

On the hill which forms the southern border of the lake the dip of the strata is in the opposite direction to the slope of the hill. It is consequently much freer from landslips, and much safer than the former, as only a few chips at most could be detached from it on the side facing the lake, by the action of rain. The nearly constant gloom however in which, from its northern aspect and its steepness combined, it is necessarily shrouded, as well as the lack of building area, naturally tends to limit its population. This hill again on its *southern* side, which faces the plains, repeats the same phenomena as the shoulder before mentioned; an enormous portion of it having become detached towards the plains, and called pre-eminently "*The* Landslip."

When staying in the Victoria Hotel in May and June, 1877, I always felt it would take very little to bring the whole hill, and especially Government House, which appeared almost vertically above us, down on top of us. The old landslip which I mentioned as being close to the present hotel buried its predecessor, and might be thought to have furnished ample warning against choosing such a dangerous spot upon to which to rear a fresh one.

To guard against such disasters in future I would suggest that all houses in the hill-stations should, if possible, be built mainly where the strata dip in the opposite direction to the slope of the hill, and that where the strata dip in the same direction as the slope of the hill all proximity to steep slopes should be avoided, and only the gentler slopes utilised for building on.

I may add that the rainfall on the present occasion seems to have been phenomenal, if, as the *Times* says, it was thirty-three inches in seventy-two hours. Still, extraordinary and sudden downpours of this kind must be expected, where the summer rainfall has varied from forty inches in 1877 to 117 inches in 1862. E. DOUGLAS ARCHIBALD

Tunbridge Wells, October 2

Branch-cutting Beetles

IT is rather curious that the story which Mr. Ober was told in the Carribbees (NATURE, vol. xxii. p. 216) should be generally believed in Southern Brazil also, viz., that a large beetle "seizes a small branch of a tree between its enormously long nippers, and buzzes round and round the branch till this is cut off." Only in the Antilles this cutting of branches is attributed to a huge Lamellicorn, the *Dynastes hercules*, and in Santa Catharina to a large Longicorn, the *Macrodontia cervicornis*.

Everybody here will tell you this story, but nobody, as far as I know, has ever seen the beetle at work. Branches *are* often cut off by some animal. On a camphor-tree in my garden six branches, from 9·5 to 13·5 centim. in circumference, have been cut off; and on a *Pithecolobium* for some time almost every morning a fresh branch had fallen down, some being even much thicker than those of the camphor-tree. The cutting is always in a plane perpendicular to the axis of the branch, as it would be were it made by a rotating beetle; but in this case an annular incision of equal depth all round the branch would be produced, and this I have never seen. On the contrary, the incision, which causes the branch to break off, consists of two parts, occupying the lower and the upper face of the branch, meeting on one or on either side of it, and being separated by a wedge-shaped interval, which is broken by the weight of the branch, and is narrower or broader according to its toughness.

Once—many years ago—I came to the *Pithecolobium* tree early in the morning, when a branch was just falling down, and with it came down the animal by which it had been amputated. It was a Longicorn beetle, the well-named *Oncideres amputator*, Fabr. I have since seen specimens of some other species of the same genus, which had been caught by others in the act of cutting branches. It is almost unnecessary to add that they do so by gnawing, and not by whirling round the branches.

Blumenau, Santa Catharina, Brazil, August 13 FRITZ MÜLLER

The Tay Bridge Storm

IN NATURE, vol. xxi. p. 468, Mr. Ley asks, relative to my letter on the Tay Bridge storm, which appeared in NATURE, vol. xxi. p. 443, on what evidence I state "that when the velocity of the cyclone centre is very great, the strength of the wind for any gradients is increased, or at all events becomes more squally and gusty."

I much regret the circumstances which have prevented my replying to him sooner, but may now state shortly the three principal pieces of evidence which led me to that conclusion:—

1. My own observation in a large number of cyclones where the velocity of translation was very great, there has been a quality of gustiness or squalliness and intensity generally greater than is usual for the observed gradients.

2. Ever since the barometer was invented it has been known that a rapid fall of the mercury indicates worse weather than a slow one. Now we know that the rate at which this fall takes place at any station depends:—(1) On the steepness of the

gradients. (2) On the nearness of the observer to the path of the cyclone centre. (3) On the velocity of translation of that centre.

In a great many cases I have observed, especially in the west of Ireland, that when a rapid fall of the barometer is reported, the wind is much stronger than existing gradients would seem to justify.

From this it would seem than the rate at which the change of pressures is taking place has some influence on the strength of the wind.

3. Prof. Loomis has shown in his examination of the U.S. Weather Charts that in American cyclones the area of rain-cloud extends further in front when these storms are going fast than when they are going slow.

From this it would appear that another element of intensity besides wind, viz., precipitation, is increased when a cyclone centre moves with great rapidity.

It was mainly on these grounds that I based the statement in my former letter. RALPH ABERCROMBY

21, Chapel Street, Belgrave Square, October 5

Deltocyathus Italicus, Ed. and H.

I FIND that Prof. Ralph Tate, F.G.S., President of the Adelaide Philosophical Society, has lately written as follows in an anniversary address. "On the other hand the Geelong coral, *Deltocyathus italicus*, Ed. and H., better known from the Italian Miocenes, is considered by Count Pourtales and Sir Wyville Thomson to be specifically distinct from its living analogue inhabiting the deep waters of Florida—an opposite opinion to that held by Prof. Duncan." During the last conversation I had with the late M. de Pourtales he informed me that after having seen and studied the Italian types, he was satisfied that I was correct in the statement I had made regarding the specific identity of the Tertiary and recent forms.

P. MARTIN DUNCAN

4, St. George's Terrace, Regent's Park, N.W.

Temperature of the Breath

MY attention has been directed to a communication under the above heading by R. E. Dudgeon, in NATURE, vol. xxii. p. 241. The speculations therein raised regarding the temperature of the breath are scarcely compatible with ascertained physiological truth. Mr. Dudgeon's friend's explanation, against which he argues, is undoubtedly correct. The great value of woollen clothing in preventing chill after exercise may be explained on the same principles. The hygroscopic state of the atmosphere (and material) is the condition which causes variation in different experiments. Different materials have effects corresponding to their hygroscopic properties. The following results of a few experiments which I recently made speak for themselves :—

No. 1.—Temp. of air, 87° F.—Air moderately dry (dew point not ascertained).
,, breath, 96° in mouth cavity.
,, ,, 102°·9.—Thermometer enveloped in four folds wool.
,, ,, 102°·2.—Thermometer enveloped in four folds silk.
,, ,, 100°·8.—Thermometer enveloped in four folds linen.

No. 2.—Temp. of air, 79° F.—Air very damp, raining heavily.
,, breath, 97° in mouth cavity.
,, ,, 99° ,, through four folds of silk.

Time occupied in each observation, three minutes.

Madras, September 9 C. J. MCNALLY

Swiss Châlets

I DO not know whether the idea has previously occurred to any one that the modern Swiss châlet is a descendant of the old lake dwelling, but I was strongly impressed with that conviction this autumn. Not only do they actually build the smaller châlets, used as storehouses, entirely on short piles, but very many of the dwelling-houses are still one half on piles, the steps leading up to the gallery passing through a hole in the middle, so that the modern exterior gallery would represent the original platform. In the lake dwelling the probability is (I would suggest) that there was a trap-door in the centre of the platform, inside the inhabited part, with a movable ladder, so that the latter could be drawn up and the trap-door closed if required. At the present day the ladder is represented by fixed wooden or stone steps leading up into the gallery. The house being now on land, the lower part is half or entirely closed in, and so forms an extra chamber, though the family still dwell above the platform (*i.e.* the gallery) as in days of yore. GEORGE HENSLOW

Fascination

FASCINATION originally meant a supposed power in man and snakes of controlling or arresting the movements of various animals by a glance. Your correspondent M. Chatel's personal anecdote, with his comment thereon, suggests that the snake in some way mesmerises his victim, not by its glance but by its movements. His supposition that "the rapid gyratory motion of a shining object" leads on to the debilitating nervous attack, is open to debate. In displays of fireworks such motion occurs before crowds without making any one sick or frightened or inclined to rush into the middle of a catharine-wheel. However then the motions of the snake, whether swift or slow, may avail in attracting and fixing attention, the final catastrophe is probably due to pure fright, according to the old saying, *Multis ipsum metuisse nocet.* We may safely infer that your correspondent himself would have felt no squeezing round his temples had he known at first that the snake was for him a harmless one, and not a viper nearly five feet long!

In the opening letter on this subject the basilisk and the bombshell seemed to be endowed alike with a semi-miraculous power of enchaining the victims that looked upon them. Now, that small birds should be paralysed with terror at the sight of a gesticulating snake is possible or probable enough; but that English officers should be rooted to the ground by mere alarm at the flight of shot or shell is an uncongenial explanation of facts which appear to me capable of interpretation on a different hypothesis.

In moral, as distinct from physical, perils, there is good reason to suppose that too close a concentration of thought upon a danger has a tendency to overpower the will and bend it to the commission of the very acts which the intellect has pronounced unchoiceworthy. But the acts so committed carry with them present gratification. To use the common simile, men fly to them as moths to a candle, not because they are panic-stricken, but because the sense of the danger is lost in the pleasure that attends it.

I am inclined, in the present state of the controversy, to group the effects of so-called fascination under three heads: (1) there is the effect of paralysing terror; (2) there is the effect of indecision; (3) there is the effect of qualities attractive and repulsive accidentally combined in the same object. The first and second effects are perhaps at times combined together in various degrees, and mixed with that absorbing curiosity of which Mr. Hodgson speaks (NATURE, vol. xxii. p. 383), but which by itself seems rather to deserve the name of abstraction than of fascination.

As to fascination in the original sense of the word, its nature may await discussion till observation proves that such a power in reality exists. THOMAS R. R. STEBBING

Tunbridge Wells, September 27

Air-Bladder of Herring

IN NATURE, vol. xxii. p. 520, there was an abstract of Mr. F. W. Bennett's paper on the "Visceral Anatomy of the Herring" (*Journ. Anat. and Phys.*, July 1880). It has escaped the notice of Mr. Bennett that Dr. E. H. Weber described and figured (Tab. vii. 63) the posterior opening of the air-bladder of *C. harengus* into the urogenital sinus in his "De Aure et Auditu Hominis et Animalium," pars i. 1820.

Zoological Museum, Cambridge ALFRED C. HADDON

The "Waiting Carriage"

M. HANREZ' proposed "waiting carriage" (NATURE, xxii. 519) has doubtless been schemed by many readers before now. A simpler form had long ago occurred to me, having the drum of cable in the *train* engine, the cable passing under the carriages and catching the waiting carriage at the tail. The running out of rope could be as well managed at one end of the train as at the other, and only an ordinary carriage without any special engine would be required, which would be dropped just before picking up another at the next station, each carriage thus slowly shifting round the line.

But any such plan would entail a fresh build of carriages; and for discontinuous carriages a plan nearly as good would be to run a railway omnibus on the rails, with a small 6 or 8 h.p. engine all in one. This would be stopped anywhere between stations, at crossings, farmhouses, and hamlets along the line, and would serve the peasantry for going shopping, beside taking up baskets of garden produce. Passengers going a long journey would change at a main station and join the ordinary train, which would only stop about every hour at the ends of forty or fifty miles' stages. Country lines only running a train every two hours or so would be easily worked thus, the 'bus being shunted by telegraph if necessary, and the line signalled clear as usual. With double lines the 'bus would run on the goods line.

Bromley, Kent W. M. F. PETRIE

A NEW KIND OF ELECTRIC REPULSION[1]

DR. GOLDSTEIN has devoted a good part of the last ten years to an investigation of the discharge of electricity through gases, and amongst the many phenomena which he has brought to light, the one described in a memoir published in a separate form is not the least interesting and important. The facts may be stated in a few words: *A negative electrode exerts a strong repulsion on the rays of the glow proceeding from itself or from another negative electrode.* Before describing the experiments proving this statement, and the laws by which this phenomenon is regulated, we shall follow Dr. Goldstein in reminding the reader of a few facts connected with a discharge of electricity through gases which he will have to bear in mind.

It is well known that the negative electrode in a gas, for which Faraday's name of cathode may be conveniently used, is surrounded with a glow which expands as the pressure of the gas is reduced. We are able to distinguish four layers in this gas, though three of them only are easily recognised. As a first approximation we may assume the outline of these layers to be parallel to the outline of the electrode, though, as we shall have to mention, Dr. Goldstein has shown that this is not strictly correct.

The layer of the negative glow adjacent to the cathode is luminous, and shines in air with a yellowish-red tint. This first layer is surrounded by a second layer, which is very little luminous. This is the dark space mentioned by Mr. Crookes; but, as Dr. Goldstein shows, it is not entirely dark, but has in air a bluish tint. We next come to the third and fourth layers, which may very well be taken as one, and which are more generally designated by means of the term, negative glow. They form the outer boundary of the luminosity surrounding the cathode. If the pressure of the gas is sufficiently reduced to enable the glow to touch the glass, it becomes phosphorescent, and only the layer of the gas immediately touching the glass causes the phosphorescence. The phosphorescence gets stronger as exhaustion proceeds; at the same time the luminosity of the glow gets weaker. The appearance and extension of the glow does not depend on the position of the anode, while the luminous positive discharge varies very much with the relative position of the electrodes, and can be made to disappear altogether by bringing the electrodes sufficiently near.

Already Plücker, and especially Hittorf, have come to the conclusion that the negative glow is propagated in rectilinear rays from the cathode, and it can further be shown that the direction of propagation is generally in a direction nearly normal to the surface of the cathode. Dr. Goldstein draws a distinction between such elements of the cathode which lie near the edge, if the surface of the cathode has edges, and elements which are removed from the edge. While those elements not near an edge only send out rays within a cone of narrow aperture in a normal direction, the edges send out rays in all directions. This difference in the behaviour of different elements of the same surface is, it appears to us, well explained by Dr. Goldstein's discovery of a repulsion between the electrode and a ray proceeding from the cathode. A little consideration will show that this repulsion will, whenever cylindrical or plane electrodes are used, be in a nearly normal direction for any part of the surface which is sufficiently removed from the edge, while near the edge the resultant repulsion will be away from the surface and from the greater angle with the normal the nearer the ray is to the edge. This would prove of course that the repulsion is not an electrostatic one, for in that case it would always be at right angles to the surface. If the exhaustion is such that the glass becomes phosphorescent, the phosphorescence, being produced by the rays proceeding from the cathode, it is clear, will form a luminous ribbon surrounding the electrode, which is a little larger than the electrode.

If now a solid body is introduced between the cathode and the glass inclosure, a shadow of this body will appear in the phosphorescent light on the glass; the formation of the shadow is a direct consequence of the rectilinear propagation of the rays.

We now proceed to describe Dr. Goldstein's experiment in its simplest form.

In a cylindrical vessel two parallel electrodes of equal length are introduced at one end, while the other end contains a third electrode which shall always form the anode. Let the pressure be such that phosphorescence appears, and let only one of the two parallel electrodes be connected with the negative pole of the coil, while the other is insulated. A shadow of this insulated wire is seen in the phosphorescent light on the glass. Now let the insulated wire be brought into metallic contact with the other electrode, and the whole appearance will change. In the phosphorescent light of the glass we shall see two dark surfaces of equal size and shape, and with distinctly marked edges. The two dark surfaces are situated in such a way that a plane which passes through the electrodes cuts them into two equal halves. They are partly bounded by straight lines, partly by two semicircular arcs.

The parts formed by straight lines are parallel to the electrodes, and of equal length; these straight lines are joined at the lower end, that is, at the free end of the electrodes, by means of a half circle, which is partially repeated at the upper end; but where the electrodes are sealed into the glass the curve is interrupted. The dark surfaces are bordered by a bright line of light. It will facilitate the understanding of the position and shape of these dark surfaces if we mention already here that they are such as would be produced if the rays emanating from each electrode, and propagated in a normal direction from it, suffer a repulsion and consequent deflection in the neighbourhood of the other electrode, so that the dark space is formed by the absence of the phosphorescent light which would be produced by the rays coming from the farther cathode.

