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# NATURE

A WEEKLY

## ILLUSTRATED JOURNAL OF SCIENCE

VOLUME X.

MAY 1874 to OCTOBER 1874

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

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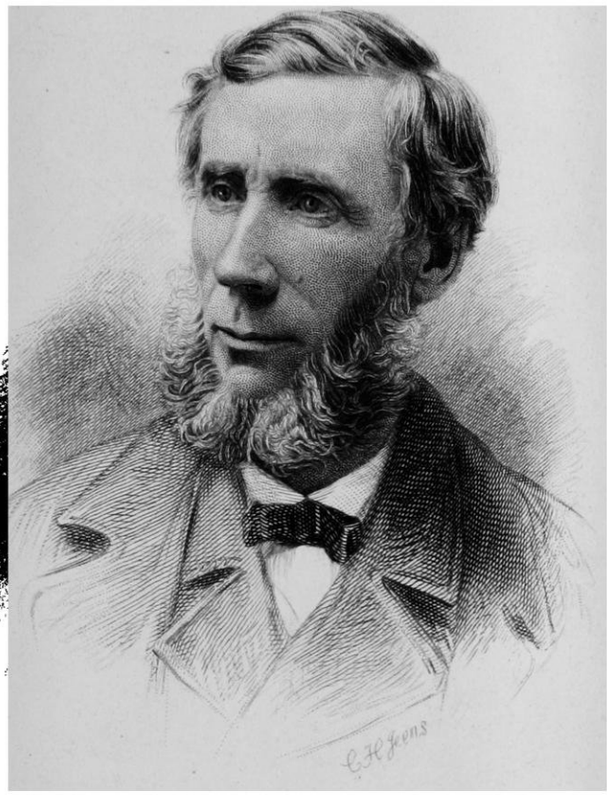


*John Tyndall*

*Engraved by E. H. Jeens from a Photograph*

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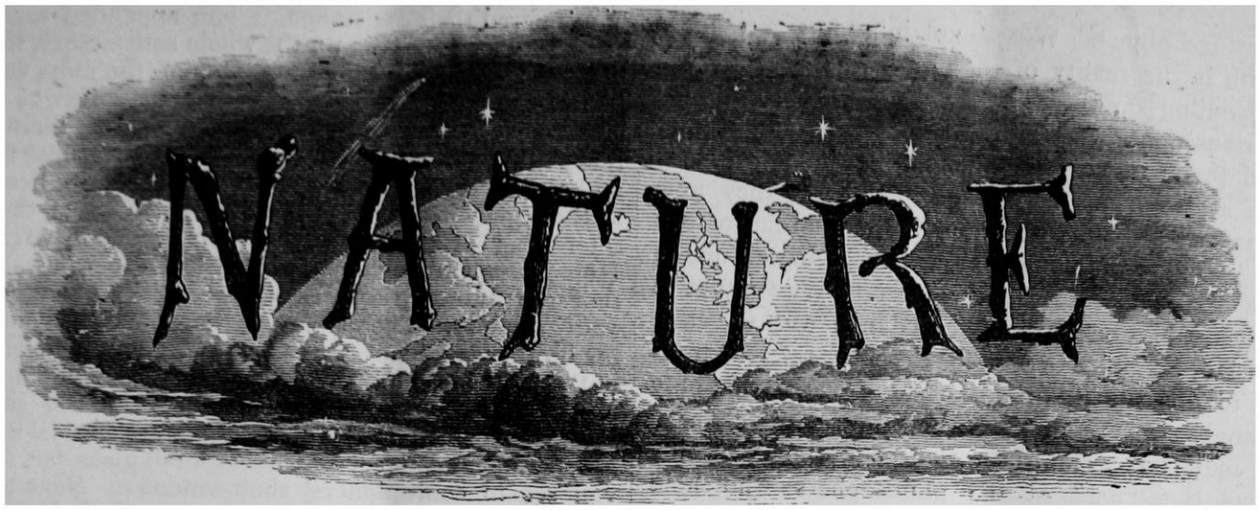


A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

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

THURSDAY, MAY 7, 1874

## *LEWES'S "PROBLEMS OF LIFE AND MIND"*

*Problems of Life and Mind.* By George Henry Lewes. First Series: The Foundation of a Creed. Vol. I. (Trübner & Co.)

IN this volume Mr. Lewes speaks in an attractive, if rather conversational way, on a great many philosophical and psychological topics; but the most striking feature of the book is the many announcements of discoveries and original views to be proved and elaborated in future volumes. And the author's opinion that the work is of "somewhat ambitious pretensions" is, we think, likely to be shared by his readers.

We are promised a Psychology, but introductory thereto Mr. Lewes has produced two volumes (the second is now under final revision), in which he aspires to lay the Foundation of a Creed. "The great desire of this age is for a doctrine which may serve to condense our knowledge, guide our researches, and shape our lives, so that Conduct may really be the consequence of Belief." Perhaps there is a general, certainly not a universal, longing for something of this kind. The first question is, what is to be the fate of this hunger of the soul? Is this longing doomed to perish for want of an object? or is it destined to be satisfied? If so, how? Religion, thinks Mr. Lewes, is not to die, but to be transformed.

According to Mr. Lewes this new Religion, "Instead of proclaiming the nothingness of this life, the worthlessness of human love, and the imbecility of the human mind, will proclaim the supreme importance of this life, the supreme value of human love, and the grandeur of the human intellect." The first half of this fine sentence is entirely negative; it tells us that the new creed will not seek to suppress or degrade human nature, after the manner imputed to some of the old religions. This is well, and, as it seems to us, sufficient for all that Mr. Lewes, so far as we can make out, has in view

Before this new doctrine, which is to reconcile the claims of Religion and Science, can be established, it is necessary as a preliminary to transform Metaphysics. Accordingly Mr. Lewes has applied himself to this task. Defining Metaphysics as the "Science of the most general conceptions," to be pursued solely by the method of Science, he discards "all inquiries whatever which transcend the ascertained or ascertainable data of experience." As a name for the province which he thus excludes from metaphysics, he suggests the word *metempirics;* and as *metempirical* has much to recommend it, besides its being the exact correlative of empirical, it will, we hope, establish itself as a useful addition to the language of philosophy. Mr. Lewes anticipates very large results from systematically keeping in view as a principle of research the necessity of clearly and completely eliminating from the statement of each problem all metempirical elements. In the light of this method all mystery, it seems, will vanish from the universe, as the shadows of the morning fly before the rising sun:—"When rationally stated there is no greater mystery in the existence of an external world, or the relations between object and subject, than the relation between activity and waste in the tissues." For, though as Mr. Lewes observes, "it may seem a very bold thing to say," yet he believes and hopes to show that "we not only know that an external Not-self exists,—know it with the same assurance that we know an internal Self to exist, but we also know the manner in which the two are combined in Feeling and Thought." Mr. Lewes will certainly have philosophised to some purpose if he put us in possession of a principle of research that will enable us so completely to transcend what at present appears to be the highest reach of our powers. One condition of understanding the manner of a combination has hitherto been a knowledge of the elements in separation. If we know how oxygen and hydrogen combine to form water, it is because we know these gases otherwise than combined in water. But of the Self and Not-self we know nothing, and can never know anything save as feeling and thought. In the author's own words, "all that we can know of the external is what we have felt or might feel." Nor do we see at this moment that this criticism would lose its point even were we to accept Mr. Lewes's peculiar doctrine of

the subject and object. When explaining how men came to lose faith in the reality of the objective, he points out that by dwelling on the fact that the same subject produces various sensations at different times, they at last "reversed their primary and instinctive judgment, and instead of saying 'qualities belong to objects,' they now said, 'It is we who invest objects with the qualities of our feelings.'" This he seems to regard as giving an undue predominance to the "subjective aspect." We venture to think that it would be more in accordance with the established use of language to describe the error referred to as a failure to observe that the sensations varied, not only with changes in the object, but also with changes in the material organism called our body,—which never was the "*we*" of the philosophers who hold that it is *we* who invest objects with the qualities of our feelings. Looked at from this point of view, the whole truth within our reach is simply this, that with the same external object and the same bodily condition, the same state of consciousness will invariably arise. The peculiarity of Mr. Lewes's position, if we understand it, is that he means by the *Self* the living body, the "sentient organism" *as we know it*, and by the Not-self the external surrounding *as known to us*; for his *reasoned realism* forbids him to seek after any deeper reality of things,—the absolute is what we see and hear. So far are we, as it appears to us, from knowing how the action of external forces on the living organism results in *feeling*, that we cannot make the very least approach to a conception of such a thing. Recognising that each feeling is related to certain vibrations set up in the nervous structure by the action of external agents, which vibrations Mr. Lewes describes as expressed by the feeling, this, as far as we can see, brings us no nearer to a conception of any sense in which "the feeling *is* what it expresses"—is the vibrations. Mr. Lewes will have to say much more than he has yet said, before we shall be able to see with him that stimuli plus mechanism can ever yield an explanation of sensation.

We regret that our space will not permit us to notice any other of the many important topics touched on in this volume. The whole demands, and will fully repay, a careful reading from every student of these matters. Only the first of Mr. Lewes's problems—the Limitations of Knowledge—is worked out at full length, the chapter on Necessary Truths being perhaps the most interesting. In the last chapter Mr. Lewes considers the place of sentiment in philosophy. What he has to show is that Sentiment, or Emotion, is one important source of knowledge. But what he says is more likely to impress his readers with its power of obscuring vision and obstructing research.

DOUGLAS A. SPALDING

## OUR BOOK SHELF

*Report of the Rugby School Natural History Society for the year* 1873. (Rugby: W. Billington, 1874.)

THIS Report is on the whole very satisfactory, and the tone of the preface exceedingly hopeful. At no time in its past history of seven years, the retiring president tells us, does the Society seem to him to have contained more promising workmen. It appears that it has been resolved to construct a geological model of the Rugby district, and for this *magnum opus* many volunteers from the Society have offered their assistance. The appended reports of the various sections are on the whole satisfactory, showing that real work is being done. One of the most valuable features in the Report for 1873 is the number of papers which have been read by the young members themselves, there being seven printed here in greater or less fulness, and a number of others mentioned as having been read at the regular meetings of the Society. One of the most interesting of the published papers is one by Mr. H. N. Hutchinson On Home-made Electrical Apparatus, showing that the author possesses very considerable originality and ingenuity. The apparatus described was made by his brother and himself five years ago, and includes some of the most essential parts of an electrical equipment, the cost of the whole not being more than a few shillings. He thus tells us how the cylinder of an electrical machine may be manufactured. "Choose a tall glass jar, such as you see in confectioners' shop-windows. Next get two wooden caps turned to fit on to the ends of the cylinder, about an inch deep, with projecting pivots. The caps are next to be cemented on to the ends of the cylinder. The cement is composed of resin, beeswax, red ochre, and a little plaster of Paris, and must be heated over a slow fire. The open end of the cylinder must be first covered over with a piece of silk to prevent bits falling in." The conductor was made of deal wood turned to the proper shape and covered very smoothly with tinfoil; the Leyden jars were made from ordinary plum jars. We recommend the paper with its accompanying sketches to those who cannot afford to buy an electrical apparatus. W. B. Lowe describes some carefully made experiments On Cohesion of Water at Various Temperatures; and other papers by pupils, evincing considerable power of observation, are—On an Excursion of Mr. Wilson's Geological Class to Mount Sorrel, by C. M. Kerr; On a Botanical Expedition to Princethorpe, by H. W. Trott; On a Geological Expedition to Atherstone and Nuneaton, by E. Mann; On an Entomological Expedition to Frankton Wood, by H. A. Bull; and On the Chameleon, by J. S. Beuttler, giving an account of the author's own observations on two specimens belonging to himself. Besides these there are several other papers by masters and outsiders; one of the latter is a very instructive paper by Mr. R. H. Scott, F.R.S., On the Weather. The Report also contains four plates by pupil members of the Society.