We cannot here give the further description of shape and the measurement of the size of these dark surfaces, but at once describe their properties. In the first place the size and shape are altogether independent of the position, form, and size of the positive electrode. The relative position of the two cathodes, on the other hand, materially affects their behaviour; and Dr. Goldstein gives their shape, for instance, if, instead of being parallel, they are at right angles to each other, either in the same plane or one in front of the other. We have already stated that in the case of parallel electrodes the parts of the outline forming straight lines are of equal length with the electrodes, and hence the length of these dark surfaces increases with the length of the electrodes, but the breadth and half-circle joining the straight lines

[1] "A New Kind of Electric Repulsion," by Dr. E. Goldstein. (Berlin: Julius Springer, 1880.)

does not vary with the length of the electrodes. The further removed the glass walls are from the two electrodes the greater is the width of the surfaces. All these and other properties follow at once if we consider that the luminosity is produced by the intersection of the rays proceeding from the cathodes with the glass walls. If we increase the thickness of one of the electrodes, the size of the dark surface nearest to it is increased. We now turn to the experiments which have been made in order to clear up the cause of the phenomena. By means of very ingenious experiments Dr. Goldstein proves that it is only light produced by the nearer electrode which is seen within the boundary of the dark surface, for although we have called them dark, they are only so by contrast, and they show a faint phosphorescence. Dr. Goldstein had, in a former paper, shown that when the cathode is perfectly smooth, the phosphorescent light produced by the glow shows inequalities. By twisting the aluminium electrodes he could obtain a series of spiral curves in the phosphorescent light more luminous than the rest. If one of the two cathodes is twisted in such a way and connected with the other, the spiral curves are interrupted in the dark space which is removed from the twisted electrode, but they are visible in the dark surface nearest to it.

The dark surface cannot be considered as enlarged shadows only of the electrodes, for their shape is different, but they might as regards shape be considered as shadows of the second and non-luminous layer of the negative glow. This remark we believe to be of importance, but Mr. Goldstein shows that they cannot really be such shadows, for they appear even when by an approach of the two electrodes the two non-luminous layers fuse into one and so lose their individuality.

The following experiment proves the repulsion. A metallic diaphragm is introduced between the two cathodes. A small hole is made in the diaphragm with its centre in a line joining the electrodes. Only some of the rays proceeding from each cathode can now reach the next, and consequently we observe only a small phosphorescent speck at the opposite side of the glass wall if one of the electrodes is insulated, but the dark shadow of the nearest electrode is visible in this phosphorescent speck. If now the two cathodes are joined the phosphorescent speck is seen to divide into two which separate and clearly show that the rays producing the phosphorescent light must have suffered a deflection as soon as the two cathodes were joined. Further experiments show that the deflection takes place at right angles to the surface of the electrode, and that it takes place at sensible distances from the repelling cathode, although it rapidly decreases in strength. Near the edge of a repelling cathode the repulsion does not take place in a normal direction, and Dr. Goldstein draws again a distinction between elements of a surface according as they are removed or near an edge. We believe this distinction to be unnecessary, and that all phenomena are explained by the fact that all parts of the electrode are repelling, and not only the elements nearest to the deflected ray.

Some remarkable secondary phenomena take place in a deflected system of rays. If, for instance, a system of rays forming a cone of narrow aperture passes near a second cathode, it is not only deflected but the aperture of the cone is increased. The phenomena are such as would be produced if a cathode not only repels the rays but also induces a state in the particles forming the ray such that they now repel each other. Also parts of the same cathode repel rays proceeding from other parts, and the repulsion increases the thicker the electrode. All these facts are illustrated and proved by a series of well-arranged experiments. Dr. Goldstein next examines the influence of an anode, but we shall not follow him, as it is found that the effect of an anode is exceedingly small, and most likely always produced by secondary causes.

The deflection is the same in all gases: air, hydrogen, carbonic oxide, and magnesium vapour having been tried.

The deflection is independent of the metal of which the cathode is formed; it is independent of the pressure. It is also independent of the intensity of discharge when the two electrodes are in metallic contact, so that the current is equally divided between the two cathodes. But remarkable changes take place if the current is not so equally divided. This can be done by joining the electrodes not metallically, but with a bad conductor, as for instance a moist thread. It is then found that the dark surface nearest the cathode through which the smaller discharge passes is much reduced in size, while the other dark surface is increased. It follows from experiments such as this that the repulsion does depend on the intensity of discharge, but that while a cathode through which more electricity passes more strongly repels, a ray which proceeds from such a cathode is less strongly deflected. If therefore we have seen that the dark surfaces do not vary in size, whatever the intensity of discharge, if the two poles are connected with a piece of metal; this is due to the fact that each cathode repels more strongly, but that the rays of the other electrode (owing perhaps to the greater velocity of the molecules proceeding from it) are less easily deflected, and that the two effects counterbalance each other. Dr. Goldstein considers, rightly no doubt, that the shadows seen when one apparently insulated metallic body is introduced between the cathode and the glass are due to a similar repulsion, because we may consider that a small part of the discharge always passes through such a body, the glass into which the body is necessarily sealed not being an absolute non-conductor. The shape of the shadow confirms this supposition.

Dr. Goldstein has also obtained the repulsion from electrodes consisting of glass and mica, so that the metallic or non-metallic nature of the electrode does not influence the phenomena. He has also proved that the source of electricity is immaterial, as might have been expected.

Dr. Goldstein has also endeavoured to prove that the deflecting power of a cathode does not act through a solid screen, but he has chosen metallic screens for his experiment.

If the repulsion is of the nature of electric repulsion a metallic body might act as a screen, while a non-metallic body would allow two bodies on opposite sides of it to repel each other. As it is impossible to form any idea on the cause of these phenomena unless we know whether the deflecting power is cut off by any solid body, it is much to be wished that Dr. Goldstein will repeat his experiments with non-metallic screens.

In the last part of his book Dr. Goldstein discusses various theories which might be proposed and have been proposed for the explanation of the phenomena taking place in the neighbourhood of the negative electrode. The result is that none of them are satisfactory. While this no doubt is true, Dr. Goldstein is too severe, we believe, in his criticisms of some of the suggestions which have been made, and which may, in our opinion, after all contain the germ of the true explanation, though in their present shape they may not be quite satisfactory. Some of the facts which to Dr. Goldstein are sufficient to reject a theory may, we believe, be explained without putting too great a strain on our present ideas, and sometimes we believe Dr. Goldstein to be in error, as when, for instance, he says that a body must necessarily move in a line of force. It would at least be a sad look-out for our earth if this was true, and Dr. Goldstein would in that case have occasion to study before long the electric phenomena on the surface of the sun. We will hope, for the sake of science, that both Dr. Goldstein and his molecules do not always move in lines of force, and that he will often favour us with such interesting and valuable contributions as the one before us.

ARTHUR SCHUSTER

PHYSICS WITHOUT APPARATUS[1]

VII.

IN the preceding articles on "Physics without Apparatus" it has been shown how a large proportion of the fundamental experiments in most branches of physics can be performed without employing expensive apparatus.

The next of these branches to claim consideration is the science of optics. Here again, as in electricity and in heat, we find that, while the higher quantitative laws of the science require for their experimental proof apparatus of the finest and most exact and therefore most expensive nature, the *elementary facts* of experiment are readily demonstrable with little or no apparatus of a formal kind.

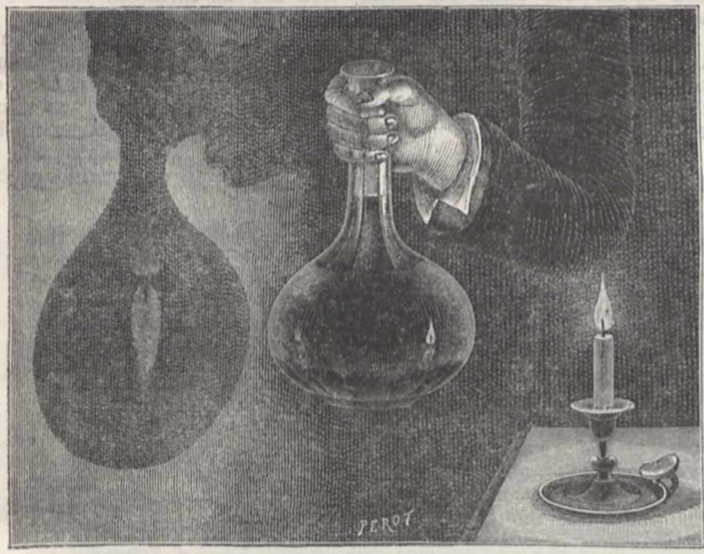


FIG. 22.

An ordinary looking-glass, a lighted taper, and a foot-rule or a measuring tape are quite sufficient to demonstrate the simple geometrical laws of reflection; for with their aid it is very easy to show that the image of the candle in the mirror is virtually situated at a distance behind the mirror equal to the actual distance of the candle in front, and that, when a ray falls obliquely on the mirror, the angle of incidence is equal to the angle of reflection. A teacher who wishes to go further into the matter, and to demonstrate the laws of reflection at curved surfaces, usually provides himself with the appropriate silvered mirrors of convex and concave form. Failing these, the exterior and interior surfaces of the bowl of a bright silver spoon will probably be as satisfactory a substitute as any. We have found even a saucer of common glazed earthenware to form a very fair concave mirror, giving upon a small tissue paper screen a beautiful little inverted image of a distant gas flame.

To illustrate the geometrical laws of refraction through lenses, a good reading-glass of large size is a desirable acquisition. Spectacle-lenses, though of smaller size, and therefore admitting less light, are also of service. In the absence of any of these articles, it is generally possible to fall back upon a water-decanter, provided one can be found of a good globular form, and not spoiled for optical purposes by having ornamental work cut upon the sides of the globe. Fig. 22 shows how this decanter, filled with water, is to be employed. It is held a few inches away from a white wall, and a candle is placed at the opposite side, so that its light falls through the decanter on to the wall. The candle is moved towards or away from the decanter until the position is found in which its rays focus themselves upon the wall giving a clear inverted image of the candle flame upon the wall. The experiment may be varied by setting down the candle on the table and then moving the decanter to and fro until a definite image is obtained. If a large hand reading-glass be available, the image will be much clearer than with the improvised water-lens; and a further improvement in the manner of experimenting may be made by using a screen of white paper or card instead of a whitened wall on which to receive the image. The sheet of paper should be set up in the simple fashion shown in Fig. 24, at one end of a table. The candle should be placed at the other end of the table, and the reading-lens moved about between them until a point is found at which it throws upon the screen a good clear image of the candle. It will be found that there are two such points, one near the candle, the other near the screen. In each case the image of the candle will be inverted, but in the first case it will be a magnified and in the second a diminished image, the size of the image, as compared with that of the real flame, being proportional to their respective distances from the lens. When the lens has been placed in a position of good focus, the candle may be removed and placed where the screen stood; if now the screen is placed where the candle was, it will be found that the image is again visible on the screen, still inverted, though altered in magnitude. This experiment, in fact, proves the law of conjugate foci.

The young beginner in science who repeats these experiments for himself will begin to understand how it is that in the photographer's camera the image in the instrument is inverted, and how it can also be true that the images cast on the sensitive retina of the eye are also inverted. The retina at the back of the eye-ball answers to the white screen on to which the image is

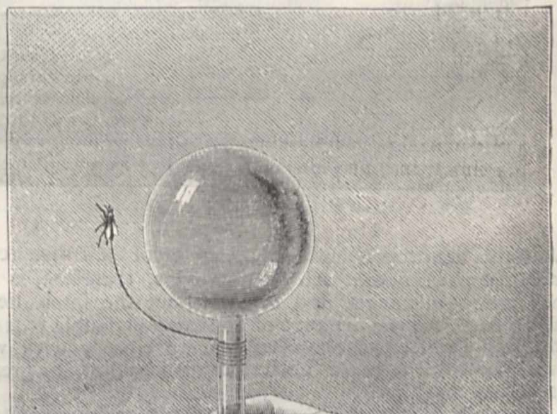


FIG. 23.

[1] Continued from p. 489.

thrown by the lens in front of it. It is possible indeed to show in actual fact that the image in the eyeball is inverted; the experiment is very simple, but we believe that this is the first time that it has been described in print. Take a candle, and hold it in your right hand as you stand opposite a looking-glass. Turn your head slightly to the left while you look at the image of yourself in the glass. Open your eyes very wide and look carefully at the image of your left eye. Move the candle about gently, up, down, forward, &c., so that the light falls more or less obliquely on to the eyeball. You will presently notice a little patch of light in the extreme outer corner of the eye; it is the image of the candle on the inside of the eyeball, which you see through the semi-transparent horny substance of the eye. If you move the candle up, the little image moves down, and if you succeed well, you will discern that it is an inverted image, the tip of the flame being downwards. You thus prove to your own satisfaction that the image of the candle in your eyeball is really upside down.

Fig. 23 shows a magnifying-glass of very simple construction, which a few years ago found a great sale in the streets of London, at the price of one penny. A bulb blown at the end of a short glass tube is filled with water. When held in front of the eye, this form a capital lens for examining objects of microscopic dimensions, which may be secured in place by a bit of wire twisted round the stem.

The principle by which the intensity of two lights is compared in the photometer is very easily shown. The arrangement depicted in Fig. 24 shows how to measure the relative brightness of an Argand oil-lamp and of an ordinary candle. Both these lights are set upon the table, and are so arranged that each casts on to a screen of white paper a shadow of a tall narrow object. The most handy object for this purpose is another candle unlighted. The Argand lamp, being the brighter light, will cast the deeper shadow of the two, unless it is placed further away. The measure of the brightness is obtained by moving the brighter light just so far off that the intensity of the two shadows is equal, for then we know that the relative intensities of the

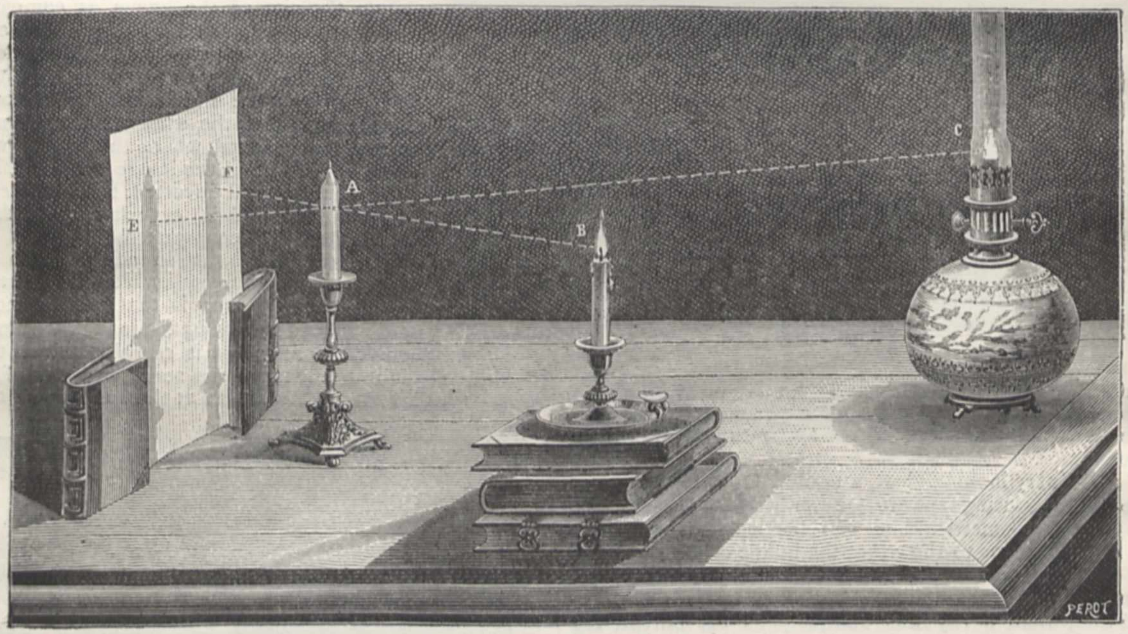


Fig. 24.

two lights are proportional to the squares of their distances from the photometer. All that remains, therefore, is to measure the distances and calculate out the intensities. If, for example, the distance of the lamp is double that of the candle when the two shadows are equally dark, we know that the brightness of the lamp is four times as great as that of the candle.