*The Surface Zones of the Globe. A Handbook to accompany a Physical Chart.* By Keith Johnston, F.R.G.S. With two Maps and six Illustrations. (W. and A. K. Johnston, 1874.)

THIS little volume will form an interesting and valuable addition to our educational manuals, either as a lesson-book for pupils or as a handbook for teachers. The author divides the surface of the globe into seven great zones, and shows that, without considering the particular species of plants, or the more minute details of the forms of natural life which occur in these belts, and which may differ in one continent from another, there is a resemblance in character throughout the whole extent of each zone, whether of forest, or pasture, or desert, which cannot be mistaken. Mr. Johnston names these zones as follows:—1. The Equatorial Forest Region; 2. The Equatorial Pasture Lands; 3. The Deserts; 4. The Temperate Pasture Lands; 5. The Temperate Forests; 6. The Barren Tundra Regions; 7. The Icy Polar Regions. He describes in detail the characteristic appearance and productions of each region, and in doing so manages to convey a considerable amount of useful information. The manual is intended to accompany a large chart of the world on which these surface zones are distinguished, and a minute copy of which forms one of the diagrams of the work. Another very curious and interesting diagram is intended to show the surface zones on the supposition of a change of 90° in the position of

the earth. The coloured illustrations showing the characteristic appearances of the various zones are as successful as anything of the kind we have seen, although, what perhaps cannot be avoided in coloured illustrations of this kind, there is a little too much of "the light that never was on sea or land" upon them.

## LETTERS TO THE EDITOR

*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

### Necessary Truths—Physical and other

I AM not about to continue a controversy which I regret having been provoked into by the misrepresentations of one who ignored the contents of works he professed to review. Reply and rejoinder may go on endlessly. I could not, to much purpose, argue with Mr. Hayward, who, instead of taking such unconsciously-formed preconceptions as those resulting from the infinite experiences of muscular tensions and their effects, proposes to exemplify unconsciously-formed preconceptions by a consciously-formed hypothesis concerning the relation between weight and motion. Nor should I care to discuss any question with my new anonymous assailant; who, when certain examples given show the "exact quantitative relations" spoken of to be those of direct proportion, describes me as "intensely unmathematical" because I subsequently use the more general expression as equivalent to the more special—which, in the case in question, it is.

The first of my objects in now writing is to remind "some bystanders, who may from their antecedents be presumed competent to judge," that the essential question is not a mathematical one, but a logical and psychological one, in respect of which I am not aware that senior wranglers, as such, can claim any special competence. Further, even admitting the assumption that the question is mathematical, I have to warn the reader that he will be much misled if he infers that there are not "some bystanders who may from their antecedents be presumed" *more* "competent to judge," who concur in the opinion that the laws of motion cannot be demonstrated experimentally.

My second object is to inclose, for publication in NATURE, a passage now standing in type to be added to future impressions of "First Principles" in further elucidation of necessary truths, and our apprehensions of them.

HERBERT SPENCER

"The consciousness of logical necessity, is the consciousness that a certain conclusion is implicitly contained in certain premisses explicitly stated. If, contrasting a young child and an adult, we see that this consciousness of logical necessity, absent from the one, is present in the other, we are taught that there is a *growing up* to the recognition of necessary truth, merely by the unfolding of the inherited intellectual forms and faculties.

"To state the case more specifically:—Before a neceesary truth can be known as such, two conditions must be fulfilled. There must be a mental structure capable of grasping the terms of the proposition and the relation alleged between them; and there must be such definite and deliberate mental representation of these terms as makes possible a clear consciousness of this relation. Non-fulfilment of either condition may cause non-recognition of the necessity of the truth; and may even lead to acceptance of its contrary as true. Let us take cases.

"The savage who cannot count the fingers on one hand, can frame no definite thought answering to the statement that 7 and 5 make 12; still less can he frame the consciousness that no other total is possible.

"The boy adding up figures inattentively, says to himself that 7 and 5 make 11; and may repeatedly bring out a wrong result by repeatedly making this error.

"Neither the non-recognition of the truth that 7 and 5 make 12, which in the savage results from undeveloped mental structure, nor the assertion, due to the boy's careless mental action, that they make 11, leads us to doubt the necessity of the relation between these two separately-existing numbers, and the sum they make when existing together. Nor does failure from either cause to apprehend the necessity of this relation make us hesitate to say, that when its terms are distinctly represented in thought, its necessity will be seen; and that apart from any multiplied experiences, this necessity becomes cognisable when structures and functions are so far developed that groups of 7 and 5 and 12 can be intellectually grasped.

"Manifestly, then, there is a recognition of necessary truths, as such, which accompanies mental evolution. Along with acquirement of more complex faculty and more vivid imagination, there comes a power of perceiving to be necessary truths what were before not recognised as truths at all. And there are ascending gradations in these recognitions. Thus a boy who has intelligence enough to see that things which are equal to the same thing are equal to one another, may be unable to see that ratios which are severally equal to certain other ratios, that are unequal to each other, are themselves unequal; though to a more developed mind this last axiom is no less obviously necessary than the first.

"All this, which holds of logical and mathematical truths, holds, with change of terms, of physical truths. There are necessary truths in Physics, for the apprehension of which, also, a developed and disciplined intelligence is required; and before such intelligence arises, not only may there be failure to apprehend the necessity of them, but there may be vague beliefs in their contraries. Up to comparatively recent times, all mankind were in this state of incapacity with respect to physical axioms; and the mass of mankind are so still. Various popular notions betray inability to form clear ideas of forces and their relations, or carelessness in thinking, or both. Effects are expected without causes of fit kinds; or effects extremely disproportionate to causes are looked for; or causes are supposed to end without effects. But though many are thus incapable of grasping physical axioms, it no more follows that physical axioms are not knowable *à priori* by a developed intelligence, than it follows that there is no necessity in logical relations because many have intellects not developed enough to perceive the necessity.

"The ultimate physical truth of which clear apprehension is eventually reached, is that force can neither arise without an equivalent antecedent, nor disappear without an equivalent consequent. Along with power of introspection there comes recognition of the fact that existence cannot be conceived as beginning or ending: the Laws of Thought themselves negative any such mental representation. And if it be asked why this intuition, which all physical axioms indirectly imply, and which is postulate in every physical experiment, is to be taken as authoritative because its negation is inconceivable, the answer is that no argument which sets out to discredit it can do this without logical suicide; since there is no other warrant for asserting the dependence of any conclusion on its premisses than the inconceivability of its negation."

This passage forms part of a revised version of the chapters on Matter, Motion, and Force, which I have contemplated making for this year past. When those chapters were written and stereotyped in April 1861 (see Preface), the modern doctrines concerning Force and its transformation were so imperfectly developed, that some of the leading technical words now currently used were not introduced. The reorganisation of "First Principles," which I made in 1867, for the purpose of more truly presenting the general Theory of Evolution, did not implicate these chapters, and I believe I did not even re-read them: the stereotype plates, in common with those of many other chapters, with the numberings of pages and sections altered, were used afresh, and continue still to stand as they originally did. But while now rectifying defects of statement which it was scarcely possible to avoid thirteen years ago, I find no reason for changing the essential conception set forth in those chapters; nor is the need for changing it suggested to me by those on whose judgments I have the best reasons for relying.—H. S.

### Royal Society Soirée

WITH reference to your account of the Royal Society's soirée (NATURE, vol. ix. p. 502), will you allow me to explain that all I "promised" concerning the missing pair of Paradise-birds was to deliver them when sent for.

They were not sent for, owing to some mistake, and consequently not exhibited.

May 5 P. L. SCLATER

### Father Secchi's Work on the Sun

WITH great surprise I read in NATURE, vol. ix. p. 500, the following note:—

"Father Secchi is preparing at Gauthier Villars a second

edition of his work on the Sun, on an enlarged scale. He has quoted so largely from Mr. Lockyer's 'Solar Physics' that an intended translation of this work is abandoned for the present."

I have the honour to inform you that the complete original of my second edition has been in the hands of M. Gauthier for more than a month, so far as that part which may have something in common with Mr. Lockyer's work is concerned, and that I had not seen Mr. Lockyer's work until a fortnight ago, when I bought it from M. Loescher here in Rome. Mr. Lockyer of course is quoted, but only from his original memoirs, and not from his new publication, nor in such a manner that his publication will render my work useless.

Rome, March 23 P. R. SECCHI

[The following explanation has been sent us by the Paris correspondent who furnished us with the note referred to by Father Secchi :—

"I was told by his (P. Secchi's) editor himself, when I spoke to him about publishing a French edition of Mr. Lockyer's 'Solar Physics,' the substance of what I have written to you. I think that the note I have written is a recommendation of Father Secchi's work ; but not so his statement that he did not possess 'Solar Physics' until it was too late to use it. There is nothing whatever dishonourable in quotation."—ED.]

## Spontaneous Generation Experiments

SINCE October 1870 I have, as opportunity offered and other work permitted, made a series of experiments bearing on the question of spontaneous generation. They seem to me to tell so plain a story that I am anxious to relate it.

The thoughts which led to the experiments were briefly these :—

The occasional or even frequent presence of living growths in fluids after they have been exposed to a temperature of 212° F. and are contained in closed tubes or flasks is rather an indication of the imperfection of a method than the proof of a theory ; for under like circumstances living organisms ought either always or never to develop ; the conditions being uniform, the results should be uniform.

When the tubes are closed at a blow-pipe flame after boiling, steam cannot be escaping from the aperture at the time of actual closure, and it is conceivable that in the momentary collapse of the contents which then occurs some atmospheric air containing organic matter may pass into the tube and invalidate the experiment.

The contained air, if any there be after the sealing of the tubes, must be vastly rarefied, and the ordinary atmospheric conditions, other than purity, which are essential, must be absent or greatly modified.

I attempted to devise an experiment which would be free from these possible sources of error ; one in which the atmospheric pressure should be normal, in which the physical structure of the air should be unaltered, and in which there should be no chance of organic contamination after heating. Further it seemed a good thing to be able to show at the same time and in the same apparatus two distinct specimens of the boiled fluid, the one exposed only to cleaned air, the other exposed also to common air ; and also to use a fluid which would indicate to the naked eye by change of colour, or of clearness, or of consistence, the time at which living growths made their appearance.

The latter condition was secured by using a fluid (for the idea of which I am indebted to Mr. Heisch's experiments on water-impurities) composed of 10 cc. of urine, 1 gramme of white sugar, and 90 cc. of distilled water. This when boiled and filtered is a clear transparent liquid, which becomes milky on the occurrence of organic growth during fermentation in thirty to forty hours, according to the heat to which it is exposed.

The other conditions were effected by using a glass tube of the shape of the capital letter M, with curved bends instead of the angles ; a tube which may be described as having four straight legs joined to each other by two loops on the upper side and one on the lower ; the first leg closed and the last leg open and short.

This tube, so bent, was made very hot, so as to expel as much air as possible from it ; the open end was then plunged into the boiled and filtered urine-sugar fluid, and such a quantity allowed to flow in on the cooling of the tube as left the first, second, and third legs about half full when the tube was held upright. The tube was again heated to the boiling of the contained fluid in order to expel as much air as possible by the generation of steam. It was then allowed slowly to cool, so that the first leg was about one-third filled with fluid ; and such an amount was left in the lower loop as would rise in the second and third legs to about the same extent as the tube cooled (and the cooling was designedly prolonged) ; air passed through the fluid in the lower loop to fill the space in the first upper loop, between the two masses of fluid, left vacant by the condensation of steam.

The tube was then hung up, away from direct sunlight, and exposed to the ordinary changes of temperature of my study.

If I have been able to describe intelligibly this very simple matter, it will be seen that I had here two portions of the same fluid separated from each other ; both having been heated to the same temperature and both exposed to atmospheric air.

The conditions were precisely similar with one exception ; intentional and crucial. The air in the first upper loop, to which air only the fluid in the first leg was exposed, had passed through and been washed by the fluid in the lower loop ; and the fluid of this loop was on one side exposed to the washed air and on the other side to the ordinary atmosphere.

In experiments with this apparatus the phenomena were, in eight cases, as follows :—On the second or third day the fluid in the loop was milky, and the fluid in the first leg was bright. At the end of a week, a month, four months, indeed as long as the tube was kept, the one continued clear, the other was turbid. At the expiration of a time, varying in different experiments from four days to four months, I tilted over the least drop of the turbid fluid in the loop into the clear fluid in the first leg, when at once the milkiness began, and in a day the whole of the leg fluid was turbid also.

In many cases I examined the two fluids, clear and turbid, with a twelfth-inch object-glass, and found Bacteria in the turbid fluid ; nothing in the clear fluid.

Twice I left (once unintentionally, once intentionally) so little fluid in the loop that, there being a small aperture, it did not fulfil its purpose as a filter and a valve, and in both cases the two masses of fluid became turbid at the same time.

In six other experiments I used urine ; in four instances the loop fluid showed symptoms of putrefaction, and became turbid in four or five days, but the leg fluid remained clear. On the closure of the experiment, at varying periods from a week to four months, the bright urine appeared, on microscopic examination, to contain no organic growth, but underwent putrefaction as ordinary urine when exposed to the air.

In the two other experiments both urines putrefied at the same time. In one case I hastened the cooling by cold ; in the other I left very little fluid in the loop.

In four experiments I used Dr. Charlton Bastian's turnip-cheese fluid. In all cases the solution was milky when made ; twice it was filtered and twice unfiltered, and in all cases, when examined by the microscope after the lapse of some days or weeks, the fluid in both leg and loop contained organic growth.

The experiments on urine and urine-sugar fluid show, in my view, both positively and negatively, that there is something in the ordinary air which is a necessary condition of the origin of organic growth in these liquids.

Positively this position is demonstrated when, after six months, the fluid in contact with unwashed air is seen to be full of organic growth, and the fluid in contact with washed air is still unchanged.

Negatively it is supported when both fluids are seen to grow turbid at the same time from imperfect washing of the air, by reason of too rapid cooling or too scanty a supply of fluid for the washing.

The experiments with Dr. Bastian's turnip-cheese fluid were for some time a puzzle to me, and made me fear that there was an undetected fallacy in my other experiments. But now it is clear that the contradiction is only apparent. Dr. Burdon Sanderson has shown that this fluid contains within itself the elements of organic growth which are not destroyed at 212° F., the temperature at which my experiments were necessarily conducted.

I am anxious not to press these experiments unduly, but they seem to me to range themselves unequivocally in opposition to the theory of spontaneous generation ; although they touch no great extent of the subject.

That the something in the ordinary air necessary for the origin of organic growth in the fluids used is a gaseous impurity of the air is supported by no fact of which I am aware ; but whether it be living organised germ or dead unorganised matter, these experiments do not explain or attempt to explain.

LEONARD W. SEDGWICK

## The Fertilisation of Fumariaceæ

IT was with great pleasure and interest that I read the communications from Mr. Darwin and Dr. Hermann Müller in NATURE, vol. ix. p. 460.

It so happens that, since writing the note on the tardy and apparently useless assumption of colour by *Fumaria capreolata* var. *pallidiflora*, I have chanced to see the flowers of this plant visited, on two occasions, by a bee in the daytime.

This insect was, on both occasions, I believe, a mason-bee, and certainly neither a hive nor a humble bee, and, as it confined its attentions to this one variety of fumitory, and was engaged for some time at its work, I had a favourable opportunity of watching the mode of operation.

The bee ranged from plant to plant, but, in every case, would only alight on and suck those flowers which, though still white, had assumed the horizontal position, these flowers alone affording a comfortable landing-stage for the insect.

The bee then clasped the lower part of the tube with its feet, and prized open the flower by thrusting its sheathed proboscis underneath the upper petal, when the tube split lengthwise, and gaped widely open, the style and stamens rising up and emerging from the cap formed by the inner petals, much as they do from the keel in many papilionaceous flowers, and rubbing against the underside of the bee's body.

I may observe that it is precisely in the short period during which the flower maintains itself in the horizontal position that the emission of pollen takes place, and this coincidence of the plant bidding for the visits of insects at that particular moment has much the appearance of special adaptation.

But an examination of the flowers certainly shows that they are capable of self-fertilisation, and Dr. Hermann Müller tells us that Dr. Hildebrand states that this is habitually the case in *F. capreolata*.

I regret that I am only acquainted with Dr. Hildebrand's paper through a review which appeared in the *Bulletin* of the Société Botanique de France, where but few of the details are given.

I have not paid special attention to the structure and habits of the *Fumariaceæ*, and I am therefore unable to say whether the plant to which I have alluded is commonly visited by insects in the daytime, or whether, as Mr. Darwin suggests, its flowers, the nearly white colour of which would render them peculiarly conspicuous in the dusk, may not prove especially attractive to moths and other night-fliers.

While watching the bee whose operations are described above, I noted with interest that it confined its attention exclusively to plants of this single variety of fumitory, winding its way through flowering masses of other fumitories and weeds.

In the same way a honey-bee, at the same spot on a later day, exclusively visited the wild mignonette (*Reseda phyteuma*), passing by the fumitories, marigolds, &c.

J. TRAHERNE MOGGRIDGE

Maison Gastaldy, Mentone, April 20

ALLOW me shortly to resume the different views which have been proposed in your columns, as giving a possible explanation of the fact that the flowers of *F. pallidiflora* attain their brightest colouring when the time for fertilisation has passed, and to point out the observations indispensable to be made, in order to ascertain which of the proposed views is right. 1. It is possible that nocturnal Lepidoptera are the fertilisers of the fumitory; in this case it would be most probable that the pale colour of its flowers has been acquired by natural selection, pale flowers being most conspicuous in the dusk. 2. Diurnal insects may be the fertilisers, and the pale hue may be sufficiently conspicuous or even more attractive for them than the brighter one. In this case, also, the former must be considered as acquired by natural selection; the latter, on the contrary, as in the first case, merely as the result of chemical processes. 3. Under the same supposition of diurnal insects being the fertilisers, it is possible that the older flowers, by their brighter hue, serve to attract insects to the younger and paler ones; in this case the bright hue of the older flowers may be looked upon as acquired under the influence of natural selection, the pale colour of the younger flowers at the same time being useless. 4. It is possible that self-fertilisation is the rule with the flowers of this fumitory, and that cross-fertilisation by insects takes place only very exceptionally; in this case not only, as in No. 3, the paler colour, but also the brighter one would be nearly independent of the influence of natural selection. In order to decide definitely which of these views is right, it is indispensable to watch perseveringly the flower of this plant, and to ascertain what kind of fertilisation naturally takes place. In case diurnal insects should prove by direct observation to be the fertilisers, it would be possible to decide whether supposition 2 or 3 is correct, by removing from many specimens every older flower as soon as its colour begins to grow brighter, and by observing whether these specimens or those with older and brighter flowers are more frequently visited by insects.

It would be a great pleasure to me to make these observations, but I do not know whence seeds of *Fumaria pallidiflora* can be obtained. Perhaps some reader of this letter may be good enough to give me information on this point.

Lippstadt, April 28 HERMANN MÜLLER

MR. COMBER'S suggestion (vol. ix. p. 484) that the coloured flowers of *Fumaria* attract insects to the uncoloured ones is very ingenious. Supposing that they are cross-fertilised, the case of *Poinsettia* is very pertinent, and is enforced by that of *Dalechampia*, also euphorbiaceous, in which the bracts, a beautiful rose colour before fertilisation, gradually assume afterwards the same green hue as the foliage when the bright colour is no longer needed. The chemical changes that take place in the flower at and after the period of its complete expansion must necessarily be complex, as well as varied in different cases. Rapid oxidation is probably one very effective agent in producing them, but the results will necessarily depend on what is operated upon. *Hibiscus mutabilis* is white in the morning, deep red by night. Species of *Lantana*, like *Myosotis versicolor*, pass through a whole series of colours as they expand. On the other hand all the beautiful species of *Franciscea* rapidly lose the tints with which their flowers open, and become nearly white. The final stages in the life of all the parts of the flower which are not accessory to the formation of the fruit are more or less processes of decay, and there is no absolute law that these should always be accompanied by inconspicuous or displeasing tints. The white flowers of *Calanthe veratrifolia* blacken when they are bruised; on the other hand, according to Kingsley, the crimson flowers of *Couroupita guianensis* turn blue when torn, as the pulp of the fruit is also known to do on exposure to the air. In the same way some fungi exhibit when bruised striking tints which yet can be of no service to them. *Agaricus georginæ* changes from snow-white to blood-red wherever it is touched, and the white flesh of *Boletus cyanescens* when broken changes instantly to the "most beautiful azure blue."

In fact if a chemical change is set up—if it produces a change of tint at all—it must *sometimes* produce a pleasing one; that it should do so is not necessarily advantageous to the plant, though open to be taken advantage of by it.

W. T. THISELTON DYER

## Fertilisation of Corydalis claviculata

WITH regard to the flowers of *Corydalis claviculata* (of the discovery of which species in this neighbourhood I have sent a note to the *Journal of Botany*), I think Mr. Bennett (vol. ix. p. 484) will find his suspicion that the styles may have been broken off in dissecting to be correct. This may easily be shown by floating off in water the petals, &c., of a withered flower, in which the process of fertilisation has been completed, when the style will be seen adhering to the ovary, though the gentlest touch will be sufficient to separate it. In the bud the anthers cover the stigma, but at the time of maturity the latter projects slightly, so that it would be first touched by the proboscis of an insect. I suspect that it is also slightly protogynous, though self-fertilisation may probably be of frequent occurrence. The manner in which the style is embraced by the stamens and petals protects it from too rough a shock from the struggles of insects in the narrow entrance to the flower. I have not, however, observed them to visit it.

W. E. HART

Kilderry, co. Donegal, April 28

## Lakes with two Outfalls

SINCE writing my letter of April 24, with which I forwarded a copy of the new Inch Ordnance map of Arran, I have received other copies from Mr. Stanford, showing, as I presume, that the early copies of General Sir H. James's admirable work have been revised. For, besides the elaborate system of contour lines, which did not appear in the first copies, *two* outlets are given to Loch-na-Davie, instead of one only. So that, as to the "matter

of fact" touching the new Inch Ordnance map, Mr. Christie and I are both right. That is, he has a copy to show for his assertion; I have one to show for mine. But the great question is not what is the "matter of fact" as touching maps, but what is the matter of fact in nature; and I assert that Loch-na-Davie has but one outlet, to the south, to Glen Iorsa. My words in the *Athenæum* are—"The water-parting is a few yards to the north of the loch, I should *guess* at the spot where a heap of stones stands, apparently lately thrown up;" and from there there is a slight trickling *inlet* to the loch. I ended my letter thus—"Most gracious reader of the *Athenæum*, go take a tourist ticket to Glasgow from Euston Square. Then a lovely run in a Clyde steamer to Arran, and *judge for yourself.*" May I repeat this advice to the "gracious reader" of NATURE, for assuredly there is no *arguing* as to a "matter of fact."

As a matter of opinion, I do not think that any quantity of rain could turn the northern inlet into an outlet. That is, I think that at the southern end there is room to emit any overflow before the northern end could be flooded. Mr. Christie seems to suppose a constant double outlet. Dr. Bryce, more modest, only claims this in "winter and wet summers" (3rd edition, p. 3), or "when it rises about eighteen inches above its level in dry weather" (p. 130).

Alresford, May 1 GEORGE GREENWOOD

I OBSERVE that a correspondence has been going on in the columns of NATURE on the subject of lakes with double outlets. It may interest your readers to learn that some glaciers afford instances of the same phenomenon. One of the most remarkable of these is the Glacier d'Arsine, in the old French province of Dauphiné (now the Département des Hautes Alpes). This glacier is broad and short; its moraines are extraordinarily large. It ends just on the watershed between the Romanche and Guizanne, and consequently streams flow from it in both directions. On one side, the stream forms a branch of the Romanche, which fall into the Drac, the united stream entering the Isère below Grenoble. On the other side, the stream flows down to the Guizanne, which, after receiving the Clairée near Briançon, assumes the name of the Durance, and falls into the Rhone below Avignon. This watershed is a prolongation of that over which the magnificent route impériale (magnificent in point of engineering and of scenery) of the Col du Lautaret has been carried. This glacier is very rarely visited, though the above-mentioned phenomenon has been remarked before. Perhaps some of your readers can supply the names of other glaciers which present a similar phenomenon. I need only add that these observations were made during personal visits to the Glacier d'Arsine on July 15 and 17, 1873.