Many other facts in optics can be shown with no greater trouble than that entailed by such simple experiments as we have described. The pendant lustre of a chandelier will provide an excellent prism of glass for showing the dispersion of light into its component tints. A couple of spectacle glasses appropriately chosen will, when pressed together, afford capital "Newton's rings" at the point where they touch. Diffraction bands of gorgeous hue may be observed by looking at a distant gas-light, or at the point of light reflected by a silvered bead in sunshine, through a piece of fine gauze, or through a sparrow's feather held close in front of the eye. And yet more remarkable effects of diffraction are obtained if the point of light be looked at through substances of still finer structure, such as the preparations of woody structure, and of the eyes of insects which are sold as microscopic objects. But the explanation of these beautiful phenomena would lead us far beyond our subject.

(*To be continued.*)

THE JAMAICA HURRICANE AND THE BOTANICAL GARDENS

THE following letter from Mr. Morris has been forwarded to us from Kew for publication :—

Botanical Department, Gordon Town, Jamaica, September 7, 1880

At the Cinchona Plantation, besides damage to our buildings and sheds of about 650*l.*, our nurseries and seed beds have suffered so much as to reduce our stock of available seedlings from something like 500,000 down to 80,000. These were intended for planting out in the latter part of this year and the beginning of the next year. We shall in consequence be unable to distribute seedlings as we intended, and so suffer considerably in expected revenue. At the plantations vegetation is so literally swept away that only here and there can we see a standing tree. There is not a leaf left on either the indigenous or cinchona-trees. After a careful inspection we have estimated that 20,000 cinchona-trees of all ages have been uprooted or so severely damaged that they must be immediately barked. Though we had given up barking definitely till the return of dry weather next year, we are now obliged to take it up with great energy and send the bark down to be dried in the plains. We hope to get a return of about 1,500*l.* to 1,800*l.* for "broken and twiggy" bark, but this will be but a poor result considering the sacrifice made to secure the bark at all hazards before it has dried and hardened on the trees.

Out of the small garden at Castleton, covering only about five to six acres, I found fifty-five trees destroyed, and ninety-eight severely injured. Out of the trees severely injured, *i.e.* probably blown quite down and put up again with trimmed limbs and supports, I found the Para-rubber mangosteen, Tonquin-bean, cam-wood, olive, cinnamon, nutmeg, East Indian mango, chocolate, Liberian coffee, &c. Even if they live we shall get no fruit from them during the next season, and we shall be unable to supply plants in great demand for some time.

I am glad to say that the superintendent did not suffer personally, though the roof of the residence was partially blown away, and the office canted almost on its side.

The Parade Garden, Kingston, felt the hurricane greatly, but as we had nothing there except ornamental trees and shrubs we hope to recover our losses soon.

The cocoanut plantation at the Palisadoes had sixty-one bearing trees blown down, and forty-one rather young ones just coming into bearing. This plantation is on a narrow spit of sand running six miles out and inclosing Kingston Harbour. The force of the wind being from the south and against the plantation, the waves broke over it at several places, and the harbour being consequently filled, much damage was done to the wharves and shipping.

You will, I am sure, be sorry to hear that the Old Bath Garden has also shared in the general injury. The fine old cinnamon-tree, the camphor-tree, and the pinus are down. Till the place is cleared the keeper is unable to give me fuller particulars.

The King's House Gardens and grounds have fortunately escaped much injury. D. MORRIS

NOTES

MESSRS. CHARLES GRIFFIN AND CO. announce that they have at last in the press the memorial volume to the late Prof. Macquorn Rankine. It is entitled "A Selection from the Miscellaneous Scientific Papers of W. J. Macquorn Rankine, C.E., LL.D., F.R.S., late Regius Professor of Civil Engineering and Mechanics in the University of Glasgow, from the *Transactions* and *Proceedings* of the Royal and other Scientific and Philosophical Societies, and the Scientific and Engineering Journals, with an Introductory Memoir of the Author, by P. G. Tait, M.A., Professor of Natural Philosophy in the University of Edinburgh; edited by W. J. Millar, C.E., Secretary to the Institution of Engineers and Shipbuilders in Scotland." The volume will contain many papers of great weight and value, at present to be found only in the Records of the various scientific and philosophical societies, and in the scientific and engineering journals, to which they were originally contributed, and therefore inaccessible to the majority of scientific workers. No doubt the bringing-together in one volume of these successive important contributions to science will be acceptable to all who knew of Rankine's high position in science. A fine portrait on steel will be prefixed to the volume.

WE have a few further details on the meeting of the German Association at Danzig. Salzburg was unanimously chosen as the town in which the next year's congress of the Association should be held. Dr. Wernicke of Berlin gave an address "On the Scientific Standpoint in Psychiatry," and in the section for physics and meteorology Dr. L. Weber read a paper upon "Lightning Strokes in Schleswig-Holstein." In the section for the superintendence of instruction in mathematics and natural science Dr. Feyerabendt spoke with reference to mathematical school-books, which, as he showed, would bear much simplification and condensation. A point which he urged among others was that the matter taught should be divided, not upon scientific principles, but with regard to its easy and ready comprehension by the scholar.

THE death is announced, on August 22, of the Hon. John Imray, M.D., of Dominica, West Indies. Dr. Imray had done much for the botany of his island, but is best known for his successful efforts to introduce Liberian coffee and the cultivation of limes into the West Indies. Another death is that of M. Edmond Barbier, the translator into French of some of the works of Mr. Herbert Spencer and Sir John Lubbock, at the age of forty-six years.

A LAUDABLE innovation has been made in the library of the French Academy, which is not open to the public. Any one wishing to consult any of the rare and precious books in the library has only to make an application to the librarian to receive the required authority.

DR. WATT, of the Bengal Educational Department, who is now engaged in the examination at Kew of his extensive collections of Indian plants, has been deputed by the Government of India to visit Manipur, on his return from furlough, for the purpose of reporting on the forest and vegetable resources of that territory.

Science, the new American record of scientific progress, states that the Rev. W. H. Dallinger has consented to become Governor and Professor of Natural Sciences of Wesley College, Sheffield, U.S.A.

MR. JAMES BLYTH of Edinburgh has been elected to succeed Prof. Forbes in the Chair of Natural Philosophy at Anderson's College, Glasgow.

DR. J. VOSMŒR of the Hague intends publishing a detailed bibliography of the sponges, and it is to be hoped that all authors of works or papers on this interesting group will send copies of their writings to him at 73, de Ruyter Straat, Haag, Holland.

THE bureau of French meteorology has been revived for 1880-81, M. Hervé Mangon being continued president.

THE recent change of Ministry in France has brought forward for the second time since 1870 the Minister of Public Instruction to the direction of the Cabinet. M. Barthelemy St. Hilaire, the new head of the French Foreign Office, is not only a member of the French Senate, but also of the Academy of Moral and Political Sciences. He has published a large number of works on philosophy, among which the most considerable is a translation of the whole works of Aristotle, with a commentary. In order to be better able to understand physics and mechanics, he studied mathematics at the age of forty-five under the direction of his friend Corioles, then scientific director of the Polytechnic School. He was an intimate friend of Leverrier. He was born in Paris in 1809, and has just completed his seventy-first year.

THE Birmingham Natural History Society, which has hitherto met in the Midland Institute, has been provided with ample accommodation in the Mason Science College. The Society, which numbers 400 members, is making an effort to fit up the rooms in an appropriate and comfortable manner.

THE Epping Forest and County of Essex Naturalists' Field Club held the seventh, and probably the last, of the summer course of field meetings at High Beech and Monk's Woods on the 2nd inst., the purpose of the meeting being the observation of the *cryptogamic* flora of Epping Forest. The conductors were Dr. M. C. Cooke, Mr. Worthington Smith, F.L.S., Mr. James English, and Mr. E. M. Holmes, F.L.S.; and the party (upwards of fifty in number) included many well-known London naturalists. Several scarce *fungi* were noticed, although the weather proved very unfavourable for field-work. After tea, botanical demonstrations were given, one of the speakers being Prof. Max Cornu of Paris, who expressed the pleasure he had in being present, and said that he hoped to establish similar meetings in Paris. It is intended to make this "fungus meeting" an annual institution.

DR. ANDREW WILSON, F.R.S.E., has in the press a new work entitled "Chapters on Evolution," in which a popular *résumé* of the Darwinian and other theories of development is to be given. Messrs. Chatto and Windus are the publishers.

THE French Minister of War has authorised the erection of a meteorological observatory in the fort which has been recently constructed in the Ballon de Servance, in the Vosges.

THE Rev. A. E. Eaton states (*Entomologists' Monthly Mag.*) that "in Lisbon male field-crickets are sold in miniature cages by bird-fanciers at the rate of a penny a-piece. They are kept in stock by hundreds together in open tea-chests, lined for the first three or four inches from the top with slips of tin, and are fed upon lettuces. The natives like to have a 'grillo' chirping in the room, and make pets of them." Has this, or a similar custom, been observed by travellers in other parts of the South of Europe? No doubt there is a superstitious element in it, on the principle that sometimes induces our own people to send to the bakers for house-crickets "for luck." In China, and elsewhere, other Orthopterous insects are well known to be sold in little cages.

HITHERTO, we must confess, Trinity College, London, has been somewhat of a *nominis umbra* to us; but with its fat Calendar before us it can be so no longer. It was established in 1872 mainly for the promotion of musical education. The Council, we are glad to see, take a liberal view of what is necessary to constitute a well-educated musician, and provide the means of a really liberal education. There is a faculty of music in which, among other subjects, the physiology of the vocal organs and of the ear is taught. In the faculty of arts, besides ancient and modern languages, there are classes in mathematics, chemistry, zoology, botany, geology, and physiology. The College has not only its curriculum for students in London, but has centres for examination all over the three kingdoms, and judging from the lists of names of those who have passed, these examinations must be widely taken advantage of. The Calendar contains all necessary information as to the College and its work, with the examination papers for the past year and other matters. If it is able to carry out its programme, the institute ought to do much good.

AT the Exhibition in connection with the Sanitary Congress which has been held at Exeter, there are several things worthy of some notice. It may be mentioned that the marked features of the collection are the gas stoves, improved flushing apparatus, ranges for the saving of fuel, various appliances for house drainage, ventilation, and arrangements to prevent sewer gas from rising into houses through closets and sinks. The number of manufacturers who exhibit under these heads shows the principal directions in which practical sanitarians are working. First as to the gas-stoves. These are divided into heating-stoves and cooking-stoves. In the heating group the object is to attain as much radiation as possible; in the cooking group the object is to prevent loss of heat by radiation. The Exeter Gaslight and Coke Company, believing that gas will soon supersede coal for heating and cooking, whilst it will itself be superseded as a lighting agent, have offered four handsome silver medals for the best stoves. It is stated on the authority of a late cook of the Reform Club that the gas kitchener No. 99 in Class III. cooked 13 lbs. of meat in fifty-one minutes, at a cost of three farthings, the gas being at the rate of 3*s.* 6*d.* per thousand. The graduation of heat can be effectively regulated by the tap of the pipe which secures the gas burners. The gas water-heaters shown are of two kinds—those in which the gas jets are introduced under the bath, and those in which they are introduced into a separate boiler placed in the bath-room or outside it. No. 25, Class III., is an example of an upright cylindrical boiler with which water enough for a bath can in twenty minutes be obtained at 95°. It is impossible to draw attention to all the novelties, but there are some few deserving special attention. Class II., No. 3, is a "twin" door. Two doors a few inches apart are hinged so as to open together. There is an open space for ventilation between them. For housemaids' sinks on different landings, for closets, and for sculleries and kitchens, they are invaluable. In filters there is not much new. A French firm shows a modification of their well-known filters, it being an adaptation of their principle to table filters with the use of Carferal. The main point is that the Carferal can be so readily changed, and it is now well recognised that no filtering material is of any good after many days' use. The trouble involved is no more than that of making tea, and a lady can see to it herself without being at the mercy of careless servants.

THE *St. James's Magazine* for October contains the first instalment of an interesting series of articles on "Lightning Protection for Telegraphs."

THE remains of a lake village have been discovered in a marsh at Regnate, near Milan. They include, it is stated, shavings of flints apparently cut with bronze instruments.

THE *Daily News* Naples correspondent writes that in the excavations commenced a short time ago at Villagrande (Sardinia), there have come to light some instruments which are very remarkable if, as believed by competent persons, they belong to the bronze epoch, which, it is asserted, was exceptionally prolonged in this part of the island. The instruments in question are two bronze saws and a four-pronged fork, all is said to be found in the same repository. Near Taranto, in some new excavations opened in the vicinity of former ones, there have been found twenty-two skeletons, each in its respective tomb, not far below the surface of the ground. The tombs are all dug in the rock, disposed in various positions, and covered with square slabs of stone. Some of them were capable of holding two corpses.

MR. PFOUNDES will hold, on Saturday afternoon, at 1, Cleveland Row, St. James's, the first of a series of meetings at which Japanese art with native sketches, photographs, &c., will be exhibited, and some account given of the country and people.

THE Philadelphia Court has forfeited the charters of the Eclectic Medical College of Pennsylvania and the American University of Philadelphia for selling bogus diplomas. These were the medical colleges managed by Dr. Buchanan, who is now awaiting his trial here.

THE exhibition of the Photographic Society opened at the Galleries, 5A, Pall Mall East, on Monday, and is quite worth a visit. There are several productions of special interest: among these are some fine photographs from Novaya Zemlya taken during the second Dutch Arctic Expedition last year; several excellent views of the Tay Bridge disaster; Burnham Beeches, by Lieut. L. Darwin, R.E.; magnificent portraits of lions and tigers taken, we presume, in the Zoological Gardens; several beautiful views taken of Siam, including a group of Laotian huts. There are also several specimens of new apparatus used in photography.

AN important innovation has been made in all the French colleges by M. Ferry. Any pupil wishing to be promoted to a superior class is obliged to pass an examination. The Government is asking important credits for the rebuilding of the principal colleges of Paris and the construction of new colleges outside of the fortifications.

Education is the title of a new international bi-monthly magazine, devoted to the science, the art, the philosophy, and the history of education. It is published at Boston, Mass., and by Trübner and Co., London.

A USEFUL exhibition is being held in Glasgow of apparatus for the utilisation of gas, electricity, oils, &c., and of hydraulic, architectural, mining, and sanitary appliances.

UNDER the name of Tong-pang-chong a Chinese remedy for skin diseases was brought to European notice some two years since. The material as brought to this country appeared like fragments of a woody root, and it was said to be produced by a plant growing in Siam, from whence it is sent to China, where its use had become quite general. From subsequent information received from China and from examination and comparison of specimens sent to this country with those already contained in the Kew Museum, there seemed but little doubt that the plant which produced the Tong-pang-chong of the Chinese was *Rhinacanthus communis*, an acanthaceous plant. A good deal of interest was attached to this remedy when it first came to notice, since which time nothing has been heard of it until within the last few weeks, when some of the material has been received in this country, and is now in the possession of Messrs. Christy and Co. of Fenchurch Street. Whether this consignment will prove to be identical with *Rhinacanthus communis*, and so prove the accuracy of the preliminary determination which was made from scant materials, or whether it will turn out to be produced by a distinct plant will no doubt, shortly be seen. The remedy is referred to in the *Kew Garden Report* for 1877, p. 41.

HERR TORNÖE has published in the *Sitzungsberichte der k. Akademie der Wissenschaft zu Wien* (81, 924) a detailed account of the estimations of salt in the Norwegian Sea, conducted by him during the late Norwegian North Sea Expedition. The paper is a valuable contribution to the physical history of the North Sea.

THE monster python which is kept alive in the Antwerp Museum having had inflammation of the jaw, a Belgian doctor volunteered to enter its cage in order to cure it; but the brute attempted to suffocate the poor doctor, who was glad to escape with his life.

THE Queenwood College Mutual Improvement Society seems to be doing much to encourage the study of natural science among its members. The Report of the Committee for the last summer term speaks highly of the various collections made for the exhibition; several useful papers were read and interesting excursions made.