Exeter College, Oxford W. A. B. COOLIDGE

### Trees "Pierced" by other Trees

THE natural phenomenon of one tree within another is very frequently witnessed in India in the case of the "pipal" (vulg. *peepul*) and the palmyra. The first instance which drew my attention to it was one in which a very large specimen of the former with a stem some 4 ft. thick was surmounted by a towering palm which *seemed* to grow out of, and in continuation of, the solid trunk at a height of about 30 ft., and rose to a height of 30 to 40 ft. more. I speak from recollection only. An amicable dispute took place between two natives, of whom I inquired about it—both strangers to the locality—the one declaring that the palm grew up *inside* the tree from the ground, and the other that it grew *upon* it. Subsequently I saw numbers of others in all stages, and recognised the fact that the fig grows up by the side of the palm and gradually *encloses* it, so completely as to defy examination of the resulting trunk. The tree that I speak of was by far the most remarkable specimen of the kind, and therefore I give its locality. It is a little south of the town of Kodangal, in the Hyderabad country, long. 77° 40′ E., lat. 17° 6′ N. J. HERSCHEL

May 5

COLONEL GREENWOOD's solution of the beech-tree pierced by a thorn plant is undoubtedly correct. The New Forest affords many cases of the branches of that tree growing together and forming holes apparently through the trunk. Ivy gives the most striking and familiar examples of its runners crossing and uniting; it is not unusual to find a triangular arrangement of runners which cross each other at intervals of a few inches apart. It may be as well to draw your readers' attention to the spasmodic way in which the leaves of the beech burst in spring: sometimes an entire branch, at others a single twig with less than twenty leaves, will be in full leaf a week or ten days before the buds have generally burst. G. H. H.

IN reference to this subject I many years ago met with an instance of a birch growing out of the fork of an oak.

The trunk of the oak at perhaps 8 ft. or 9 ft. from the ground divided into two large arms from between which a birch sprung. The oak was of very considerable age but apparently was not hollow (of this, however, I am not positive). The birch was perhaps 12 ft. or 14 ft. high. P. P. C.

### The Antipathy of Spiders to the Wood of the Spanish Chestnut

CAN any of your readers establish the truth of the following assertion? Spiders' webs are never found upon beams from the Spanish or sweet chestnut tree, even when the timber is several centuries old. The keeper of the ruins of Beaulieu Abbey, in Hampshire, asserts that this is a fact, and the buildings of the Abbey, where beams of Spanish chestnut are used, are free from the invasion of spiders. His attention was drawn to this four years ago, and since then his observations have not thrown any doubt upon its accuracy.

Birkenhead, April 23 G. H. H.

## *FLOWERS OF THE PRIMROSE DESTROYED BY BIRDS*

WE have received several additional letters on this subject, the important statements in which we have brought together here, in continuation of last week's article (vol. ix. p. 509).

Prof. Newton of Cambridge, in reference to Prof. Thiselton Dyer's letter of last week, writes as follows:—

Allow me to remark that the observation of Gilbert White (quoted by Prof. Dyer in NATURE, vol. ix., p. 509) respecting the bird said to "sip the liquor which stands in the nectarium" of the crown-imperial, has not, so far as I know, been confirmed by anyone else. Yielding to no man in my general trust in White's wonderful accuracy, I think that here we ought to suspend our belief, caution being perhaps the more needed, since, as has been pointed out by several of his editors, it is almost certain that the bird he saw was not the bird he supposed it to be.

Major E. R. Festing writes:—

A month ago I saw a caged hen bullfinch that would treat any quantity of primroses which were given to her in precisely the way described by Mr. Darwin in NATURE, vol. ix. p. 482. She gave one snip only to each flower, not again touching the remains of it, which fell to the floor of the cage.

My experience in trying to keep a small garden in London some years ago was, that the yellow crocus flowers were always destroyed by the sparrows as soon as they come into full bloom, no doubt with the same object as the finches have in destroying primroses. I do not remember that the purple or white flowers suffered in the same way.

A correspondent, dating from Exeter College, Oxford, writes as follows:—

Your article on the destruction of primroses brought to my mind several facts which came under my notice lately in a manse-garden in the south of Scotland. Under a cherry-tree the ground was thickly planted with primroses, all the flowers of which were picked by the sparrows. As not only was this cherry-tree in flower at the time, but there was also a good show of flower on the various other fruit-trees in the garden, in this instance, at least, the flowers of the fruit-trees seem not to have exercised a superior attraction.

Again, I myself saw that the work was done by sparrows.

Another writer in your article asks, if any other birds besides sparrows have been seen to use fresh flowers in nest-building? In this same manse-garden, some weeks ago, I watched some jackdaws busily plucking and carrying to their nests in a neighbouring chimney the leaves, flowers, and stalks of a variegated form of the common *Glechoma hederacea*.

Mr. J. Southwell states that in his garden in the suburbs of Norwich, the yellow crocuses are yearly destroyed by sparrows. He says:—

Formerly I have seen these mischievous birds pulling

the petals in pieces and scattering them on the ground, to enable them to reach the nectary, which is situated about on a level with the soil; but of late they have altered their tactics and simply bruised the perianth tube sufficiently to extract the nectar, leaving the bloom uninjured but fallen over as though killed by severe frost. The primroses have hitherto escaped, but this spring for the first time the sparrows have attacked the blooms of a cherry-tree, bruising the nectary between their mandibles, and generally detaching the blossom from the foot-stalk close to the calyx. That in both cases this is the work of sparrows I have had ample opportunities of observing. Some years ago a border of Virginian stock which was in full bloom appeared mysteriously to be growing thinner every day. I accidentally saw from a window the sparrows vigorously engaged in pulling up the plants, which they could only do by great exertion, and flying off with them to form their nests. This lasted till the whole were carried away. The fact of the sparrows having altered their form of attack on the crocuses, going direct to the nectary instead of pulling the flowers to pieces, would seem to indicate that the habit is acquired, and not inherited; it also appears, so far as I can learn, to be an increasing habit with them.

Mr. A. F. Buxton, of Cambridge, has frequently observed the same fact about primroses in a wood near Ware. He says:—

I could give no satisfactory explanation of the phenomenon, if it were not that I have noticed the propensity of tame bullfinches to act in the same way towards flowers, especially primroses. In the wood I speak of, bullfinches are abundant; but whether or not they are the only birds which act thus I am of course unable to decide.

Mr. W. E. Hart, of Kilderry, co. Donegal, states that the primroses there suffer much every spring in the manner described by Mr. Darwin. The cowslips and oxlips are seldom, if ever, touched. Mr. Hart says:—

The blame is commonly laid upon the chaffinch, though I have only been able to gather circumstantial evidence against it. I have frequently disturbed both chaffinches and greenfinches from primrose-beds, and found the cut-off flowers strewn about. One lady tells me that she once saw a thrush deliberately cut off a number of primrose flowers in her garden, turning each time to stare defiantly at her. Another has frequently seen hedge-sparrows do so. Thus it appears that several different species of birds have acquired the same habit.

J. M. M. has cultivated polyanthuses at Sidmouth, South Devon, for seven or eight years, and each year they have been more or less destroyed by birds, as described by Mr. Darwin. She does not remember to have noticed it till she came to Sidmouth. The wild primroses suffer also, but not, she thinks, to any great extent, though they are abundant in the neighbourhood.

Another correspondent, writing from Poplar, informs us that many years ago he became aware of the fact that flowers containing nectar are attacked by some small animal; having had a bed of crocuses in his garden, the flowers of which were morning after morning destroyed by, he believes, the sharp bills of the sparrows. He, however, suggests that mice frequently might have been the depredators, "as last year," he says, "they destroyed all the grapes in my greenhouse. They are just able to reach such flowers as the crocus and primrose, and they are very hard up at the early season when these delights appear."

M. T. M. mentions, "on the authority of a good observer," that the flowers of the laburnum are sometimes utilised in nest-building by suburban sparrows, "whose destructive habits in the matter of crocuses," he says, "are only too well known to suburban gardeners."

Mr. C. H. Beasley, of Liverpool, writes, that he had a canary some years ago which was particularly fond of primroses, and always bit them in the manner described by Mr. Darwin, usually leaving everything but the part containing the honey untouched. As this peculiarity was exhibited by a domesticated bird, he thinks it highly probable that it was inherited.

## THE LECTURES AT THE ZOOLOGICAL SOCIETY'S GARDENS

### III.

MR. SCLATER commenced his fifth and concluding lecture on the geographical distribution of the mammalia, by impressing the importance of precise definition of the exact localities from which zoological specimens are obtained. He showed that by further careful collecting, new animals, even of considerable size, most probably remain to be discovered, considering that a previously unknown rhinoceros and a fresh genus of deer had been made known within the last three years.

The importance of the geographical distribution of the larger divisions of the mammalia is well illustrated in the case of the *Bassaris* of Mexico, an animal supposed for a long time to belong to the civet cats, which are peculiar to the Ethiopian and Indian regions, but now known in its internal structure to agree with the racoons, which are typically American forms. So also the so-called musk deer are often said to inhabit northern Asia, India, and Africa, but there is only a single species of the true musk deer, which is from northern Asia, whilst the Tragulidæ (with which it has been erroneously united) form quite an independent group, found in India and Africa.

The facts given in the preceding lectures suggest the question as to how the world may be most naturally divided according to the distribution of the animal life upon it, which is part of the great problem of the distribution of organic life generally; and it is evident that all great deductions made from any one group must in the long run correspond with those from other groups.

At the outset it is evident that the ordinary geographical divisions of the world do not hold. Europe must be combined with the northern part of Asia, and also with Africa north of the Atlas Mountains. In the same way central America and part of Mexico have to be included with South America. Taking the division of the mammalia into Monodelphs, Didelphs, and Ornithodelphs, the peculiarities of their distribution are very instructive: dividing the surface of the earth into four major divisions —1. *Arctogæa*, or North Land; 2. *Dendrogæa*, or Tree Land; 3. *Antarctogæa*, or South Land; and *Ornithogæa*, or Bird Land.

Arctogæa is divisible into four minor regions—(α) the Palæarctic, (β) the Ethiopian, with the Lemurian subregion of Madagascar, (γ) the Indian, and (δ) the Nearctic. The Palæarctic region possesses few characteristic families and genera. Its boundaries, as are those of all regions except when sea-bound, are ill-defined; Palestine, for example, is doubtful. Quadrumana are almost entirely absent; *Rhinopithecus*, a Thibetan form, belonging, apparently, to the region. The genera *Ælurus* and *Catra* are characteristic forms. Bears are mostly confined to it, some being, however, found in North America and one in South America. Among the Ungulata, the genus *Equus* is more truly Palæarctic than otherwise, and *Cervi* are abundant.

The Ethiopian region embraces Africa south of the Sahara. The genera Troglodytes, Colobus, Cercopithecus, and Cynocephalus are characteristic, as are Hyæna, Proteles, Lycaon, Hippopotamus, Camelopardus, and others. Madagascar forms a well-marked sub-region, containing no antelopes nor cats, but Lemur, Chiromys, and Cryptoprocta. It is the true home of the lion.

The Indian region extends along Southern Asia to Wallace's line in the Malay Archipelago. The only ruminant animal in the Indian Archipelago is the peculiar *Anoa depressicornis*.

The Nearctic region is very much like the Palæarctic. Castor, Gulo, and Lynx are common to the two. Taxidea, Procyon, and Antilocapra are characteristic, whilst Didelphys has entered from the south.