IN the report of the awards made by the different juries of the Exhibition of Agriculture and Insectology at Paris it is stated that a public company has been formed in Spain for the rearing of the silkworm fed on the oak, and the number of cocoons to be collected this year will probably amount to no less than three millions. A special machine for weaving this new silk has worked during the whole time that the Exhibition has been open. A medal was awarded to an exhibitor for a lamp specially arranged to catch insects. It is suggested in the report that the same experiment should be tried by electric light, and a recent instance has been quoted to prove that it would be really successful. A certain number of electric lights, for ordinary illuminating purposes, were used this summer in the gardens of the Meaux Exhibition, in the vicinity of the Forest of Fontainebleau. No arrangements were made for catching the insects, and they fell round the lamps, except a few that got admittance through the holes of the regulator. The number of the latter was so large that two of these lamps placed at a coffee stall in the open air had to be removed, all the consumers being covered by moths of every description.

THE piscicultural experiments at Ercildoune, Victoria, Australia, have been unusually successful; 9,100 ova were collected, of which 2,000 were salmon trout.

THE additions to the Zoological Society's Gardens during the past week include a Purple-faced Monkey (*Semnopithecus leucoprymnus*) from Ceylon, presented by Mr. Wm. Collingwood; a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Mr. Henry Thimbleby; a White-cheeked Capuchin (*Cebus lunatus*) from Brazil, presented by Mr. Henry Ch. Marckman de Lichtabbell; two Common Cranes (*Grus cinerea*), European, presented by Mr. Norman W. Shairp; a Rose Hill Parrakeet (*Platycercus eximius*) from New South Wales, presented by Mr. Charles Porter; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. Percy Day; a West African Python (*Python sebæ*) from West Africa, presented by Dr. F. Speer; a Bless-bok (*Alcelaphus albifrons*) from South Africa, a Prince Albert's Curassow (*Crax alberti*) from Columbia, deposited; a Sulphur-breasted Toucan (*Ramphastos carinatus*) from Mexico, purchased.

OUR ASTRONOMICAL COLUMN

THE BINARY STAR α CENTAURI.—Mr. W. L. Elkin, who has been recently a student at the University of Strassburg, has given, in a dissertation for the degree of Doctor, a new determination of the orbit of this remarkable star, in which he has had the advantage of a fine series of measures executed by Sir T. Maclear, Mr. W. Mann, and Mr. G. Maclear at the Royal Observatory, Cape of Good Hope, collected and forwarded to him by Mr. Gill. We subjoin his elements, which, though not considered definitive, yet appear to represent the whole course of micrometrical measures very satisfactorily. Mr. Gill's measures in 1877 seem to indicate well the position of the companion about its nearest approach to the principal star, which it was feared at one time there would be danger of losing at this passage of the periastre. For the sake of comparison the provisional orbit deduced in 1879 by Dr. Doberck is annexed; the most noticeable difference is in the period of revolution.

	Elkin.	Doberck.
Passage of periastre	1875·97	1875·12
Node	25° 47′	25° 32′
Node to periastre on orbit..	54° 47′	45° 58′
Inclination	79° 32′	79° 24
Excentricity	0·5260	0·5332
Semi-axis major	17″·50	18″·45
Revolution	77·42 years ...	88·536 years.

Mr. Elkin's orbit gives the following angles and distances:—

1880·0 ...	Position	185°·7	...	Distance	4″·79
1881·0 ...	,,	192·4	...	,,	6·81
1882·0 ...	,,	196·1	...	,,	8·70
1883·0 ...	,,	198·5	...	,,	10·42
1884·0 ...	,,	200·2	...	,,	11·98

For the absolute parallax of α_2 Centauri, he states that the series of 156 altitudes observed on the same days, directly and by reflection with the Cape circle in the years 1856-60, assigns $+0''\cdot798 \pm 0''\cdot068$; Moesta from observations at Santiago had found 0″·88. Although a large parallax, the largest perhaps yet detected, may still be attributed to this star, it appears to be Mr. Elkin's conclusion that it yet remains to be determined within very narrow limits. Probably Mr. Gill, with the aid of the heliometer, may in due course give a good account of it.

THE VARIABLE R HYDRÆ.—Dr. Gould, at Cordoba, has given much attention to the changes in this variable star, respecting which Argelander remarked that so long as observations were confined to European latitudes little would probably be understood, and he has deduced a formula closely representing the observations, excepting one by Maraldi, about which there appears to be a large error. The earliest recorded observations of this celebrated variable Dr. Gould remarks were those of Hevelius in April, 1662, published in the scarce volume of the "Machina Cœlestis" in 1679. Montanari of Bologna comparing Bayer's Uranometry with the sky on April 15, 1670, remarked it as a star of the fourth magnitude, not entered upon the map, and notified it as a new object. Its variability was recognised by Maraldi at Paris in 1704, who watched it at intervals till 1712. There then appears to be a gap in the observations until we come to those of Pigott in 1784 and 1785. Argelander collected and discussed all the observations to the beginning of 1863, and deduced a formula which fairly represented the data since 1784. The length of the period is decreasing rapidly, amounting, as Dr. Gould says, to more than nine hours at each successive recurrence—a circumstance which impeded the determination of the number of periods elapsed between Montanari's observation in 1670 and the first maximum noted by Pigott. Twelve periods having elapsed since the latest maximum included in Argelander's investigation, present data allow of clearing up several doubtful points.

Dr. Gould finds that the number of periods between the maxima of 1670 and 1784 must have been eighty instead of eighty-four, as assumed by Argelander, and the number between the maxima of 1670 and 1704 must have been twenty-three instead of twenty-five. Assuming that Maraldi's second maximum is erroneously dated in 1708, instead of 1707, he finds that all existing observations except Maraldi's first, may be represented within quite tolerable limits, "by supposing a uniform diminution in the period, upon which are superposed variable terms, according to which a symmetric perturbation completes its cycle in seventy-two years," and the following formula is finally inferred. The days are counted from the beginning of the year 1875:—

$$T = 35{\cdot}6\text{d.} + 434{\cdot}445\text{d.}\, n - 0{\cdot}37974\text{d.}\, n^2 + 32{\cdot}0\text{d.} \sin(5^\circ n + 10^\circ) + 2{\cdot}6\text{d.} \sin(10^\circ n + 324^\circ) + 6{\cdot}8\text{d.} \sin(15^\circ n + 205^\circ)$$

It will be found that the formula fixes the next maximum to January 18, 1881; Schmidt alone has observed the minima, which occur on the average at about 9-16ths of the interval between the maxima.

A NEW COMET.—On the evening of September 29 Dr. Ernst Hartwig of the Imperial Observatory, Strassburg, discovered a bright comet about 10° north of Arcturus, and having obtained observations on three consecutive nights, has calculated the following elements:—

Perihelion passage, September 6·9528 M.T. at Berlin.

Longitude of perihelion	° 80	′ 0·6
,, ascending node	43	32·3
Inclination of orbit	38	48·3
Logarithm of perihelion distance	9·56450	

Motion—retrograde.

Hence he finds, for Berlin midnight:—

	R.A. h.	m.	s.	Decl. °	′	Log. distance from Earth.	Sun.
Oct. 6 ...	16	7	40 ...	+24	35·5 ...	9·8147 ...	9·9231
8 ...	16	29	22 ...	22	46·2 ...	9·8488 ...	9·9432
10 ...	16	47	18 ...	21	3·5 ...	9·8827 ...	9·9623
12 ...	17	2	15 ...	19	29·6 ...	9·9158 ...	9·9805
14 ...	17	14	51 ...	+18	5·0 ...	9·9476 ...	9·9978

The intensity of light is rapidly diminishing, being on October 14 only one-sixth of that at the time of discovery.

The above orbit places the comet at 6 a.m. G.M.T. on September 12 near to Regulus, so that it is distinct from the object notified by Mr. Lewis Swift of Rochester, N.Y.

The comet was seen for a few seconds between clouds at the Royal Observatory, Greenwich, and at Mr. Barclay's observatory, Leyton, on the 5th, and is described by Mr. Talmage as "very bright," with a long tail."

CHEMICAL NOTES

IN connection with the subject of water of hydration the results of Van Bemmelen, described in the *Berliner Berichte*, are of interest. He has determined the quantities of water parted with, and also taken up by various hydrated oxides under different conditions of temperature and humidity of surrounding atmosphere. The results afford another instance of the graduation of chemical into physical actions. The amount of water taken up varies but little, but the strength of the combination varies much. The formation of hydrates appears to be a function of molecular weight of the oxide and of the temperature.

Two papers of great importance by Thomsen have just appeared in the *Berliner Berichte*. Thomsen attempts to base a general theory of the structure of carbon compounds on thermal determinations. He does this by measuring (indirectly, of course) the heat of dissociation of the carbon molecule, and from this and other data, finding a thermal value for the combination of two carbon atoms, to form a gaseous compound, by four, three, two, or one "link." Hence he deduces a thermal value for each "link." General equations are given for calculating the heats of formation of various isomers, assuming a certain "linking" of the atoms for each. In cases where various "linkings" may be assumed, a determination of the heat of formation may determine which "linking," and therefore which structural formula, is the more probable.

IN a paper read before the Owens College Chemical Society Messrs. Bevan and Cross detail experiments on jute fibre, which lead them to regard the intercellular portion of this fibre as probably consisting of an aromatic compound of the quinone class, together with a substance allied to the carbohydrates, and somewhat of the nature of cellulose. The presence of this intercellular substance confers on jute the power of retaining various dye-stuffs. The authors also describe a method of separating cellulose from jute fibre, based on the action of chlorine or bromine, subsequent boiling with dilute caustic lye, and washing in acid. Jute fibre which has been acted on by chlorine is coloured deep magenta by immersion in a solution of sodium sulphite. The work of Messrs Bevan and Cross promises results of considerable importance.

MR. O. HEHNER publishes in the *Analyst* the results of his determinations of phosphoric acid in potable waters. He concludes that the presence of more than 0·5 parts per million of P_2O_5 should be regarded with suspicion; also that absence of phosphates affords no positive proof of freedom from pollution.

IT is stated in the *Chemiker Zeitung* that if a solution of two parts of citric and one of molybdic acids be evaporated to dryness, heated to incipient fusion, and dissolved in 30 to 40 parts of water, a solution is obtained which imparts a blue colour to paper immersed in it, and dried at 100°. This paper is bleached by water, and may be used as a test for the presence of water in alcohol, ether, &c.

M. DE SCHULTER states in *Comptes rend.* that he has succeeded in preparing pellucid crystals of analcite by heating a solution of sodium silicate or caustic soda along with aluminous glass in sealed tubes to about 190°.

FROM analyses and determinations of specific heat of cerium tungstate, Cossa and Zecchini (*Gazetta chim. Italiana* for July) think that the atomic weight of cerium is better represented by 92, the number formerly adopted, than by 138, which—or more probably 141—is generally regarded as correct. The data of the Italian observers are as follows:—$Ce_2(WO_4)_3$ (Ce = 141) = 1026, × 0·0821 (sp. heat found) = 84·2, atomic heat of W = 6·4, of O = 4; hence molecular heat of $(WO_4)_3$ = 67·2, but 84·2 − 67·2 = 17, which ÷ 2 gives 8·5 as the atomic heat of cerium. $CeWO_4$(Ce = 92) = 340, × 0·0821 = 27·9; but 27·9 − 22·4 (that is, molecular heat of WO_4) gives 5·5 as the atomic heat of cerium. The careful determinations of the specific heat of metallic cerium made by Hillebrand, and the general analogies of the cerium salts, must however be regarded as of more value in determining the atomic weight of this metal than a series of estimations of the specific heat of a compound containing oxygen, concerning the influence of which element on the specific heat of compounds thereof we have so little exact knowledge.

THERE has of late been a considerable amount of discussion as to the existence of pentathionic acid, $H_2S_5O_6$. In a recent paper in the *Journal* of the Chemical Society, Messrs. Takamatsu and Smith bring forward evidence which appears conclusively to prove that this acid does exist.

HELL has studied the action of bromine on acids of the acetic series, and in a paper in the *Berichte* he shows that the substitution of bromine for hydrogen proceeds slowly, until from

10 to 20 per cent. of the change is completed, then more rapidly until about 60 per cent. is reached, and then again slowly. He also shows that the greater the molecular weight of the acid the more rapidly is the period of maximum action reached. In these phenomena we have fresh examples of the so-called "Chemical Induction" of Bunsen and Roscoe. This supposed special phase of chemical change would indeed appear to be of very frequent occurrence, being only absent in those changes—if such exist—which consist of a single part, the direct change only.

BERTHELOT, in the *Comptes rendus* of the Paris Academy, describes experiments which lead him to believe that by the electrolysis of dilute sulphuric acid a new oxide of sulphur—S_2O_7—is produced. This substance belongs to the class of peroxides, and is analogous with ozone and hydrogen peroxide; the formation of each of these substances is attended with absorption of heat. From the study of the thermal changes accompanying the solution of chlorine in aqueous hydrochloric acid and in water, the same author thinks that a trichloride of hydrogen, HCl_3, probably exists.

BOUSSINGAULT, in *Annales Chim. Phys.*, has examined the action of heat on barium dioxide under diminished pressure, and has shown that in a vacuum this substance parts with oxygen at a low red heat, and that oxygen is readily absorbed from the atmosphere by the baryta thus produced at about the same temperature, under ordinary pressures. It seems therefore that baryta may be employed as a carrier of oxygen from the atmosphere; hitherto the high temperature required for the decomposition of barium dioxide has brought about some molecular change in the baryta produced, which has rendered it incapable of absorbing more than very small quantities of oxygen from the atmosphere.

IN *Comptes rendus*, Hautefeuille states that he has obtained crystals of orthoclase and of quartz in the same tube by heating a mixture of acid potassium phosphate—previously fused with silica and alumina—with silica and a little potassium fluosilicate in a glass tube.

RADZISZEWSKI in Liebig's *Annalen* gives a careful study of the conditions under which various carbon compounds exhibit phosphorescence; he concludes that this phenomenon occurs with those compounds which combine, in presence of alkalis, with the active oxygen of ozone or other peroxide. Phosphorescence he regards as a special case of the phenomenon of combustion; during slow oxidation active oxygen is produced; hence it is in such processes of oxidation that phosphorescence is noticed. When oxidation is rapid much of the active modification of oxygen is produced, combination occurs rapidly between this and the oxidising substance, and we have the phenomenon of combustion. The phosphorescence of certain organised creatures is due, according to the author, to the slow oxidation, by the agency of active oxygen, of such compounds as lecithin, cholesterin, spermacetti, myricylic alcohol, sugar, fats, or ethereal oils. He shows that these substances are decomposed by cholin and neurin, and generally by bases of the formula $R_4 . N . OH$ (where R is a monovalent alcoholic radicle, *e.g.*, $CH_3 . C_6H_5$, &c.), and that this decomposition is attended with phosphorescence.

A SMALL pamphlet, "Report on Two Kinds of Coal submitted by the Chesapeake and Ohio Railroad Coal Agency," published by the Bureau of Steam-Engineering of the U.S. Navy Department, contains a detailed account of the methods of determining on the large scale the relative ratios of steam coals, which must be of very considerable service to any who require to perform such determinations.

IF aluminium hydrate, optained by precipitating a solution of alum by ammonia, be allowed to remain in contact with water for three or four months, it undergoes, according to M. Tommasi (*Comptes rendus*), a molecular change whereby it is rendered very much less soluble in acids, and is no longer capable of forming a compound with aluminium chloride.

PHYSICAL NOTES

THE conditions of geysers are investigated at length by Herr Otto Lang in a recent paper to the Göttingen Society of Sciences (*Nachr.*, No. 6). The theory of Bunsen he considers inadequate, and he proposes another, which has an interesting similarity to that of Mr. Mallet regarding the mechanism of the intermittent volcano at Stromboli.

OBSERVATIONS as to the changes of length of iron bars through magnetisation having been somewhat discordant, Prof. Righi has lately taken up the subject afresh (*Il Nuovo Cim.*, ser. 3, tom. vii.), and, to measure the displacements, he attached a fine steel spring, with mirror, to one end of the bar (which was magnetised by means of a spiral), the mirror being observed through a telescope. Changes in length were thus magnified 8,000 times. The results were as follows:—1. Magnetism produces in iron and steel an increase of dimension in direction of the magnetisation. 2. On cessation of the magnetising force a part of this increase remains, and more or less of it according to the coercive force. 3. The elongations are proportional to the square of the current's intensity when this is not very great. 4. When, after a strong current through the spiral, a weak current is sent in the opposite direction, it produces a shortening; but even when it is strong enough to demagnetise the bar, the latter retains a greater length than in the normal state. 5. During reversal of the polarity of a bar its length becomes momentarily less, and it oscillates in length. 6. A bar or wire of iron traversed by a current contracts at the moment of closing the circuit. 7. On opening the circuit it elongates, but this elongation is less than the initial contraction, indicating that transverse magnetism partly remains. 8. In reversal of the transverse polarity the bar elongates for a moment, and thus oscillates in length. 9. The contraction produced by the current is greater when the bar has before been longitudinally magnetised. 10. Some iron bars show a tendency to take spiral magnetisation, *i.e.* to rotate the magnetic axes of their molecules in the direction of the spiral. This is shown by the contractions caused by a current passing through the bars, which are different according to the direction of the current and that of the previous longitudinal magnetisation.