The Neotropical region (*Dendrogæa*) possesses great individuality, Cebus, Hepale, Icticyon, Nasua, and

Cercoleptes being characteristic. Hystricidæ abound, and Ruminants are very badly represented, only lamas, peccaries, and tapirs being found. Sloths, armadillos, and opossums are not found elsewhere, and there are no frugivorous bats, Insectivores, Viverridæ, nor elephants. The West India Islands form a well-marked (Antillean) sub-region, possessing Solenodon, and peculiar Rodents.

The Australian region, including Australia and the Malay Archipelago up to Wallace's line (or *Antarctogæa*), is characterised by the presence of the Monotremes and Marsupials. Lastly New Zealand (*Ornithogæa*) has no Mammals at all except two Bats.

Mr. Sclater, in conclusion, explained the different answers which had been given to the question: Why are animals thus distributed? showing that the Darwinian hypothesis is a key to the whole subject, rendering quite simple most of those difficulties which were previously insurmountable.

## CAMPHOR

THE camphor of commerce, it is well known, is the produce of *Camphora officinarum* Nees., a tree of China and Japan. To obtain it the wood is cut up into pieces and boiled in water, when the camphor is deposited. It is afterwards purified by sublimation, and further refined after its arrival in this country Immense quantities of this article are imported from Singapore, and though so valuable in European commerce, in Sumatra and Borneo a much higher value is put upon that known as Sumatra camphor, which is obtained from *Dryobalanops aromatica* Gaert. (*D. camphora* Coll.), which does not come to this country as an article of trade. Besides these there is a third kind of camphor, known in China as Ngai camphor; this, in point of value, stands between the ordinary commercial article and the Malayan or Sumatra camphor. Its botanical source has for a long time been doubtful, but it has generally been attributed to an unknown species of *Artemisia*. Mr. D. Hanbury, however, who has done so much in clearing up doubts on the botany of many of our important articles of trade, more especially in relation to drugs, has recently, in a paper read before the Pharmaceutical Society, identified the plant with *Blumea balsamifera* D.C. It is a tall, herbaceous plant, and has long been known for the powerful smell of camphor emitted from the leaves when bruised. It is common in Assam and Burma, and indeed throughout the Indian islands.

The materials from which Mr. Hanbury has been enabled to solve the problem of the origin of this peculiar camphor were sent him from Canton, and consisted of a small branch of the plant, and specimens of the camphor itself. These specimens, he says, "represented two forms of the camphor—the one a perfectly colourless crystalline substance, in flattish pieces as much as an inch in length;" the other, which was sent as crude camphor, was a crystalline powder of a dirty white colour, mixed with some fragments of vegetable tissue. "The purer sample has an odour scarcely distinguishable from that of ordinary camphor; but the odour of the other is perceptibly contaminated with a smell like that of wormwood." This camphor, though seldom seen in this country, was at one time attempted to be brought into commerce, one hundred pounds of it having been made in Calcutta. It is used in the East, both in medicine and in the manufacture of the scented Chinese inks. It is stated that "about 15,000 dols.' (3,000*l.*) worth is annually exported from Canton to Shanghai and Ningpo, whence it finds its way to the ink-factories of Wei-chau and other places."

Though it is now proved that *B. balsamifera* is the plant yielding the bulk of Ngai camphor, it is not improbable that some other plants lend their aid, for the term "Ngai" is, it appears, applied to several belonging to the Labiatæ and Compositæ. JOHN R. JACKSON

## THE "SPAR CAVES" OF THE NORTH BRIDGE, EDINBURGH

THE North Bridge, which spans the deep valley lying between the Old and New Towns of Edinburgh, was built upwards of a hundred years ago, and its huge arches must be familiar to all who have entered Edinburgh from the south by railway, the terminus for the main southern lines being situated just below. Between the arches of the bridge and the roadway above are a number of chambers or vaults which have not been opened, till recently, since the bridge was built. In carrying out the operations necessary for the widening of the now too narrow bridge, these vaulted chambers have been opened up, and one of them has been visited by Prof. Geikie, who, in a communication to the *Scotsman*, describes the wonderful sights he saw.

"The chamber we examined," he says, "was about eight or ten feet broad, and varied in height according to the rise and fall of the floor over the arch underneath, the floor coming sometimes so near the roof that we needed to stoop low to get through. From the vaulted ceiling, and especially from the joints of the masonry, hung hundreds of 'stalactites'—delicate spar icicles of snowy whiteness. In many cases they reached to the floor, forming slender thread-like pillars. In making our way we were under the necessity of brushing down many of these pendant masses. Now and then we seemed to be marching through a grove of white and brittle canes. The longest entire one we could see measured rather more than six feet in length. Usually they were slim stalks somewhat like thick and not very well-made tobacco-pipes, but towards the sides of the vaults they became thicker and stronger, one which we carried off measuring about four feet in length, and as stout as an ordinary walking-stick. The same material as that forming the stalactites spread in ribbed sheets down the sides of the vault. The floor, too, was dotted all over with little monticules of the same snow-white crystalline spar.

"A more illustrative example of a stalactitic cavern could not be found. The whole process was laid open before us in all its stages. Along the joints of the masonry overhead could be seen here and there a drop of clear water ready to fall. At other places the drop hung by the end of a tiny white stone icicle, to which it was adding its own minute contribution as it evaporated. From the mere rudimentary stumps the stalactites could be traced of all lengths until they were found firmly united to the spar hillocks on the floor. Every one of these hillocks, too, lay directly beneath the drip, catching the remainder of the stone dissolved in the dropping and evaporating water. In every case the stalactites were tubes; even the thickest of them, though it had undergone great changes from deposit on its outer surface, retained, nevertheless, its bore. Usually there hung a clear water-drop from the end of the stalk, ready to descend upon its white stony mound beneath.

"So far, except for the undisturbed perfection of the whole, there was nothing which may not be seen under many an old vault. But what astonished me most was the evidence of a continuous growth and destruction of these slim stalks of stone during an actually known period. In a great many cases the little 'stalagmite' mounds were each surmounted by a short slender stalk, as the Calton Hill is by Nelson's monument. There could be no doubt that these monumental-looking objects were merely the lower ends of once-continuous stalactite pillars. And indeed, searching round the mound I could usually find fragments of the broken column imbedded in the growing stalagmite. What had broken them? Perhaps a heavy omnibus thundering overhead, or a laden lorry or a deftly-fired royal salute. Anyhow, for a hundred years

this delicate tapestry has been hanging and growing, and breaking and growing again, quietly in darkness, beneath the grind of our carriage wheels, and yet high in air, with the stream of human life flowing underneath it too. Alike in the pendant stalks, on the walls, and in the mounds on the floor, the prevailing colour of the crystalline incrustation is pure white. These caves in middle air have been shut up from the contamination from town smoke. Now and then, however, the dripping water has come upon soluble iron as well as lime. Hence the mounds on the floor are sometimes curiously coloured yellow, brown, and red.

"As the bridge is built of sandstone, wholly or almost wholly free from lime, it is evident that the material which has converted these vaults into such picturesque caverns has been derived from the mortar. All rain-water, as is well known, takes up a little carbonic acid from the air, and of that acid there is in the air of a town usually more than the normal proportion. Filtering through the masonry, it dissolves the lime, carrying it downward in solution, and, if made to halt and evaporate, depositing it again in the form of the white crystalline substance which we call spar. It would be a curious question for the architect how long his masonry could resist this action. Certainly, in spite of what these vaults in the North Bridge reveal, the masonry of that structure is to all appearance as solid and firm as ever. It is evidently impossible, however, that the mortar, if necessary at all, can be piecemeal removed without in the end causing the destruction of a building."

## *REPORT OF PROF. PARKER'S HUNTERIAN LECTURES "ON THE STRUCTURE AND DEVELOPMENT OF THE VERTEBRATE SKULL"**

### III.

IN the types already considered, the exo-skeleton consists of small placoid scales having the structure of teeth, and imbedded in the skin, but being altogether irrelative to the true cartilaginous endo-skeleton. In the group of fishes which form so perfect a mean between these Elamobranchs and the osseous fish—the Ganoids—the body is covered with close-set "ganoid" scales, which consist of two layers, a deeper one of bone (dermostosis), and a superficial one of enamel, covered only by a thin layer of epidermis. In the head these scales pass insensibly into a set of bones in close relation with the chondro-cranium, and having the connections, positions, &c. which characterise the roofing-bones of one of the higher skulls (parietals, frontals, nasals, &c.). In many cases these bones are so deeply imbedded in the subcutaneous tissue as to deserve the name rather of parostoses than of dermostoses, but are always easily removed by maceration or boiling. They are evidently of an entirely different nature to another series found in the same skulls, but in intimate connection with the cartilage, and only separable by its entire destruction. These last are ossifications of the chondro-cranium, and are often spoken of as "cartilage-bones;" the former kind have only a secondary relation to the primordial skull, and are known as "membrane-bones."

In the osseous fish both these varieties of bone appear, but the investing or membrane-bones are all true parostoses developed in the deeper subcutaneous tissue, and the place of the ganoid dermostoses is taken by cycloid or ctenoid scales. Still the insensible gradation between scales and skull-bones is very apparent: along the side of the trunk passes a series of curious tubular or grooved bones containing mucous glands and known as the "lateral line series;" these, on reaching the head, branch out so as to produce a tree-like arrangement instead of a single row, and the burrowing is now, not in a set of modified scales, but in true cranial bones, some belonging to the opercular apparatus, some to the series above and below the eye.

IV.—*Skull of the Salmon* (Salmo salar).—In the Teleostean the investing bones attain a greater development than in any other group, and, in the description of the salmon's skull, will be considered before the cartilage-bones which they overlie, and from which they come away with great ease by maceration.

There are, in the first place, on the upper surface of the skull, three pairs of bones and a single median ossification. Of these, a pair of small bones, separated from one another by a considerable interval, and lying over the auditory region, answer to the parietals (Fig. 7, Pa); a much larger pair roofing over all the central portion of the brain case, from the parietals behind to the nasal region in front, are the frontals (Fr); and a very small and insignificant pair situated just above the nasal sacs the nasals (Na). All these are well known from their occurrence in the higher animals; but the bone marked S.Eth (super-ethmoid), which lies between the nasals and over the cartilage separating the olfactory organs, is peculiar to certain osseous fishes.

Above the eye is a small bone, known as the supra-orbital (S.Or), and below and at its sides a chain of bones, deeply excavated by slime-glands, the sub-orbitals (Sb.Or); the most anterior of these (Lch) seems to answer to the lachrymal bone of the higher animals. The gape of the mouth, instead of being formed, as in the shark and ray, by the naked pterygo-palatine and Meckelian cartilages, is bounded entirely by membrane-bones, three in the upper jaw, the pre-maxilla (Pmx), maxilla (Mx), and malar or jugal (Ju), and one in the lower, ensheathing Meckel's cartilage, the dentary (D). The maxilla, unlike that of most typical Teleosteans is dentigerous, and takes a large share in the formation of the gape. Immediately below the angle of the lower jaw is situated a small bone, the angular (Ang).

Two very important parostoses occur on the under surface of the skull, where they clamp and strengthen the cartilage; these are the vomer (Fig. 8, Vo), which bears a few teeth, and the para-sphenoid (Pa.S), the enormous development of which is so characteristic of the bony Ichthyspsida.

Lastly there are the bones supporting the gill-cover, or operculum proper, and branchiostegal membrane, each of which has its own set of osseous strengthenings. In the first set are included the opercular (Op), sub-opercular (S.Op), pre-opercular (P.Op), and inter-opercular (I.Op); in the second, the branchiostegal rays (Brs.R). The operculars are also divisible into two categories; two of them—the pre- and inter-opercular—are developed in the fold of skin growing from the mandibular arch, which covers the cleft (existing only in the embryo) between it and the hyoid (Fig. 1, p. 425, Ty.Eu), while the remaining two belong in like manner to the operculum of the hyoid arch covering the branchial slits (Fig. 1, Cl). The pre-opercular is interesting as being the homologue of the lower part of the mammalian squamosal, and the inter-opercular as representing the tympanic, the two membrane-developed ossifications of the complex temporal bone of human anatomy. The branchiostegal rays are flat sabre-like bones, twelve in number, attached to the hinder edge of the hyoid apparatus. In most Teleostei these bones are seven slender terete rays, the four upper of which are attached to the outer and the three lower to the inner side of the hyoid. At the point where the branchiostegal membranes of opposite sides meet below the throat a median ossification is developed in the subcutaneous tissue; this is the so-called uro-hyal, or basi-branchiostegal (B.Brs).