THE absorption of radiant heat in gases and vapours form th subject of a recent valuable paper to the Vienna Academy (July 1) by Messrs. Lecher and Pernter. They consider "vaporhesion" to have been an important source of error in Tyndall's experiments. In their own method the thermopile and the heat-source were brought into the same vessel. Air-currents were avoided by causing the surface of radiation to be heated in each case suddenly from without, by means of a steam jet, to 100° C. Among other results the absorption of water-vapour is found, in opposition to Tyndall, immeasurably small. Violle found, on Mont Blanc, that a metre of the air absorbed only 0·007 per cent. of the whole radiation; according to this, a layer of 300 m. length would be necessary to produce, with water-vapour saturated at 12°, that absorption which Tyndall obtains in 1·22 m. This and the authors' own experimental results are considered to prove beyond dispute the very small absorption of aqueous vapour. The authors' results for gases agree pretty well with Tyndall's. No simple connection between absorption and pressure of the substance was discoverable. The absorption, even for radiation of a heat-source of 100° C., is selective. The authors found the absorption of certain substances of the fat series examined to increase rapidly with increasing proportion of carbon. It seems to be otherwise, however, with bodies from other groups; thus, *e.g.* benzol, notwithstanding its six C-atoms, has a fairly small absorptive power.

MESSRS. A. P. LAURIE and C. I. Bruton of Edinburgh have devised a new electromotor engine, in which four electromagnets act successively upon an eccentric armature of soft iron rotating about a central shaft, thus avoiding the back pull of Froment's and other forms of electromotor. The gradual approach thereby secured between the armature and the active field-magnets is a feature common to this engine and to that of Mr. Wiesendanger. The principle has long been applied, though somewhat differently, in the little motors employed for whirling Geissler's tubes.

SIGNOR MACALUSO has recently described a new form of mercurial air-pump, on the Sprengel principle, sufficiently simple to be capable of construction from the materials at hand in any chemical laboratory, and requiring no india-rubber connections. An outline diagram of the pump is given in the August number of the *Beiblätter*.

HERR A. SCHERTEL has determined the fusing-points of a number of difficultly-fusible substances by comparing them with those alloys of gold and platinum in various proportions. He gives the fusion-point of basalt as 1,166° C.; that of adularia (from the St. Gotthardt) is stated as being between 1,400° and 1,420°; and nickel between 1,392° and 1,420°.

THE electric conductivity of gas-carbon and its variability under pressure has been re-examined by MM. Naccari and Pagliani. Carbon prisms were carefully covered at certain points of their surface with copper by electro-deposition to secure good contact with the wires by which they were inserted in a Wheatstone's bridge to determine their resistance. When subjected to great pressures the resistances of the rods of carbon showed scarcely any change. Hence it appears that the changes of conductivity which carbon exhibits in the microphone and in the carbon telephone under varying pressures are due not to any alteration of the contact between the particles in the intimate structure of the substance, but to mere changes in the external contact.

DR. WERNER SIEMENS has lately described to the Berlin Academy a new series of experiments on the electric conductivity of carbon, and the way it is affected by temperature. He finds that of gas retort carbon at 0° C. 0·0136 (mercury = 1), and the coefficient of increase of conductivity 0·000345 per degree Celsius. The artificial carbon rods produced by compression of carbon powder also show greater conducting power with increasing temperature, but the increase is not so great (as in retort carbon). Dr. Siemens thinks other experimenters may have been led to erroneous results by faulty connections. He effected the union of the carbon ends with the conducting wires by means of galvanic coppering. The property of conducting better at higher temperatures is regarded as a property of the carbon material itself, not as a consequence of its structure. It may be explained (Dr. Siemens says) as in the case of crystalline selenium, if we assume that the carbon is an allotropic modification (containing latent heat) of a hypothetical metallic carbon.

IN his theory of the bifilar magnetometer Gauss considered that the torsion of the suspending wires, and the induction of the earth's magnetism on that of the suspended magnet, might be neglected, as very small. In the course of several years' observations, Herr Wild having found this to cause serious discrepancy between theory and experience, has (at Pawlowski Observatory) developed the theory anew, taking account of those two factors. Substituting cocoon-threads for wires, he considers the moment of torsion can be reduced to considerably less than 0·3 per cent. of the moment of gravity (it was more than 5 per cent. with wires). The improved theory, while agreeing much better with experience, affords an excellent method of determining separately, from direct observation of the angle of torsion and the three durations of vibration of the magnet in the normal, reversed, and transverse position, its two kinds of induction-coefficients, viz., that in weakening, and that in increase of the magnetic moment by induction; also of determining the temperature-coefficient of magnets and of absolute measurement of the horizontal intensity (*Wied. Ann.*, No. 8).

IT appears from recent experiments by Herr Knoblauch (*Wied. Ann.*, No. 8) that in reflection of polarised heat-rays from metals, the rays of different heat-colours behave differently, in that they have in general different angles of polarisation, presenting, in the case of certain metals, as gold and silver, great differences, and in that of others, as copper and speculum metal, smaller. In the case of lead and arsenic these differences wholly disappear. With the former metals the transitions in reflection of different rays from linear to elliptic vibrations do not keep equal pace with each other; changing the angle of incidence from 0° to the angle of polarisation, the transformation of the vibration of one heat-tint is prominent, while in change of incidence from 90° to the angle of polarisation, it is that of another. With lead and arsenic, at all angles of incidence from 0° to 90°, the ellipses of certain constant heat-rays are always more extended than those of the other heat colours.

GEOGRAPHICAL NOTES

THE full details of the Franklin Search Expedition published in the *New York Herald* of September 23 and following numbers do not contain much of scientific interest in addition to what we gave last week. The narrative contains a graphic and interesting account of the sledge journeys of Lieut. Schwatka's party, of the various Eskimo tribes met with, of the country traversed, and the remains of the Franklin Expedition. Some precision is given to our knowledge of the country, and many valuable hints given as to how to brave an Arctic winter. Although the extreme cold endured, 103° F. below freezing, is not so great as has been experienced in one or two previous instances, we question whether an average temperature of 100° of frost for 16 days was ever before met with. A good many interesting relics of the Franklin party were collected, and there seems no doubt that the Eskimo did at one time have a number of books in a tin box belonging to the party who left the ships; but these, with gold watches and other mysteries, were given to the children for playthings, and have long ago disappeared. It is probable enough that among the books were some records of the progress of the expedition; but all hope of recovering them may now be abandoned. We trust that there will be no delay in the publication of the scientific observations which were doubtless made by Lieut. Schwatka's expedition.

THE new number of the Geographical Society's *Proceedings* provides us with an unusual supply of good readable papers of moderate length. Lieut. G. T. Temple furnishes "Notes on Russian Lapland," accompanied by a new map; the Rev. W. G. Lawes, the well-known missionary, "Notes on New Guinea and its Inhabitants"; the Rev. C. T. Wilson, lately of the Nyanza mission, a brief narrative of a journey over new ground in East Africa from Kagéi to Tabora; and lastly, Major W. M. Campbell, R.E., an account of his visit to the previously unknown (except from hearsay) Shorawak valley and the Toba plateau, Afghanistan. The Geographical Notes supply particulars regarding the murder of Messrs. Carter and Cadenhead in East Central Africa, and Capt. T. L. Phipson-Wybrants' expedition to Umzila's country, east of Matabele-land, as well as a French surveying expedition for West Africa. These are followed by a *résumé* of some of Père Duparquet's notes on Orampo-land, an Egyptian exploring expedition in Somali-land, M. Regel's journey in Eastern Turkestan, and a summary of the Indian Marine Survey Report for 1878–79. There are also some useful additions to our knowledge of Eastern Perak, and an abstract of a Consular report on the Chinese province of Shantung. We must not omit to mention that the present number contains the map (postponed from last month) of the country between Sind and Candahar, showing the course of the proposed railway, on which Sir Richard Temple recently lectured before the Society and at Swansea.

THE new expedition despatched by the London Missionary Society to Lake Tanganyika, and consisting of the Revs. A. J. Wookey and D. Williams, with Dr. Palmer, left Zanzibar on June 14, and crossing to the mainland at Saadani, marched thence to Ndumi. Here they remained for a few days, until they got their full complement of *pagazi*, and finally started for the interior on June 21. Accomplishing some twelve or fifteen miles a day, they reached Mpedapwa on July 14, and were most kindly received by the Church Missionary Society's agents. They were to recommence their journey to the lake on July 19. Their caravan consists of 309 men, the chief of whom is Ulia, who accompanied the Rev. Roger Price, when the bullock-waggon experiment was tried some four years ago.

FROM a letter in *L'Exploration* we learn that M. Wiener had in July reached Archedona, in his exploration of the Napo, one of the great tributaries of the Amazon; unless he meets with disaster, we may expect to hear of him by and by from Pará.

THE *Mittheilungen* of the German African Society, of which six parts are published, contains much very valuable information on recent exploration in Africa by German explorers. We have details of the progress of Herr Schütt's expedition in the Loanda region, of Rohlfs' attempt to push southwards from Tunis, of Dr. Büchner to Muata Janvo's kingdom, of Dr. O. Lenz's determined and so far successful attempt to push southwards through Morocco to Timbuctoo and beyond. We have, besides, records of the doings of the International African Association, and of the various other societies for the exploration of Africa throughout the world. In the double number, 4 and 5, Dr. Reichenau gives a detailed list of the collection of birds sent home from Malanga in Angola by Herr Schütt.

A TELEGRAM from New York, October 5, states that the commander of the United States steamer *Alert* reports the discovery of a submarine volcano near San Alessandro, an island in the Pacific.

THE eruption of the volcano Fuego in Guatemala, to which we referred some weeks ago, ceased almost suddenly in the second half of the month of July. M. de Thiersant, French representative in Guatemala, writes to *La Nature* that another volcano of the same country, Pacaya, seems inclined in its turn to resume activity. At Amatitlan, a small town on the slope of the mountain, subterranean noises succeeded each other almost constantly on July 28.

INTELLIGENCE received at Lloyd's from Christiania, dated October 1, states that the *Neptune* steamer, Capt. Rasmussen, which arrived at Vardö, previous to September 25, from the Obi, reports that on September 19, in Jugor Straits, she fell in with the *Siberiakoff's* expedition proceeding eastward.

THERE is a useful article in the last number of *La Nature* on French Guiana and its forest produce, by Dr. J. Harmand.

SCIENCE AND CULTURE[1]

SIX years ago, as some of my present hearers may remember, I had the privilege of addressing a large assemblage of the inhabitants of this city, who had gathered together to do honour to the memory of their famous townsman, Joseph Priestley; and, if any satisfaction attaches to posthumous glory, we may hope that the manes of the burnt-out philosopher were then finally appeased.

No man, however, who is endowed with a fair share of common sense and not more than a fair share of vanity, will identify either contemporary or posthumous fame with the highest good; and Priestley's life leaves no doubt that he, at any rate, set a much higher value upon the advancement of knowledge and the promotion of that freedom of thought which is at once the cause and the consequence of intellectual progress.

Hence I am disposed to think that, if Priestley could be amongst us to-day, the occasion of our meeting would afford him even greater pleasure than the proceedings which celebrated the centenary of his chief discovery. The kindly heart would be moved, the high sense of social duty would be satisfied, by the spectacle of well-earned wealth, neither squandered in tawdry luxury and vain-glorious show; nor scattered with the careless charity which blesses neither him that gives nor him that takes; but expended in the execution of a well-considered plan for the aid of present and future generations of those who are willing to help themselves.

We shall all be of one mind thus far. But it is needful to share Priestley's keen interest in physical science; to have learned, as he had learned, the value of scientific training in fields of inquiry apparently far remote from physical science; to appreciate, as he would have appreciated, the value of the noble gift which Sir Josiah Mason has bestowed upon the inhabitants of the Midland district.

For us children of the nineteenth century, however, the establishment of a college under the conditions of Sir Josiah Mason's Trust, has a significance apart from any which it could have possessed a hundred years ago. It appears to be an indication that we are reaching the crisis of the battle, or rather of the long series of battles, which have been fought over education in a campaign which began long before Priestley's time, and will probably not be finished just yet.

In the last century, the combatants were the champions of ancient literature, on the one side, and those of modern literature on the other; but, some thirty years ago, the contest became complicated by the appearance of a third army, ranged round the banner of Physical Science.

I am not aware that any one has authority to speak in the name of this new host. For it must be admitted to be somewhat of a guerilla force, composed largely of irregulars, each of whom fights pretty much for his own hand. But the impressions of a full private, who has seen a good deal of service in the ranks, respecting the present position of affairs and the conditions of a permanent peace, may not be devoid of interest; and I do not know that I could make a better use of the present opportunity than by laying them before you.

From the time that the first suggestion to introduce physical science into ordinary education was timidly whispered, until now, the advocates of scientific education have met with opposition of two kinds. On the one hand they have been pooh-poohed by the men of business who pride themselves on being the representatives of practicality; while on the other hand they have been excommunicated by the classical scholars, in their capacity of Levites in charge of the ark of culture and monopolists of liberal education.

[1] An Address delivered on the occasion of the opening of Sir Josiah Mason's Science College, at Birmingham, on October 1, by Thomas H. Huxley, F.R.S.

The practical men believed that the idol whom they worship—rule of thumb—has been the source of the past prosperity, and will suffice for the future welfare of the arts and manufactures. They were of opinion that science is speculative rubbish; that theory and practice have nothing to do with one another; and that the scientific habit of mind is an impediment rather than an aid in the conduct of ordinary affairs.

I have used the past tense in speaking of the practical men—for although they were very formidable thirty years ago, I am not sure that the pure species has not been extirpated. In fact, so far as mere argument goes, they have been subjected to such a *feu d'enfer* that it is a miracle if any have escaped. But I have remarked that your typical practical man has an unexpected resemblance to one of Milton's angels. His spiritual wounds, such as are inflicted by logical weapons, may be as deep as a well and as wide as a church door, but beyond shedding a few drops of ichor, celestial or otherwise, he is no whit the worse. So if any of these opponents be left I will not waste time in vain repetition of the demonstrative evidence of the practical value of science; but, knowing that a parable will sometimes penetrate where syllogisms fail to effect an entrance, I will offer a story for their consideration.

Once upon a time, a boy, with nothing to depend upon but his own vigorous nature, was thrown into the thick of the struggle for existence in the midst of a great manufacturing population. He seems to have had a hard fight, inasmuch as, by the time he was thirty years of age, his total disposable funds amounted to twenty pounds. Nevertheless middle life found him giving proof of his comprehension of the practical problems he had been roughly called upon to solve, by a career of remarkable prosperity.

Finally, having reached old age with its well-earned surroundings of "honour, troops of friends," the hero of my story bethought himself of those who were making a like start in life, and how he could stretch out a helping hand to them.

After long and anxious reflection this successful practical man of business could devise nothing better than to provide them with the means of obtaining "sound, extensive, and practical scientific knowledge." And he devoted a large part of his wealth and five years of incessant work to this end.

I need not point the moral of a tale which, as the solid and spacious fabric of the Scientific College assures us, is no fable, nor can anything which I could say intensify the force of this practical answer to practical objections.

We may take it for granted then, that, in the opinion of those best qualified to judge, the diffusion of thorough scientific education is an absolutely essential condition of industrial progress, and that the College opened to-day will confer an inestimable boon upon those whose livelihood is to be gained by the practice of the arts and manufactures of the district.

The only question worth discussion is, whether the conditions, under which the work of the College is to be carried out, are such as to give it the best possible chance of achieving permanent success.

Sir Josiah Mason, without doubt most wisely, has left very large freedom of action to the trustees, to whom he proposes ultimately to commit the administration of the College, so that they may be able to adjust its arrangements in accordance with the changing conditions of the future. But, with respect to three points, he has laid most explicit injunctions upon both administrators and teachers.

Party politics are forbidden to enter into the minds of either, so far as the work of the College is concerned; theology is as sternly banished from its precincts; and finally, it is especially declared that the College shall make no provision for "mere literary instruction and education."

It does not concern me at present to dwell upon the first two injunctions any longer than may be needful to express my full conviction of their wisdom. But the third prohibition brings us face to face with those other opponents of scientific education, who are by no means in the moribund condition of the practical man, but alive, alert, and formidable.

It is not impossible that we shall hear this express exclusion of "literary instruction and education" from a College which, nevertheless, professes to give a high and efficient education, sharply criticised. Certainly the time was that the Levites of culture would have sounded their trumpets against its walls as against an educational Jericho.

How often have we not been told that the study of physical science is incompetent to confer culture; that it touches none of the higher problems of life; and, what is worse, that the continual devotion to scientific studies tends to generate a narrow and bigoted belief in the applicability of scientific methods to the search after truth of all kinds. How frequently one has reason to observe that no reply to a troublesome argument tells so well as calling its author a "mere scientific specialist." And, as I am afraid it is not permissible to speak of this form of opposition to scientific education in the past tense; may we not expect to be told that this, not only omission, but prohibition of "mere literary instruction and education" is a patent example of scientific narrow-mindedness?

I am not acquainted with Sir Josiah Mason's reasons for the action which he has taken; but if, as I apprehend is the case, he refers to the ordinary classical course of our schools and universities, by the name of "mere literary instruction and education," I venture to offer sundry reasons of my own in support of that action.

For I hold very strongly by two convictions—The first is, that neither the discipline nor the subject-matter of classical education is of such direct value to the student of physical science as to justify the expenditure of valuable time upon either; and the second is, that for the purpose of attaining real culture, an exclusively scientific education is at least as effectual as an exclusively literary education.

I need hardly point out to you that these opinions, especially the latter, are diametrically opposed to those of the great majority of educated Englishmen, influenced as they are by school and university traditions. In their belief culture is obtainable only by a liberal education, and a liberal education is synonymous not merely with education and instruction in literature, but in one particular form of literature, namely, that of Greek and Roman antiquity. They hold that the man who has learned Latin and Greek, however little, is educated; while he who is versed in other branches of knowledge, however deeply, is a more or less respectable specialist, not admissible into the cultured caste. The stamp of the educated man, the University degree, is not for him.

I am too well acquainted with the generous catholicity of spirit, the true sympathy with scientific thought, which pervades the writings of our chief apostle of culture to identify him with these opinions; and yet one may cull from one and another of those epistles to the Philistines, which so much delight all who do not answer to that name, sentences which lend them some support.

Mr. Arnold tells us that the meaning of culture is "to know the best that has been thought and said in the world." It is the criticism of life contained in literature. That criticism regards "Europe as being for intellectual and spiritual purposes one great confederation, bound to a joint action and working to a common result; and whose members have for their common outfit a knowledge of Greek, Roman, and Eastern antiquity, and of one another. Special local and temporary advantages being put out of account, that modern nation will in the intellectual and spiritual sphere make most progress which most thoroughly carries out this programme. And what is that but saying that we too, all of us as individuals, the more thoroughly we carry it out shall make the more progress!"

We have here to deal with two distinct propositions. The first, that a criticism of life is the essence of culture; the second, that literature contains the materials which suffice for the construction of such a criticism.

I think that we must all assent to the first proposition. For culture certainly means something quite different from learning or technical skill. It implies the possession of an ideal, and the habit of critically estimating the value of things by comparison with a theoretic standard. Perfect culture should supply a complete theory of life, based upon a clear knowledge alike of its possibilities and of its limitations.

But we may agree to all this, and yet strongly dissent from the assumption that literature alone is competent to supply this knowledge. After having learnt all that Greek, Roman, and Eastern antiquity have thought and said, and all that modern literatures have to tell us, it is not self-evident that we have laid a sufficiently broad and deep foundation for that criticism of life which constitutes culture.

Indeed, to any one acquainted with the scope of physical science, it is not at all evident. Considering progress only in the "intellectual and spiritual sphere," I find myself wholly unable to admit that either nations or individuals will really advance if their common outfit draws nothing from the stores of physical science. I should say that an army without weapons of precision and with no particular base of operations might more hopefully enter upon a campaign on the Rhine than a man, devoid of a knowledge of what physical science has done in the last century, upon a criticism of life.

When a biologist meets with an anomaly, he instinctively turns to the study of development to clear it up. The rationale of contradictory opinions may with equal confidence be sought in history.

It is, happily, no new thing that Englishmen should employ their wealth in building and endowing institutions for educational purposes. But, five or six hundred years ago, deeds of foundation expressed or implied conditions as nearly as possible contrary to those which have been thought expedient by Sir Josiah Mason. That is to say, physical science was practically ignored, while a certain literary training was enjoined as a means to the acquirement of knowledge which was essentially theological.

The reason of this singular contradiction between the actions of men alike animated by a strong and disinterested desire to promote the welfare of their fellows, is easily discovered.

At that time, in fact, if any one desired knowledge beyond such as could be obtained by his own observation, or by common conversation, his first necessity was to learn the Latin language, inasmuch as all the higher knowledge of the western world was contained in works written in that language. Hence Latin grammar, with logic and rhetoric, studied through Latin, were the fundamentals of education. With respect to the substance of the knowledge imparted through this channel, the Jewish and Christian Scriptures, as interpreted and supplemented by the Romish church, were held to contain a complete and infallibly true body of information.

Theological dicta were, to the thinkers of those days, that which the axioms and definitions of Euclid are to the geometers of these. The business of the philosophers of the middle ages was to deduce from the data furnished by the theologians, conclusions in accordance with ecclesiastical decrees. They were allowed the high privilege of showing, by logical process, how and why that which the Church said was true, must be true. And if their demonstrations fell short of or exceeded this limit, the Church was maternally ready to check their aberrations, if need be, by the help of the secular arm.

Between the two, our ancestors were furnished with a compact and complete criticism of life.

They were told how the world began and how it would end; they learned that all material existence was but a base and insignificant blot upon the fair face of the spiritual world, and that nature was, to all intents and purposes, the playground of the devil; they learned that the earth is the centre of the visible universe, and that man is the cynosure of things terrestrial; and more especially was it inculcated that the course of nature had no fixed order, but that it could be, and constantly was, altered by the agency of innumerable spiritual beings, good and bad, according as they were moved by the deeds and prayers of men. The sum and substance of the whole doctrine was to produce the conviction that the only thing really worth knowing in this world was how to secure that place in a better which, under certain conditions, the Church promised.

Our ancestors had a living belief in this theory of life, and acted upon it in their dealings with education, as in all other matters. Culture meant saintliness—after the fashion of the saints of those days; the education that led to it was, of necessity, theological; and the way to theology lay through Latin.

That the study of nature—further than was requisite for the satisfaction of every-day wants—should have any bearing on human life was far from the thoughts of men thus trained. Indeed, as nature had been cursed for man's sake, it was an obvious conclusion that those who meddled with nature were likely to come into pretty close contact with Satan. And if any born scientific investigator followed his instincts he might safely reckon upon earning the reputation, and probably upon suffering the fate, of a sorcerer.

Had the western world been left to itself in Chinese isolation, there is no saying how long this state of things might have endured. But, happily, it was not left to itself. Even earlier than the thirteenth century, the development of Moorish civilisation in Spain and the great movement of the Crusades had introduced the leaven which, from that day to this, has never ceased to work. At first, through the intermediation of Arabic translations, afterwards, by the study of the originals, the western nations of Europe became acquainted with the writings of the ancient philosophers and poets, and, in time, with the whole of the vast literature of antiquity.

Whatever there was of high intellectual aspiration or dominant capacity in Italy, France, Germany, and England, spent itself for centuries in taking possession of the rich inheritance left by the dead civilisations of Greece and Rome. Marvellously aided by the invention of printing, classical learning spread and flourished. Those who possessed it prided themselves on having attained the highest culture then within the reach of mankind.

And justly. For, saving Dante on his solitary pinnacle, there was no figure in modern literature at the time of the Renascence to compare with the men of antiquity; there was no art to compete with their sculpture; there was no physical science but that which Greece had created. Above all, there was no other example of perfect intellectual freedom—of the unhesitating acceptance of reason as the sole guide to truth and arbiter of conduct.

The new learning necessarily soon exerted a profound influence upon education. The language of the monks and schoolmen seemed little better than gibberish to scholars fresh from Virgil and Cicero, and the study of Latin was placed upon a new foundation. Moreover, Latin itself ceased to afford the sole key to knowledge. The student who sought the highest thought of antiquity, found only a second-hand reflection of it in Roman literature, and turned his face to the full light of the Greeks. And after a battle, not altogether dissimilar to that which is at present being fought over the teaching of physical science, the study of Greek was recognised as an essential element of all higher education.

Thus the Humanists, as they were called, won the day; and the great reform which they effected was of incalculable service to mankind. But the Nemesis of all reformers is finality; and the reformers of education, like those of religion, fell into the profound but common error of mistaking the beginning for the end of the work of reformation.

The representatives of the Humanists, in the nineteenth century, take their stand upon classical education as the sole avenue to culture, as firmly as if we were still in the age of Renascence. Yet surely the present intellectual relations of the modern and the ancient worlds are profoundly different from those which obtained three centuries ago. Leaving aside the existence of a great and characteristically modern literature, of modern painting, and, especially, of modern music, there is one feature of the present state of the civilised world which separates it more widely from the Renascence, than the Renascence was separated from the middle ages.

This distinctive character of our own times lies in the vast and constantly increasing part which is played by Natural Knowledge. Not only is our daily life shaped by it, not only does the prosperity of millions of men depend upon it, but our whole theory of life has long been influenced, consciously or unconsciously, by the general conceptions of the universe, which have been forced upon us by physical science.

In fact, the most elementary acquaintance with the results of scientific investigation shows us that they offer a broad and striking contradiction to the opinions so implicitly credited and taught in the middle ages.

The notions of the beginning and the end of the world entertained by our forefathers are no longer credible. It is very certain that the earth is not the chief body in the material universe, and that the world is not subordinated to man's use. It is even more certain that nature is the expression of a definite order with which nothing interferes, and that the chief business of mankind is to learn that order and govern themselves accordingly. Moreover this scientific "criticism of life" presents itself to us with different credentials from any other. It appeals not to authority, nor to what anybody may have thought or said, but to nature. It admits that all our interpretations of natural fact are more or less imperfect and symbolic, and bids the learner seek for truth not among words but among things. It warns us that the assertion which outstrips evidence is not only a blunder but a crime.

The purely classical education advocated by the representatives of the Humanists in our day, gives no inkling of all this. A man may be a better scholar than Erasmus, and know no more of the chief causes of the present intellectual fermentation than Erasmus did. Scholarly and pious persons, worthy of all respect, favour us with allocutions upon the sadness of the antagonism of Science to their mediæval way of thinking, which betray an ignorance of the first principles of scientific investigation, an incapacity for understanding what a man of science means by veracity, and an unconsciousness of the weight of established scientific truths, which is almost comical.

There is no great force in the *tu quoque* argument, or else the advocates of scientific education might fairly enough retort upon the modern Humanists that they may be learned specialists, but that they possess no such sound foundation for a criticism of life as deserves the name of culture. And, indeed, if we were disposed to be cruel we might urge that the Humanists have brought this reproach upon themselves, not because they are too full of the spirit of the ancient Greek, but because they lack it.

The period of the Renascence is commonly called that of the "Revival of Letters," as if the influences then brought to bear upon the mind of western Europe had been wholly exhausted in the field of literature. I think it is very commonly forgotten that the revival of science, effected by the same agency, although less conspicuous, was not less momentous.

In fact, the few and scattered students of nature of that day picked up the clue to her secrets exactly as it fell from the hands of the Greeks a thousand years before. The foundations of mathematics were so well laid by them that our children learn their geometry from a book written for the schools of Alexandria two thousand years ago. Modern astronomy is the natural continuation and development of the work of Hipparchus and of Ptolemy; modern physics of that of Democritus and Archimedes; it was long before modern biological science outgrew the knowledge bequeathed to us by Aristotle, Theophrastus, and Galen.

We cannot know all the best thoughts and sayings of the Greeks unless we know what they thought about natural phenomena. We cannot fully apprehend their criticism of life unless we understand the extent to which that criticism was affected by scientific conceptions. We falsely pretend to be the inheritors of their culture, unless we are penetrated, as the best minds among them were, with an unhesitating faith that the free employment of reason, in accordance with scientific method, is the sole guide to truth.

Thus I venture to think that the pretensions of our modern Humanists to the possession of the monopoly of culture and to the exclusive inheritance of the spirit of antiquity must be abated, if not abandoned. But I should be very sorry that anything I have said should be taken to imply a desire on my part to depreciate the value of classical education, as it might be and as it sometimes is. The native capacities of mankind vary no less than their opportunities; and while culture is one, the road by which one man may best reach it is widely different from that which is most advantageous to another. Again, while scientific education is yet inchoate and tentative, classical education is thoroughly well organised upon the practical experience of generations of teachers. So that, given ample time for learning and destination for ordinary life, or for a literary career, I do not think that a young Englishman in search of culture can do better than follow the course usually marked out for him, supplementing its deficiencies by his own efforts.

But for those who mean to make science their serious occupation; or who intend to follow the profession of medicine; or who have to enter early upon the business of life; for all these, in my opinion, classical education is a mistake; and it is for that reason that I am glad to see "mere literary education and instruction" shut out from the curriculum of Sir Josiah Mason's College, seeing that its inclusion would probably lead to the introduction of the ordinary smattering of Latin and Greek.

Nevertheless, I am the last person to question the importance of genuine literary education, or to suppose that intellectual culture can be complete without it. An exclusively scientific training will bring about a mental twist as surely as an exclusively literary training. The value of the cargo does not compensate for a ship's being out of trim; and I should be very sorry to think that the Scientific College would turn out none but lop-sided men.

There is no need however that such a catastrophe should happen. Instruction in English, French, and German is provided, and thus the three greatest literatures of the modern world are made accessible to the student.

French and German, and especially the latter language, are absolutely indispensable to those who desire full knowledge in any department of science. But even supposing that the knowledge of these languages acquired is not more than sufficient for purely scientific purposes, every Englishman has, in his native tongue, an almost perfect instrument of literary expression; and, in his own literature, models of every kind of literary excellence. If an Englishman cannot get literary culture out of his Bible, his Shakspere, his Milton, neither, in my belief, will the profoundest study of Homer and Sophocles, Virgil and Horace, give it to him.

Thus, since the constitution of the College makes sufficient provision for literary as well as for scientific education, and since artistic instruction is also contemplated, it seems to me that a fairly complete culture is offered to all who are willing to take advantage of it.

But I am not sure that at this point the "practical" man, scotched but not slain, may ask what all this talk about culture has to do with an Institution, the object of which is defined to be "to promote the prosperity of the manufactures and the industry of the country." He may suggest that what is wanted for this end is not culture, nor even a purely scientific discipline, but simply a knowledge of applied science.

I often wish that this phrase, "applied science," had never been invented. For it suggests that there is a sort of scientific knowledge of direct practical use, which can be studied apart from another sort of scientific knowledge, which is of no practical utility, and which is termed "pure science." But there is no more complete fallacy than this. What people call applied science is nothing but the application of pure science to particular classes of problems. It consists of deductions from those general principles, established by reasoning and observation, which constitute pure science. No one can safely make these deductions until he has a firm grasp of the principles; and he can obtain that grasp only by personal experience of the processes of observation and of reasoning on which they are founded.

Almost all the processes employed in the arts and manufactures fall within the range either of physics or of chemistry. In order to improve them, one must thoroughly understand them; and no one has a chance of really understanding them who has not obtained that mastery of principles and that habit of dealing with facts which is given by long-continued and well-directed purely scientific training in the physical and the chemical laboratory. So that there really is no question as to the necessity of purely scientific discipline, even if the work of the College were limited by the narrowest interpretation of its stated aims.