* Continued from vol. ix] p. 468.

When all the foregoing bones are stripped off, the salmon's skull is far more comparable than in its perfect state with that of an Elamobranch, being reduced to the chondro-cranium, a cartilaginous structure, with certain endogenous ossifications, but retaining to a remarkable extent the characters of a "primordial skull." A side view of the chondro-cranium is shown in Fig. 9: viewed from above it presents, like that of the ray, expanded sense capsules, and a narrowed inter-orbital region; the walls of the brain-case are, however, much thicker, and its cavity relatively smaller than in the preceding type (see Fig. 8); the rostrum also is short, and the roof of the skull or tegmen cranii produced into a strong ridge (culmen cranii). The end of the snout divides into two short processes (hypo-trabeculars, H.Tr), on each of which two labial cartilages are borne ($l^1$, $l^2$).

The bones developed in the chondro-cranium of the salmon very rarely come together so as to form sutures, but are usually separated by considerable tracts of cartilage or synchondroses. Ankylosis only takes place in the case of a single pair of bones—the orbito-sphenoids—which are fused together in the mid-line, so as to form a structure not unlike the "girdle-bone" of the frog.

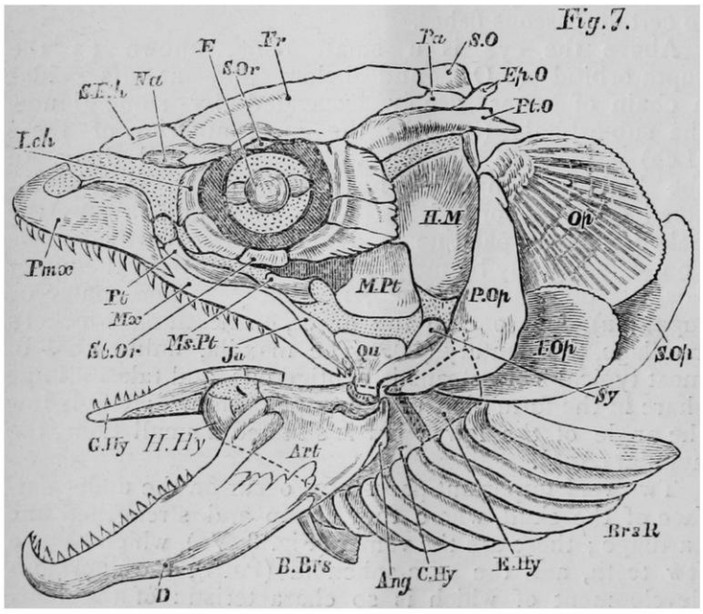


Fig. 7.—Skull of Salmon. Pa, parietal; Fr, frontal; Na, nasal; S.Eth, supra-ethmoidal; S.Or, supra-orbital; Sb Or, sub-orbitals; Lch, lachrymal; Pmx, pre-maxilla; Mx, maxilla; Ju, jugal; D, dentary; Ang, angular; Op, opercular; S.Op, sub-opercular; I.Op, inter-opercular; P.Op, pre-opercular; Brs.R, branchiostegal rays; B.Brs, basi-branchiostegal; S.O, supra-occipital; Ep.O, epiotic; Pt.O, pterotic; Pl, palatine; Ms.Pt, meso-pterygoid; Art, articular; Sy, symplectic; G.Hy, glosso-hyal. The cartilaginous parts are dotted.

The hinder or occipital region of the skull is ossified by four bones, which surround the foramen magnum, and together form the "occipital segment;" these are the basi-occipital (Figs. 8 and 9, B.O) below, the exoccipitals (E.O) at the sides, and the supra-occipitals (S.O) above. The first of these bears a concave surface or condyle (O.C) for articulation with the first vertebra, the space between the two being filled up with the remains of the notochord. The auditory capsules are strengthened by no less than five bones: the prootic (Pr.O) formed in the anterior part of the capsule; the opisthotic (Op.O) over the ampulla, and the epiotic (Ep.O) over the arch of the posterior semicircular canal; the pterotic (Pt.O) over the arch and ampulla of the horizontal, and the sphenotic (Sp.O) over the ampulla of the anterior canal. The prootics of opposite sides meet in the mid-line (Fig. 8), and form a bridge of bone on the base of the skull, in front of the basi-occipital. Anterior to this "prootic bridge," and completing the basis cranii, is a small bone, Y shaped in section, the basi-sphenoid (B.S), which, curiously enough, has no cartilaginous predecessor, but is ossified directly from membrane. Above this bone, and in front of the sphenotic, the ali-sphenoids (As) are found in the side-walls of the brain-case, and, together with the basi-sphenoid below and the parietals above, form the "parietal segment" of the skull. The "frontal segment" has no basal element, the pre-sphenoid being absent, but its side-pieces are represented by the coalesced orbito-sphenoids (O.S) The only remaining bone in the skull proper is the large lateral ethmoid (L.Eth), which occurs immediately behind the depression for the nasal sac (Na).

Certain very constant relations exist between these bones and the cranial nerves. The trigeminal (V.), for instance, always determines the prootic, as its third division makes its exit just in front of that bone, or, in other

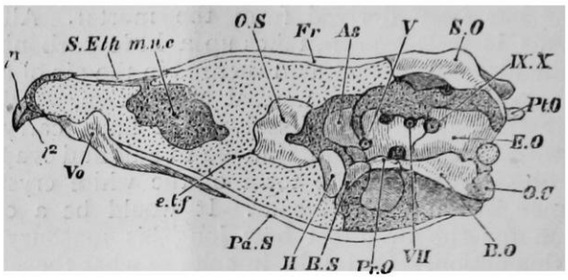


Fig. 8.—Longitudinal section of Salmon's Skull. Pa.S, para-sphenoid; Vo, vomer; B.O, basi-occipital; E.O, exoccipital; Pr.O, prootic; B.S, basi-sphenoid; As, ali-sphenoid; O.S, orbito-sphenoid; O.C, occipital condyle; $l^1$, $l^2$, labial cartilages; m.n.c, middle nasal cavity; e.t.f, ethmo-trabecular fissure.

words, between the anterior boundary of the auditory capsule and the parietal segment. The glosso-pharyngeal and vagus (IX. and X.) in like manner limit the posterior boundary of the ear capsule, passing out either between it and the exoccipital, or through the front part of the latter. The optic nerve (II.) passes between the parietal and frontal segments, usually being bounded in front by the orbito-sphenoid, and behind by the orbito-sphenoid. In the salmon a bar of bone grows across the trigeminal notch of the prootic, so that part of the nerve passes through a complete foramen.

An interesting instance of the retention of embryonic characters is seen in the slit marked e.t.f in the sectional view, Fig. 8. This is a fissure in the otherwise solid cartilage running forwards for a short distance from the lower anterior angle of the orbito-sphenoid, and indicating

*Fig. 9.*

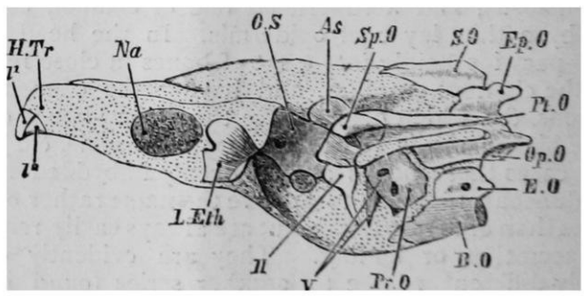


Fig. 9.—Skull of Salmon, with investing bones and facial arches removed. Op.O, opisthotic; Sp.O, sphenotic; L.Eth, lateral ethmoid; H.Tr, hypo-trabecular.

the line of separation between the trabecular portion of the skull and the part produced by the chondrification of its originally membranous walls; this structure is called the ethmo-trabecular fissure. In front of and above this fissure is a large cavity (m.n.c) filled with fat, and opening on the surface of the chondro-cranium beneath the supra-ethmoidal bone; there is no doubt that this seemingly useless space represents the single nasal chamber of the lamprey or hag.

The structure of the facial arches, and the chief points in the development of the salmon's skull, will be considered in the next paper.

(*To be continued.*)

## THE COMING TRANSIT OF VENUS*

### III.

IN the previous articles various methods have been indicated by means of which we may discover the scale upon which the plan of the solar system is drawn. The last article concluded by illustrating the nature of the methods of employing a transit of Venus, as proposed by Halley. It will be noticed that this method can be utilised in the way there indicated only when Venus passes nearly across the diameter of the sun. Halley, in fact, founding his calculations upon erroneous data, was led to conclude that this would be the case in 1761. In this he erred, and another slight but important mistake having been made in his calculations, it followed that at Hudson's Bay, his northern station, the transit was invisible.

The present article will be devoted to a description of the methods to be employed in the coming transit for determining the solar parallax. In subsequent articles the preparations which have actually been made for observing the transit of 1874 will be described; and the difficulties encountered in this kind of observation enumerated.

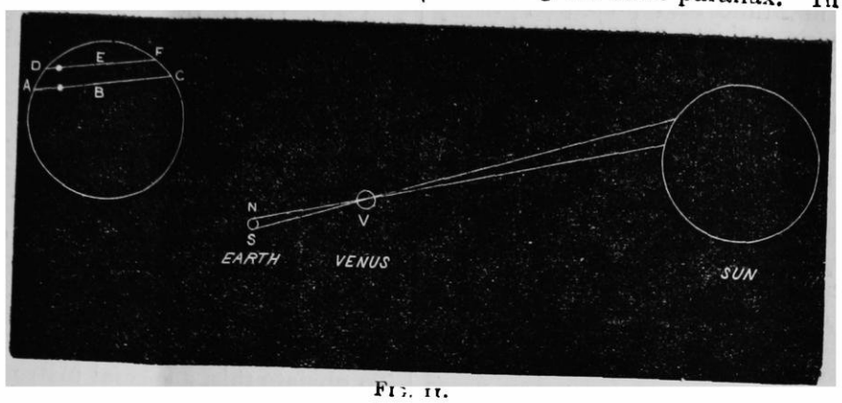


FIG. 11.

Let the reader now examine Fig. 11 and pay particular attention to the description of it, and he will thus be enabled better to understand what follows. The earth, Venus, and the sun are here represented in their relative positions; and lines are drawn to show the directions in which two observers at opposite sides of the earth will see Venus upon the solar disc. It follows from this that an observer on the southern portion of the earth will see Venus trace a path D E F upon the sun's disc farther north than the path A B C which a northern observer on the earth sees it trace. Now Venus will be three times as far from the sun as from the earth on that date. From this it follows that the distance between the two lines A B C and D E F will be three times as great as the distance N S. But the distance N S upon the earth can be easily found out. Suppose it to be 6,000 miles. In that case the distance between A B C and D E F is known to be 18,000 miles. But it needs no demonstration to convince us that if we have a distance of 18,000 miles measured out for us upon the sun's surface we can dete mine the distance of the sun from the earth.

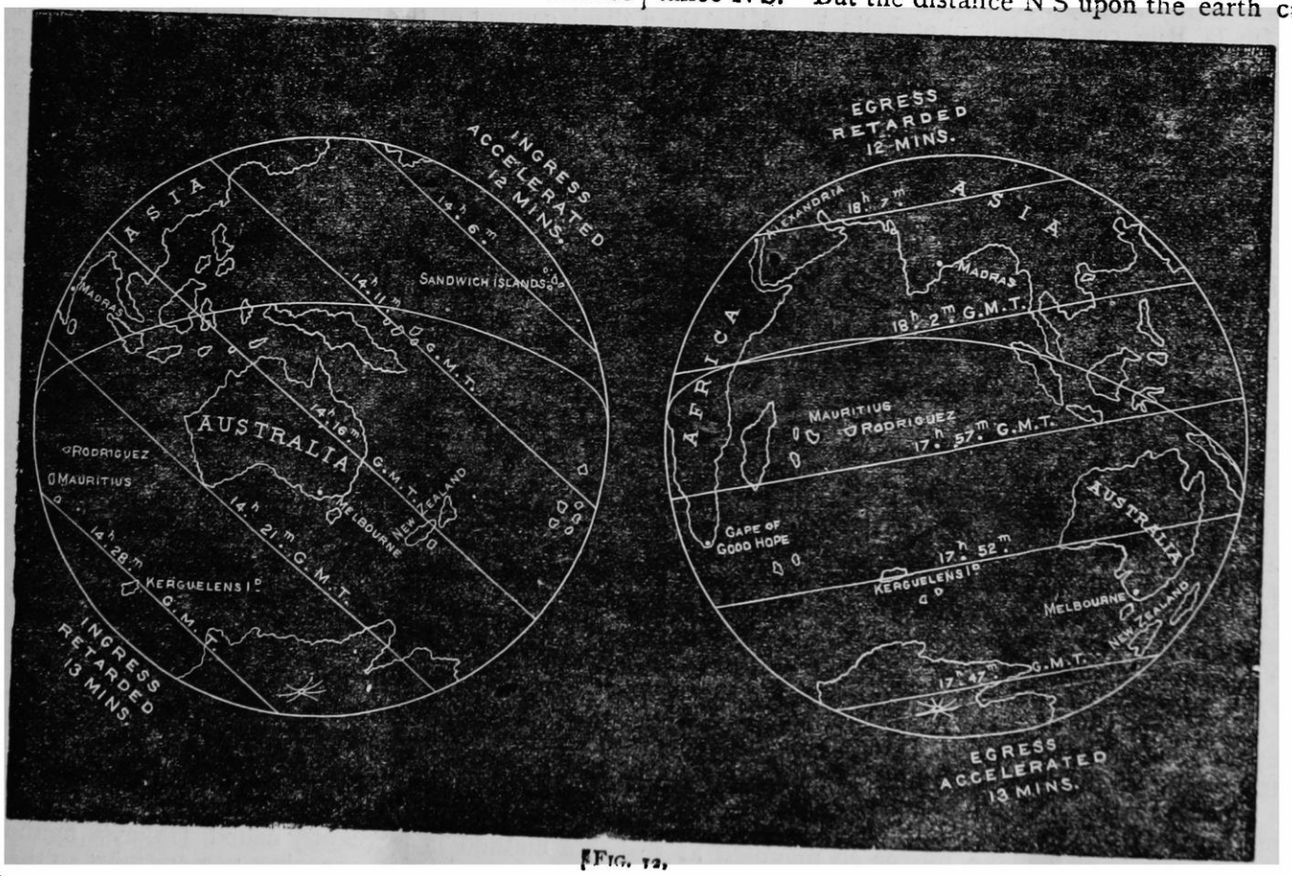


FIG. 12.

Continued from vol. IX. p. 489

Now the apparent distance between the two lines A B C and D E F is the least observed distances between Venus' centre and the sun's during the transit. *If then, we can measure accurately the least distance between the centres of Venus and the sun, at two stations suitably chosen, we can determine the sun's distance.*

There are three methods by means of which this may

be effected; the photographic method, the heliometric method, and the method of durations. We shall consider these in order.

I. *The Photographic Method.*—It is easy to see that by continuing during the transit to take photographs of the sun, in which Venus will be represented as a black spot, these photographs may be so combined as to indicate definitely the apparent path of Venus as seen at these two stations. This method is looked forward to with much interest, because it is the first time that photography has been extensively employed in delicate astronomical measurements. It is not generally known how extremely accurate a means of observation photography is. We owe much to Mr. De la Rue, whose success in the application of photography to astronomy has been unequalled, for having given us a most clear account of what has been done in this way.* The method has been employed in America to measure the distances between double stars. The double star is photographed and the distance is afterwards measured as accurately as possible. Prof. Bond finds that the probable error of such a measurement is 0″·072 or $\frac{1}{3}$ of the probable error of a similar measure made with a filar micrometer as estimated by Struve. Photographic pictures of the sun were for many years daily taken at Kew, and it was found that an extremely accurate measure of the sun's diameter could thus be made. If the lens of a common telescope were used to produce an image of the sun upon the sensitive plate the picture would be too small for accurate measurement. Hence a special instrument called a photoheliograph must be devised to give an enlarged picture upon the sensitive plate. Two perfectly distinct kinds of instruments are to be used for this purpose, the one English, the other American. Mr. Dallmeyer has, under the superintendence of Mr. De la Rue, constructed photoheliographs for the English and Russian expeditions. In these instruments the image of the sun produced in the focus of an ordinary telescope is enlarged by a special arrangement so as to give a picture of the sun about four inches in diameter. This instrument, based upon the principle of the Kew photoheliograph, is very perfect in its results and convenient in actual practice. It is mounted equatorially so as to follow the motion of the sun. The sensitive plate, which is prepared in an adjoining room, can be readily inserted and exposed. The intensity of direct solar light is so great that special means are necessary to give a short enough exposure. Before a photograph is taken a sliding shutter in the interior of the instrument cuts off all light from the sensitive plate. This shutter is held in its place by a cotton thread. So soon as this thread is cut, a strong spring draws down the shutter, in which is a slit about $\frac{1}{40}$th of an inch wide. The time taken by this slit to pass over any part of the sun's image is the whole interval required for an exposure.

The other method of obtaining a large picture of the sun is by employing a lens of great focal length. This method was originally proposed by Mr. Rutherford, of New York, and will be employed by the Americans, and also by Lord Lindsay in his observations at the Mauritius. The focal length of the lens is forty feet. But a telescope of such dimensions could not be conveniently mounted in the ordinary way. To overcome this, a siderostat similar to the one originally constructed by M. Foucault for the Observatory of Paris is employed. This instrument consists of a plane mirror so mounted as to send the sun's rays always in the same horizontal direction. In the path of these rays, and close to the siderostat the lens is placed, and at a distance of forty feet an image of the sun about four inches in diameter is produced. At this place a window is arranged in the photographer's hut, and by means of this arrangement the photographer need never leave his dark room. After preparing a plate he places it in position at the window; when exposure has been made he may remove the plate and develop it.

Considerable advantage is likely to accrue to the employment of dry plates, which will diminish the labour of the photographer. Researches upon this matter have been undertaken by Prof. Vögel, in Holstein, Col. Smysloff, at Wilna, and by Capt. Abney, at Chatham. The employment of a dry process prevents all danger from the shrinking of the collodion-film. Herr Paschen* and Mr. De la Rue have made experiments upon this point. The latter gentleman finds that all shrinkages take place in the thickness of the film, so that the measurements would not be affected by it. But the more convenient dry-plate process is undoubtedly safer. Judging from the data furnished by Mr. De la Rue, this photographic method will give results of the utmost value.

II. *The Heliometric Method.*—The exact measurement of the distances of the edges of Venus from opposite edges of the sun would enable us easily to determine what is required, viz., the least distance between the centres of the sun and planet. But the ordinary astronomical means are useless in measurements of this magnitude. To obviate this, a special instrument, called a heliometer, will be employed by the Germans and Russians, and by Lord Lindsay. This instrument was originally invented for measuring the diameter of the sun. The object-glass of a common telescope is divided so as to form two semicircles. A screw adjustment allows us to slip one-half of the lens past the other one along their line of junction; a fine scale measures this displacement. When the two halves of this object glass are relatively displaced, two images of the sun are seen overlapping. The distance between the two images is proportional to the relative displacement of the two halves of the object-glass. This instrument has been brought to a state of great perfection by Mr. Repshold, of Hamburg. It is a very troublesome instrument to manipulate, and the corrections due to the influence of temperature are extremely difficult to apply. Yet with great care there is little doubt that very accurate measurements can be made. The nature of the measurements required to obtain the distance between the centres of Venus and the sun will readily be understood. The method has been most ably discussed by Lord Lindsay and Mr. Gill in the Monthly Notices of the R.A.S., November 1872. At the same time it is difficult to conceive that this direct method will give results of equal value with the methods hereafter described. In fact, an opposition of Mars would be expected to give equally good results; for the distance of Mars from a fixed star can be more accurately observed with a micrometer than the distance between the centres of Venus and the sun; and a larger number of observations could be made.

III. *The Method of Duration.*—The third method of determining the least distance between the centres of the sun and Venus is less direct than either of the preceding methods; but it has stood the test of a previous trial, and we cannot say but that it will be more satisfactory than the other methods in the coming transit. The method of duration closely resembles the method originally proposed by Halley. The duration of the transit, as viewed from two distinct stations, is accurately determined. But the difference in this duration is affected by choosing stations upon a different system. Nevertheless this method is frequently called Halley's method. His method consisted in choosing two stations, so that during the transit the one should be moving eastward and the other westward. It is further essential for success that Venus should pass nearly along the diameter of the sun. In the method employed last century, the two stations were chosen—the one far north, and the other far south. On referring to Fig. 11 it will be seen that in each case Venus appears to pass along a chord of the sun. But in

* Address to the Mathematical and Physical Section of the British Association, Brighton, 1872.

* *Astronomische Nachrichten*, 1872, lxxix. 161.

the one case this chord is farther from the sun's centre, and consequently shorter than the other. The duration of the transit, so far as this effect is concerned, is directly proportional to the length of the chord traced out by Venus. Thus from observation we obtain the lengths of these chords; and by geometry we can deduce the least distance between the centres of the sun and Venus at each of the two stations, and hence we can determine the sun's parallax. Fig. 12 illustrates this point very clearly. The duration is determined by two distinct observations made at each station, the internal contact at ingress and the internal contact at egress. The time of an internal contact is the time at which Venus appears to be just wholly within the sun's disc. These two times must be accurately determined; they will be separated by an interval of nearly four hours. Fig. 12 represents the illuminated hemispheres of the globe at the time of ingress and at the time of egress respectively in 1874. At either of these epochs the sun will be visible from every place marked on the corresponding map. The sun will be vertical at the place occupying the centre of the map; at all stations near the edges of the map the sun will at that time be near the horizon. The point from which the phenomenon will be first observed is there indicated, and likewise the point at which it is last seen. Straight lines are drawn across each map, and the hours marked upon them indicate the time at which the phenomenon will be seen.

Fig. 13, taken from Lockyer's "Popular Astronomy," shows the same facts for the transit of 1882.

Take now the case of two particular stations. At some point on the east coast of China the ingress is accelerated by 6 minutes, but at the same point the egress is retarded 7 minutes; consequently the duration of the transit is lengthened 13 minutes. Again, at Kerguelen's Island the ingress is retarded 10 minutes, while the egress is accelerated 5 minutes. Here then the duration of the transit is shortened 15 minutes. The difference in duration as observed from these two stations will therefore be about 28 minutes. These maps have no pretension to great accuracy. They are calculated upon a certain assumption as to the value of the solar parallax which is probably not far from the truth.