And, as to the desirableness of a wider culture than that yielded by science alone, it is to be recollected that the improvement of manufacturing processes is only one of the conditions which contribute to the prosperity of industry. Industry is a means and not an end; and mankind work only to get something which they want. What that something is depends partly on their innate, and partly on their acquired, desires.

If the wealth resulting from prosperous industry is to be spent upon the gratification of unworthy desires; if the increasing perfection of manufacturing processes is to be accompanied by an increasing debasement of those who carry them on, I do not see the good of industry and prosperity.

Now it is perfectly true that men's views of what is desirable depend upon their characters; and that the innate proclivities to which we give that name are not touched by any amount of instruction. But it does not follow that even mere intellectual education may not, to an indefinite extent, modify the practical manifestation of the characters of men in their actions, by supplying them with motives unknown to the ignorant. A pleasure-loving character will have pleasure of some sort; but, if you give him the choice, he may prefer pleasures which do not degrade him to those which do. And this choice is offered to every man, who possesses in literary or artistic culture a never-failing source of pleasures, which are neither withered by age, nor staled by custom, nor embittered in the recollection by the pangs of self-reproach.

If the Institution opened to-day fulfils the intention of its founder, the picked intelligences among all classes of the population of this district will pass through it. No child born in Birmingham, henceforward, if he have the capacity to profit by the opportunities offered to him first in the primary and other schools, and afterwards in the Scientific College, need fail to obtain, not merely the instruction, but the culture most appropriate to the conditions of his life.

Within these walls, the future employer and the future artisan may sojourn together for a while, and carry through all their lives the stamp of the influences then brought to bear upon them. Hence, it is not beside the mark to remind you that the prosperity of industry depends not merely upon the improvement of manufacturing processes, not merely upon the ennobling of the individual character, but upon a third condition, namely, a clear understanding of the conditions of social life on the part of both the capitalist and the operative, and their agreement upon common principles of social action. They must learn that social phenomena are as much the expression of natural laws as any others; that no social arrangements can be permanent unless they harmonise with the requirements of social statics and dynamics; and that, in the nature of things, there is an arbiter whose decisions execute themselves.

But this knowledge is only to be obtained by the application of the methods of investigation adopted in physical researches to the investigation of the phenomena of society. Hence, I confess, I should like to see one addition made to the excellent scheme of education propounded for the College, in the shape of provision for the teaching of Sociology. For though we are all agreed that party politics are to have no place in the instruction of the College; yet in this country, practically governed as it is now by universal suffrage, every man who does his duty must exercise political functions. And if the evils which are inseparable from the good of political liberty are to be checked, if the perpetual oscillation of nations between anarchy and despotism is to be replaced by the steady march of self-restraining freedom; it will be because men will gradually bring themselves to deal with political, as they now deal with scientific questions; to be as ashamed of undue haste and partisan prejudice in the one case as in the other; and to believe that the machinery of society is at least as delicate as that of a spinning-jenny, and not more likely to be improved by the meddling of those who have not taken the trouble to master the principles of its action.

In conclusion, I am sure that I make myself the mouthpiece of all present in offering to the venerable Founder of the Institution, which now commences its beneficent career, our congratulations on the completion of his work; and in expressing the conviction, that the remotest posterity will point to it as a crucial instance of the wisdom which natural piety leads all men to ascribe to their ancestors.

ON A SEPTUM PERMEABLE TO WATER, AND IMPERMEABLE TO AIR, WITH APPLICATION TO A NAVIGATIONAL DEPTH GAUGE[1]

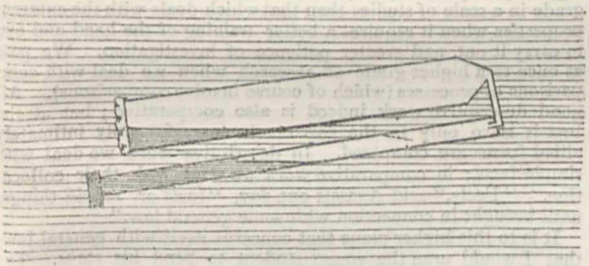
A SMALL quantity of water in a capillary tube, with both ends in air, acts as a perfectly air-tight plug against difference of pressure of air at its two ends, equal to the hydrostatic pressure corresponding to the height at which water stands in the same capillary tube when it is held upright, with one end under water and the other in air. And if the same capillary tube be held completely under water, it is perfectly permeable to the water, opposing no resistance except that due to viscidity, and permitting a current of water to flow through it with any difference of pressure at its two ends, however small. In passing it may be remarked that the same capillary tube is, when not plugged by liquid, perfectly permeable to air.

A plate of glass, or other solid, capable of being perfectly wet by water, with a hole bored through it, acts similarly in letting air pass freely through it when there is no water in the hole; and letting water pass freely through it when it is held under water; and resisting a difference of air-pressures at the two sides of it when the hole is plugged by water. The difference of air-pressures on the two sides which it resists is equal to the hydrostatic pressure corresponding to the rise of water in a capillary tube of the same diameter as the narrowest part of the hole. Thus a metal plate with a great many fine perforations, like a very fine rose for a watering-can for flowers, fulfils the conditions stated in the title to this communication. So does very fine wire cloth. The finer the holes, the greater is the difference of air-pressures balanced, when they are plugged with water. The shorter the length of each hole the less it resists the passage of water when completely submerged; and the greater the number of holes, the less is the whole resistance to the permeation of water through the membrane.

[1] Paper read at the British Association by Sir William Thomson.

Hence, clearly, the object indicated in the title is more perfectly attained, the thinner the plate and the smaller and more numerous the holes. Very fine wire cloth would answer the purpose better than any metal plate with holes drilled through it; and very fine closely-woven cotton cloth, or cambric, answers better than the finest wire cloth. The impenetrability of wet cloth to air is well known to laundresses, and to every naturalist who has ever chanced to watch their operations. The quality of dry cloth to let air through with considerable freedom, and wet cloth to resist it, is well known to sailors, wet sails being sensibly more effective than dry sails (and particularly so in the case of old sails, and of sails of thin and light material).

An illustration was shown to the meeting by taking an Argand lamp-funnel, with a piece of very fine closely-woven cotton cloth tied over one end of it. When the cloth was dry, and the other end dipped under water, the water rose with perfect freedom inside, showing exceedingly little resistance to the passage of air through the dry cloth. When it was inverted, and the end guarded by the cloth was held under water, the water rose with very great freedom, showing exceedingly little resistance to the permeation of water through the cloth. The cloth being now wet, and the glass once more held with its other end under water, the cloth now seemed perfectly air-tight, even when pressed with air-pressure corresponding to nine inches of water, by forcing down the funnel, which was about nine inches long, till the upper end was nearly submerged. When it was wholly submerged, so that there was air on one side and water on the other, the resistance to permeation of air was as decided as it was when the cloth, very perfectly wet, had air on each side of it.



Water indicated by horizontal shading; Air by white paper.

Once more, putting the cloth end under water; holding the tube nearly horizontal, and blowing by the mouth applied to the other end:—the water which had risen into the funnel before the mouth was applied, was expelled. After that no air escaped until the air-pressure within exceeded the water pressure on the outside of the cloth by the equivalent of a little more than nine inches of water; and when blown with a pressure just a very little more than that which sufficed to produce a bubble from any part of the cloth, bubbles escaped in a copious torrent from the whole area of the cloth.

The accompanying sketch represents the application to the Navigational Depth Gauge. The wider of the two communicating tubes, shown uppermost in the sketch, has its open mouth guarded by very fine cotton cloth tied across it. The tube shown lower in the diagram is closed for the time of use by a stopper at its lower end. A certain quantity of water (which had been forced into it during the descent of the gauge to the bottom of the sea) is retained in it while the gauge is being towed up to the surface in some such oblique position as that shown in the sketch. While this is being done the water in the wide tube is expelled by the expanding air. The object of the cloth guard is to secure that this water is expelled to the last drop before any air escapes; and that afterwards, while the gauge is being towed wildly along the surface from wave to wave by a steamer running at fourteen or sixteen knots, not a drop of water shall re-enter the instrument.

ON THE CLASSIFICATION OF BIRDS[1]

ABOUT twelve years ago Prof. Huxley had taken up the subject of the classification of birds in his usual zealous and original way, and from quite a new point of view. Prof. Huxley, treating birds mainly from their bones and as if they were extinct animals of which these parts of their structure only were known, had proposed an entirely new plan of arrangement, based mainly upon the characteristic variations of the palatal bones, which had passed almost unnoticed by previous writers. The author, who had long been dissatisfied with the Cuvierian system, which with certain modifications he had employed up to 1872, had in that year been constrained to consider the whole subject in order to decide what arrangements should be adopted in the "Nomenclator Avium Americanarum" (a joint work by Mr. O. Salon and himself), then ready for publication. Prof. Huxley had commenced his system with the lowest and most reptilian birds, and had ended it with the highest and most specialised. But it seemed to the author that by exactly reversing this arrangement he would obtain a scheme which would not very far deviate from that which he had previously employed for the first three orders, and would offer many improvements on the Cuvierian system in the remaining ones. Such a scheme had accordingly been promulgated in the Introduction to the "Nomenclator" and followed in that work. In the various subsequently issued editions of the "List of Vertebrated Animals in the Zoological Society's Gardens" a nearly similar arrangement had been followed. A certain amount of adhesion having been secured to this system, the author had been recently induced to devote some labour to its improvement and development. As now elaborated it did not profess to be in any respects original, except as regarded certain small details on points to which he had devoted special attention. The arrangement was in fact simply that of Huxley reversed, with slight modifications consequent upon the recent researches of Parker and Garrod on the anatomy and osteology of little known forms.

The author then proceeded to explain further the "Systema Avium" thus advocated, as shown in the subjoined table, in which the approximate number of known species was added after each Order.

ORDERS OF EXISTING BIRDS

SUBCLASS CARINATÆ (10,121 SPECIES)

	Species.		Species.
I. Passeres	5,700	XIII. Gallinæ	320
II. Picariæ	1,600	XIV. Opisthocomi ...	1
III. Psittaci	400	XV. Hemipodii ...	24
IV. Striges	180	XVI. Fulicariæ ...	150
V. Accipitres... ...	330	XVII. Alectorides ...	60
VI. Steganopodes ...	60	XVIII. Limicolæ ...	250
VII. Herodiones ...	130	XIX. Gaviæ	130
VIII. Odontoglossæ ...	8	XX. Tubinares ...	100
IX. Palamedeæ ...	3	XXI. Pygopodes ...	65
X. Anseres	180	XXII. Impennes ...	20
XI. Columbæ	355	XXIII. Crypturi	40
XII. Pterocletes ...	15		

SUBCLASS RATITÆ (18 SPECIES)

XXIV. Apteryges	4	XXVI. Struthiones ...	4
XXV. Casuarii	10		

In submitting this arrangement, as one which on the whole he was disposed to regard as the best to be adopted after many years' study of the Class of Birds, the author observed that it should be recollected that, although a linear system is an absolute necessity for practical use, it could never be a perfectly natural one. It would always be found that certain groups were nearly equally related to others in different places in the linear series, and that it was a matter of difficulty to decide with which of the allied forms they were best located. But, a linear arrangement being an absolute necessity, it became our duty to make it as natural as possible.

[1] Abstract of a paper read at the British Association by P. L. Sclater, M.A., Ph.D., F.R.S.

THE GREEN COLOUR OF OYSTERS

IN NATURE, vol. xvi. p. 397, mention was made of the fact that the green colour observed in oysters in certain localities is caused by a variety of navicula, to which the name *Navicula ostrearia* has been given. Further particulars of experiments made by M. Puységur, at Sissable, are not without interest.[1]

"The green slime was collected by lightly scraping the margin of one of the 'clears' with a spoon, and was put in flasks, shaken for a moment and then allowed to settle, so as to get rid of the mud, some admixture of which is inevitable. The coloured fluid, containing little or nothing besides diatoms, was then poured off into other flasks. Care and some little dexterity are requisite, as if there is too much silt or too large a quantity

[1] *Revue maritime et coloniale*, February, 1880.

of water, which is generally the case when the task is intrusted to a subordinate, it is sometimes next to impossible to concentrate the fluid enough to show the results with the desired plainness.

"Returning home, we poured the fluid into soup-plates set on a table before a window. The diatoms speedily settled on the sides and bottoms of the plates, coating them with a green slime, the thickness and tint of which varied with the proportion of diatoms present. In each plate, according to its size, we put three to six perfectly white oysters which had never been in the 'clears,' and the shells of which had previously been washed and brushed clean. In similar plates like numbers of the same oysters were laid in ordinary sea-water. Twenty-six hours after the commencement of the experiment the oysters in the water charged with diatoms had all acquired a marked greenish hue; the other oysters remained unaltered. The experiment was repeated many times with identically the same results. The green colour in the oysters was found to be more decided in proportion as the water was more highly charged with diatoms. In the course of the experiments the shell of one of the oysters was perforated, so as to lay bare the mantle. After the oyster had turned green, it was laid in ordinary sea-water for a few days, when the greenness disappeared altogether. It reappeared when the oyster was replaced in fresh water containing *Navicula ostrearia*. The experiment was repeated, with like results, in the laboratory of M. Decaisne, Jardin des Plantes, Paris, to which a supply of white oysters and sealed flasks of the water containing the diatoms was forwarded.

"In the course of the experiments it was observed that by the opening and closing of their valves the oysters induced currents in the water, by means of which they drew towards them and surrounded themselves with the particles of matter suspended therein. The existence and direction of these currents were shown by the disappearance of the slime and the consequent laying bare of the sides and bottoms of the plates, the diatoms remaining only at points out of reach of the currents.

"Directed towards the buccal aperture by the ciliæ with which the branchiæ are provided, the naviculæ enter the stomach of the mollusc, and there part with their nutritive constituents. The yellow chlorophyll is digested and decomposed; the soluble colouring matter passes direct into the blood, to which it imparts its colour. Thus it happens that the most vesicular portions of the structure, as the branchiæ, are the most highly coloured.

"Examination of the digestive tubes of the oysters experimented upon proved the fact of the absorption of the diatoms. The stomachs, intestines, and exuviæ were strewed with carapaces of naviculæ. The carapaces, being siliceous, are not affected by the digestive juices, and it would seem extraordinary that with so tenacious a covering their contents should be evolved, were it not for the knowledge of the fact that the covering is not continuous, the line of suture separating the valves composing the frustule being scarcely silicified at all."

It would therefore appear to be established beyond dispute that the green hue in oysters is due exclusively to their absorption of certain naviculæ contained in the circumambient water. The facts are in perfect keeping with the observations of growers that heavy rains (which increase the supply of fresh water) cause the disappearance of the green from the "clears," while, on the other hand, dry north-east gales, which greatly increase the saturation of the water, bring it, as it is called, "into condition."

Two points of special interest in connection with the subject remain for future investigation. These are:—

1. Does the navicula in question remain all the year in the waters where it is found in winter?

2. Is the coloration of the beds accidental or temporary?—in other words, does this alga disappear from the reservoirs when the water changes its colour, or does it become itself discoloured for a time?

H. M. C.

MODERN ENTOMOLOGY[1]

It is the good fortune of your president on this occasion to welcome you to his native heath, where our favourite science has been longer, more uninterruptedly, and perhaps more zealously cultivated than anywhere else in the New World. Here, in the last century, Peck studied the Canker-worm and the Slug-worm of the Cherry, and in late years *Rhynchænus*, *Stenocorus*, and *Cossus*—all highly destructive insects. Here lived Harris, who cultivated entomology in its broadest sense, and whose classic treatise was the first important Government publication on injurious insects. Here to-day we have two associations for our work, consisting, it will be confessed, of nearly the same individuals, and not many of them, but meeting frequently —one in Boston, the other in Cambridge. Harvard acknowledges the claims of our study in supporting not only an instructor in entomology at its Agricultural School, but a full Professor of the same in the University at large.

In our own day the spreading territory of the United States, the penetration of its wilds, and the inersection of its whole area by routes of travel, the wider distribution and greatly-increased numbers of local entomologists, as well as the demand for our natural products abroad, have set before *us* temptation to study only new forms and to cultivate descriptive work, to the neglect of the choicer, broader fields of our ever-opening science. It is this danger to which I venture briefly to call your attention to-day, not by way of disparaging the former, but rather in the hope that some of our younger members, who have not yet fallen into the ruts of work, may be induced to turn their attention to some of the more fruitful fields of diligent research.

We should not apply the term descriptive work merely to the study of the external features of insects. The great bulk of what passes for comparative anatomy, physiology, and embryology is purely descriptive, and is only to be awarded a higher grade in a scale of studies than that which deals with the external properties when it requires a better training of the hand and eye to carry it out, and greater patience of investigation. We pass at once to a higher grade of research when we deal with comparisons or processes (which of course involve comparisons). All good descriptive work indeed is also comparative; but at the best it is so only in the narrowest sense, for only intimately allied forms are compared. In descriptive work we deal with simple facts; in comparative work we deal with their collocation. "Facts," said Agassiz one day, "facts ar stupid things, until brought in connection with some general law."

It is to this higher plane that concerns itself with general laws that I would urge the young student to bend his steps. The way is hard; but in this lies one of its charms, for labour is its own reward. It is by patient plodding that the goal is reached; every step costs and counts; the ever-broadening field of knowledge exhilarates the spirit and intensifies the ambition; there is no such thing as satiety—study of this sort never palls.

It is hardly necessary to point out that so-called systematic work never reaches this higher grade unless it is monographic; unless it deals in a broad way with the relationship and general affinities of insects. It is not my purpose to call attention here to the needs of science in this department, as they are too patent to escape observation; but if one desires a model upon which to construct such work, one need not look further than the "Revision of the Rhynchophora," by Drs. LeConte and Horn. Rather than linger here we prefer to pass directly to some of the obscurer fields of study.

When we compare the number of insect embryologists in America with that of their European colleagues, the result is somewhat disheartening and discreditable; although perhaps the comparison would be not quite so disproportionate were some of our students to publish their notes. But take all that has been done upon both sides of the water, and what a meagre showing it makes! Of how many families of Coleoptera alone have we the embryonic history of a single species?

In following the post-embryonal history of insects there is work for all. While allied forms have in general a very similar development, there are so many which are unexpectedly found to differ from one another, that every addition to our knowledge of the life histories of insects is a gain, and they are to be praised who give their close attention to this matter. Here is a field any entomologist, even the most unskilled, may cultivate to his own advantage and with the assuiance that every new history he works out is a distinct addition to the science. The importance of an accumulation of facts in this field can hardly be overestimated, and those whose opportunities for field-work are good should especially take this suggestion to heart. Nor, by any means, is the work confined to the mere collection of facts. How to account for this extraordinary diversity of life and habits among insects, and what its meaning may be, is one of the problems of the evolutionist. There are also here some specially curious inquiries, to which Sir John Lubbock and

[1] Annual Address before the Entomological Club of the American Association for the Advancement of Science, by the President, Mr. S. H. Scudder, of Cambridge.

others have recently called attention, and to which Mr. Riley has contributed by his history of *Epicauta* and other *Meloidæ*. I refer to the questions connected with so-called hypermetamorphosis in insects. In these cases there are changes of form during the larval period greater than exist between larva and pupa, or even between larva and imago, in some insects. There are also slighter changes than these which very many larvæ undergo; indeed it may safely be asserted that the newly-hatched and the mature larvæ of all external feeders differ from each other in some important features. The differences are really great (when compared to the differences between genera of the same family at a similar time of life) in all lepidopterous larvæ, as well as in all Orthoptera which have come under my notice. No attempt to co-ordinate these differences, or to study their meanings, or to show the nature of their evident relationship to hypermetamorphosis has ever been attempted.

Not less inviting is the boundless region of investigation into the habits of insects and their relation to their environment. The impulse given to these studies by the rise of Darwinism, and the sudden and curious importance they have assumed in later investigations into the origin and kinship of insects, need only to be mentioned to be acknowledged at once by all of you. The variation in coloration and form exhibited by the same insect at different seasons or in different stations, "sports," the phenomena of dimorphism, and that world of differences between the sexes, bearing no direct relation to sexuality; mimicry also, phosphorescence and its relations to life, the odours of insects, the relation of anthophilous insects to the colours and fructification of flowers, the modes of communication between members of communities, the range and action of the senses,[1] language, commensalism—these are simply a few topics selected quite at random from hundreds which might be suggested, in each of which new observations and comparative studies are urgently demanded.

The fundamental principles of the morphology of insects were laid down by Savigny in some memorable memoirs more than sixty years ago; the contributions of no single author since that time have added so much to our knowledge, notwithstanding the aid that embryology has been able to bring. Nevertheless there remain many unsolved problems in insect morphology which by their nature are little likely to receive help from this source. Let me mention three:—

The first concerns the structure of the organs of flight. The very nomenclature of the veins shows the disgraceful condition of our philosophy of these parts; the same terminology is not employed in any two of the larger sub-orders of insects; names without number have been proposed, rarely however by any author with a view to their applicability to any group outside that which formed his special study; and a tabular view which should illustrate them all would be a curious sight. A careful study of the main and subordinate veins, their relations to each other, to the different regions of the wing, to the supporting parts of the thorax and to the alar muscles, should be carried through the entire order of insects; by no means, either, neglecting their development in time, and possibly deriving some assistance in working out homologies by the study of their hypodermic development.

The second concerns the mouth parts. The general homologies of these organs were clearly and accurately enough stated by Savigny, though one may perhaps have a right to consider the last word not yet said when one recalls Saussure's recent claim to have found in *Hemimerus* a second labium. What I refer to, however, is another point: it relates to the appendages of the maxillæ and the labium. Considering the labium as a soldered pair of secondary maxillæ, we have at the most, on either pair of maxillæ, three appendages upon either side. These appendages, as you know, are very variously developed in different sub-orders of insects, or even in the same sub-order; and it has at least not been shown, and I question if it can be done, that the parts bearing similar names in different sub-orders are always homologous organs. Here is a study as broad and perhaps as difficult as the last.

The third is the morphological significance of monstrosities, especially of such as are termed monstrosities by excess. The literature of the subject is very scattered, and the material much more extensive than many of you may think. At present this subject is, so to speak, only one of the curiosities of entomology, but we may be confident that it will one day show important relations to the story of life.

[1] Notice Meyer's beautiful studies on the perception of sound by the mosquito.

After all the labours of Herold, Treviranus, Lyonet, Dufour, and dozens of other such industrious and illustrious workers, is there anything important remaining to be done in the gross anatomy of insects? some of you would perhaps ask. Let the recent work of some of our own number answer, which has shown in the Hemiptera and Lepidoptera the existence of a curious pumping arrangement by which nutritious fluids are forced into the stomach. It is certainly strange that after all that has been said as to the mode in which a butterfly feeds, no one should have dissected a specimen with sufficient care to have seen the pharyngeal sac which Mr. Burgess will soon show us. No! the field is still an open one, as the annual reviews clearly show. The curious results of Flögel's studies of the brain, the oddly-constructed sense-organs found by Graber and Meyer (earlier noticed briefly by Leydig) in the antennæ of Diptera, the important anatomical distinctions discovered by Forel in different groups of ants, the strange modification of the tip of the spiral tongue in *Ophideres*, which Darwin, Brietenbach, and Künckel have discussed, and, above all, the extensive investigations of the nervous system in insects generally which Brandt has recently undertaken, the exquisite memoir of Grenacher on the structure of the compound eye, and the keen researches of Graber in various departments of insect anatomy, show by what has been accomplished how many harvests are still unreaped. The microtome, too, has put a new instrument of precision into the hands of the investigator in the field.

If these few words shall arouse in any one a higher ambition, leading to better work, their aim will have been accomplished.

SCIENTIFIC SERIALS

American Naturalist, August 1880.—D. P. Penhallow, the fabrication of Aino cloth.—H. D. Minot, English birds compared with American.—J. S. Gardner, on the age of the Laramie formation as indicated by its vegetable remains.—J. E. Todd, on the flowering of *Saxifraga sarmentosa*.—Prof. A. N. Prentiss, distribution of obnoxious insects by means of fungoid growths.—Recent literature.—General notes.—Scientific news.

September.—J. Walter Fewkes, the Siphonophores:—No. 1, the anatomy and development of Agalma.—Prof. A. N. Prentiss, destruction of obnoxious insects by means of fungoid growths (concluded); the result of these experiments would seem to indicate plainly that yeast cannot be regarded as a reliable remedy against such insects as commonly affect plants cultivated in greenhouses or in windows, but the general question is by no means as yet decided.—O. B. Johnson, birds of the Willamette Valley, Oregon (concluded).—C. O. Whitman, Do flying-fish fly?

Annalen der Physik und Chemie, No. 8.—On electric expansion (continued), by G. Quincke.—Clausius' law and the motion of the earth in space, by E. Budde.—On the dependence of the electric conductivity of carbon on the temperature, by W. Siemens.—On the phenomena in Geissler tubes under external action, by E. Reitlinger and A. v. Urbanitzky.—Complete theory of the bifilar-magnetometer and new methods of determining the absolute horizontal intensity of the earth's magnetism, as also the temperature and induction coefficients of magnets, by H. Wild.—On the comparison of the electrodynamic fundamental law with experience, by R. Clausius.—On a direct transformation of the vibrations of radiant heat into electricity, by W. Hankel.—On fluorescence, by E. Lommel.—On the behaviour of different heat rays in the reflection of polarised rays from metals, by H. Knoblauch.—Remark on the heat conductivity of mercury, by H. Herwig.—Remarks on H. Weber's memoir on heat-conduction in liquids, by A. Winkelmann.—On air-resistance, by G. Recknagel.—On the action of hollow, in comparison with that of solid, steel magnets, by W. Holtz.

No. 9.—On the compressibility of gases, by F. Roth.—On the electric conductivity of some salt solutions, by J. H. Long.—New experimental researches on fluorescence, by O. Lubarsch.—On constants of refraction, by L. Lorenz.—Experimental researches on refraction constants, by K. Prytz.—Theory of reflection and refraction at the limit of homogeneous, isotropic, transparent bodies, with generalisation and extension of the foundations of Neumann's method, by M. Réthy.—Thermal theory of development of electricity, by J. L. Hoorweg.—On the behaviour of electricity in gases, and especially in vacuum, by F. Narr.—Defence of the law of corresponding boiling temperatures, by U. Dühring.—Equation of the state of atmospheric air, by G. Schmidt.—Time of discharge of the Leyden battery, by P. Riess.

Journal of the Royal Microscopical Society, vol. iii. No. 4 (August, 1880), contains: John Badcock, notes on Acinetina (*Trichophrya epistylidis* and *Podophrya quadripartita*) with a plate.—J. W. Stephenson, on the visibility of minute objects mounted in phosphorus, solutions of sulphur, bisulphide of carbon, and other media.—Dr. George Hoggan and Dr. F. Elizabeth Hoggan, on the development and retrogression of blood vessels, with a plate.—Dr. Jas. Edmunds, on a parabolised gas slide.—The record of current researches relating to invertebrata, cryptogamia, microscopy; bibliography, and proceedings of the society.

Journal de Physique, September.—On the alternating currents and the electromotive force of the electric arc, by M. Joubert.—On the formula of interpolation of M. Pictet, by M. Szily.—Absolute measurement of Peltier's phenomenon in contact of a metal, and its solution, by M. Bouty.

Bulletin de l'Académie Royale des Sciences (*de Belgique*), No. 8.—On the embryonal leaves and the notochord in Urodela, by M. van Bambeke.—Researches on the spectrum of magnesium in relation to the constitution of the sun, by M. Fiévez.—On the presence of phosphoric acid in the urine of cows, by M. Chevron.—Excretory apparatus of Trematodes and Cestoides (2nd paper), by M. Fairfont.—Researches on fusel oil (amylic alcohol, &c.) in commercial alcohol, brandies, &c., by M. Jorissen.—On the structure of the venomous apparatus of Araneides, by Mr. MacLeod.—On the gastric gland of the American ostrich, by M. Remouchamps.—On the geometric representation of co-variants of a biquadratic form, by M. Le Paige.

Morphologisches Jahrbuch (*Gegenbaur's*), Bd. vi., Heft 3.—J. E. V. Boas, on the heart and arch of the aorta in Ceratodus and Protopterus, with three plates and woodcuts (a memoir both descriptive and critical of the various researches on this subject by Hyrtl, Owen, Peters, Lankester, and Günther).—G. v. Koch, notes on corals, with a plate.—George Ruge, researches on the process of development of the sternum, and on the sterno-clavicular attachments in man, with three plates.—W. Salensky, contribution to the developmental history of the ear cartilages in mammals, with a plate.

Zeitschrift für wissenschaftliche Zoologie, Bd. xxxiv., Heft. 3, July.—Gustav Häuser, physiological and histological investigations on the organ of smell in insects, three plates (finds in most insects well-marked nerves springing from the cephalic ganglia distributed to the antennæ, where special hypodermic cells receive them; the development and structure of these are beautifully illustrated).—O. Zimmermann, on a peculiar formation in the abdominal vessels in an Ephemeris larva.—Prof. F. E. Schulze, researches on the structure and development of the sponges: No. 9, the Plakinidæ, three plates (three new genera and five new species described).—John Hönigschmied, brief notices concerning the distribution of the gustatory papillæ in mammals.—Dr. J. W. Spengel, contribution to a knowledge of the Gephyrea, four plates (*Echiurus Pallasii*).

SOCIETIES AND ACADEMIES

Paris

Academy of Sciences, September 27.—M. Wurtz in the chair.—The following papers were read:—On the non-recurrence of the anthracoid affection, by MM. Pasteur and Chamberland. Their experiments prove that in the case of *charbon*, as in that of chicken cholera, inoculations that do not prove fatal are preventive of a recurrence of the disease. M. Pasteur argues against M. Chauveau's theory that such non-recurrence is due to production of matters adverse to the proliferation of the bacterium. Experiments had been made with a view to testing a remedy for charbon devised by M. Louvrier, but were indecisive.—On the results obtained by M. Rondaire in his exploration of the Tunisian and Algerian chotts, by M. de Lesseps. M. Rondaire's conclusions are entirely favourable to filling the basin situated between the Gulf of Gabes and the projected line of railway from Biskra to Tuggurt. This would make an interior sea about 400 km. in length and 1,600 km. in circumference.—A vapour-tension manometer for analysing liquids and measuring pressures, by M. Perrier. A glass tube, tapering at the lower end, stands with this (open) end in mercury, contained in, but not filling, an oblong closed bulb, a few drops of a volatile liquid being imprisoned above the mercury. The liquid to be determined is heated in a small boiler and the bulb referred to is placed in the vapour. The liquid of the manometer (which should emit vapour of greater tension than the liquids examined) acts by its vapour on the mercury, forcing it up the tube to various heights.—On a property of Poisson's function, and on the integration of equations with partial derivatives of the first order, by M. Gilbert.—On the theory of sines of superior orders, by M. Farkas.—On the invention of binocular telescopes, by M. Govi. The invention is commonly attributed to the Capuchin monk Schyrleus de Rheita, who published an account of it in 1645. M. Govi finds, from the papers of Peirescq in the Bibliothèque Nationale, that a spectacle maker in Paris, D. Chorez, made and presented binocular glasses to the king in 1625, *i.e.* twenty years earlier.—On the difficulty of absorption and the local effects of the poison of *Bothrops jararaca*, by MM. Couty and Lacerda. Whichever the mode of introduction, cellular, muscular, or serous tissue, brain, heart, or lung, and whatever the quantity of poison injected (vascular ruptures and antecedent wounds apart), there is no distinct sign of penetration of the poison into the blood. There is always local inflammation, which for some organs may prove rapidly fatal. The lung is most sensitive in this respect, the stomach and intestine least.—Study of the vertebræ in the order of Ophidians, by M. Rochebrune.—On the ciliated embryo of the *Bilharzia*, by M. Chatin. The signification assigned by helminthologists to this embryo in the cycle of development of the species requires (in the author's opinion) to be profoundly modified (a superiority of constitution being observed).—Researches on the presence of micrococcus in the diseased ear; considerations on the *rôle* of microbes in auricular furuncle (boil) and general furunculosis; therapeutic applications, by M. Loewenberg. He has observed a microbe in furuncle of the ear. These small abscesses spread in the ear by what he calls *autocontagion*, and from individual to individual contagiously. In treatment he employs thymic or boric acid. In cases of neglected otorrhea or wetness of the ear, especially with fetidity, he has always found micrococcus in large quantity.

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