In 1761 considerable preparations were made for observing the transit of Venus in this manner. The English were represented by Messrs. Mason and Dixon at the

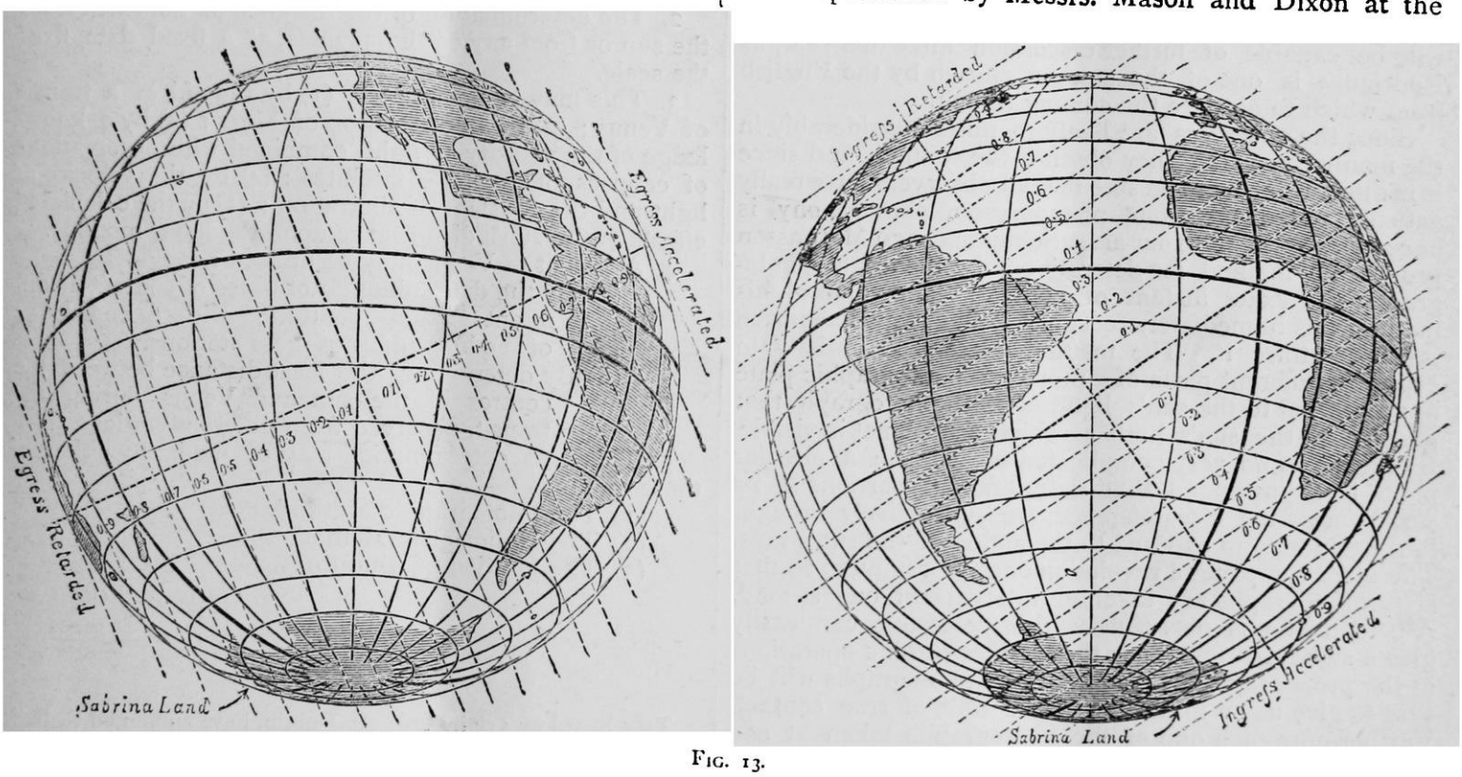


FIG. 13.

Cape of Good Hope, and the French by the celebrated Pingré at the island of Rodriguez. A host of observers watched the phenomenon from northern regions. Unfortunately at scarcely a single station was the transit seen completely. Hence the method of durations was inapplicable, and another, originally proposed by De l'Isle,* came into use. This takes advantage of the fact that the ingress will take place later when seen from some parts of the earth than from other parts, as explained above; so with the egress of the planet from the sun's disc. Hence, if the absolute time of contact of Venus with the sun's edge at ingress or at egress be observed at two places suitably chosen, the difference in time will be a measure of Venus's parallax.

The method of De l'Isle will perhaps be better understood by looking upon the orbit of Venus as a vast protractor for measuring small angles. Venus passes relatively to the earth round the sun, that is through 360° in 584 days. From this it follows that she passes over 1″·5 in one minute of time. Now conceive two straight lines to be drawn from the sun's edge, the one to the Sandwich Islands, where the ingress is most accelerated, and the other to Kerguelen's Island, where it is most retarded. Venus passes across these two lines like the radial arm of a protractor. The observed difference in the time of observing the phenomenon at these two stations will be about 21 minutes. Of this about 11 minutes is due to the fact that the Sandwich Islands are north of Kerguelen's Island, as before explained; the remaining 10 minutes or so will be a measure of the angle between the two lines drawn from the sun's edge to the two stations. Since Venus passes over 1″·5 in 1 minute, 10 minutes gives us 15″ for the effect of parallax looked at in this light.

It is a comparatively easy matter to set one's clock accurately to local time by astronomical observations. But it is a matter of considerable difficulty for an observer in Kerguelen's Island to set his clock accurately to the local time of the Sandwich Islands, or *vice versâ*. Consequently there will be some difficulty in determining the absolute difference of time of contact as observed at these two stations. The difficulty simply consists in determining the longitude accurately. This is a matter involving a long series of astronomical observations even now; still

* Histoire de l'Acad. des Sciences, p. 112.

more so in 1761. Such observations were then wanting. Hence the application of this method was not successful, and results of that transit were unsatisfactory.

Not daunted by the comparative failure of that attempt, the astronomers of last century made vigorous efforts to make the transit of 1761 successful. The transit of 1761 was utilised in so far as it pointed out the difficulties in this kind of observation and gave them an approximate value of the sun's parallax to help them in choosing the most advantageous stations from which to observe the next transit.

Halley had no conception, when he proposed this kind of observation, of the difficulties attending it. The difficulty chiefly consists in determining accurately the exact instant when the contact seems to take place. The values which have been deduced from the observations of last century, and especially of the year 1761, have varied considerably according to the mode of reducing the observations. Thus in 1761 Lalande * found, from the observations of Pingré, 9″·4 for the solar parallax, while Maskelyne found from the work of Mason and Dixon 8″·6; Short † made it 8″·65; Wargentin, 8″·1 to 8″·3. Encke ‡ showed that the differences were partly due to an error in the longitude of Rodriguez. This question will be capable of further discussion after this year, as Rodriguez is one of the stations chosen by the English from which to observe the coming transit.

Since the observers are likely to differ considerably in the manner in which they observe the contact, and since it is difficult for us to be sure that all observers have really actually noted the same phenomenon, photography is once more brought to our aid. Some time ago M. Janssen proposed a method for determining by the aid of photography the exact instant of contact. The value of his method was immediately recognised, and steps have been taken to utilise it. The method consists essentially in exposing different parts of a prepared photographic plate in succession to the sun's light, so as to photograph that portion of the sun's limb at which the planet is visible. By the aid of no very complicated mechanism a circular plate is so arranged that sixty different portions of its surface near the circumference are successively brought into position, and exposed to the action of the sun's rays. The plate completes a revolution once in a minute, so that sixty photographs are taken at intervals of one second. A person who is observing with a telescope can easily give a signal to commence these photographic operations at the proper time. Thus one of the photographs will be sure to give us an indication of the time of true contact. Furthermore each one of the photographs taken at one station can be compared with a corresponding one taken at another station, so as to give us a means of deducing the sun's parallax. The advantages of this method are enormous. The uncertainty which exists with respect to eye observations is in a great measure due to fluctuations arising from tremors in the instruments, and variations in the density of the intervening air. In the photographic method, means have been taken to avoid these tremors as far as possible; and the instantaneous manner in which the photographs are taken will reduce these uncertainties to a minimum.

Various suggestions have been made as to the possibility of observing the exact time of the external contact by using a spectroscope in a beautiful manner originally executed by Mr. Lockyer and M. Janssen for observing the solar protuberances. Father Secchi has, in a very able memoir, pointed out a way by means of which this can be done; M. Zöllner has likewise pointed out the advantages of this method.

The observation of external contact is doubtless very useful as supplementary to the internal contact. The chief difficulty consists in the uncertainty of fixing the telescope in the proper position, so as catch the exact point of the sun's limb. This difficulty would certainly be to a large extent obviated by the employment of the ingenious adjustible ring-slit devised by Mr. Lockyer. This device has, we believe, been fully tested, with satisfactory results. It is much to be regretted that more observations to test its utility have not been made; as on this account it is not likely to be employed in the coming transit.

We have now completed the geometrical examination of the nature of the observations on the transit of Venus, by means of which the sun's parallax will be deduced. The complete examination of the question, including analytical methods, cannot be here dwelt upon. Anyone who is interested in this should consult the valuable work "Les passages de Vénus sur le disque Solaire," by M. Edmond du Bois, lately published, in which the theoretical part of the question is very fully investigated.

RECAPITULATION.—Before leaving the technical view of the matter it will be well to recapitulate what has hitherto been stated.

1. We know the *relative dimensions* of the solar system accurately; but we do not know the *scale*.

2. The determination of the distance of the earth from the sun or from any of the planets, at a fixed date, fixes the scale.

3. This may be determined (1) by the aid of a transit of Venus; (2) by an opposition of Mars; (3) by a knowledge of the velocity of light combined with observations of eclipses of Jupiter's satellites; (4) by the velocity of light and the constant of aberration; (5) by the calculated effects of the sun's disturbance upon the lunar motions.

4. A transit of Venus may be utilised:—

(α) By the determination of times of contact at different stations, combined with a knowledge of the longitudes of these stations.

(β) By determining the least distance between the centres of the sun and Venus during the transit, observed from different stations.

5. This last determination may be made by either of these methods:—

(1) The Photographic Method.
(2) The Heliometric Method.
(3) The Method of Durations.

GEORGE FORBES

* Phil. Trans., vol. liii., p. 647.
† *Ibid.*, p. 648.
‡ Zach. Corresp. ii., 1810, p. 367.

## NOTES

THE Board of Trinity College, Dublin, have appointed R. Ball, LL.D., F.R.S., to be Royal Astronomer of Ireland, on the foundation of Dr. Andrews. The announcement of this appointment will be received with every satisfaction, as Dr. Ball has already, while acting as assistant to Lord Rosse, distinguished himself as a practical observer. We feel sure he will not forget to profit, or omit to allow astronomical science to profit too, by the excellently appointed observatory at his command. This vacates the chair of Applied Mathematics in the Royal College of Science, Dublin.

AT a meeting of the donors of the Yorkshire College of Science (see NATURE, vol. ix. p. 157) held at Leeds last Thursday, the constitution of the College was agreed upon, and a board of governors elected. The sum required to establish a College of Science in any way worthy of Yorkshire would be 60,000*l.*, of which only about 25,000*l.* has as yet been collected. With this sum, however, we are glad to see that it has been resolved to make a start, and we have no doubt that when the practical benefits of the institution become evident there will be little difficulty from lack of funds. We trust with Lord F. Cavendish that, ere long, the institution just organised will occupy in Yorkshire a position similar to that occupied by Owens College in Lancashire. Several speakers referred to the fact that in the

practical applications of Science Britain is being distanced by Germany and other countries, and that the only means by which we can hope to compete with foreign rivals is the spread of scientific education. It is hoped that, before the close of the year, a staff of thoroughly competent professors will be giving their lectures in Leeds.

THE annual general meeting of the Iron and Steel Institute commenced yesterday in the rooms of the Institution of Civil Engineers, under the presidency of Mr. Lowthian Bell, F.R.S.

THE Port Louis *Overland Commercial Gazette* (Mauritius) of April 4 contains the report of a violent cyclone which embraced Mauritius in its sweep on March 27 and 28. Indications of the approaching hurricane were observed on the 22nd in a falling barometer and a gradually rising wind, which increased until it reached its height on the two days mentioned. Its greatest force was 11 (Beaufort scale), and the barometer sank as low as 28·566 at 3.30 P.M. on the 28th. The mischief done to the growing canes was not nearly so great as was anticipated, though in several places considerable damage has been sustained. Shops in many parts of Port Louis were closed, and on the 27th two of the local newspapers did not appear. The town itself presented a very sad appearance after the storm was over, the roofs and *débris* of fallen houses and dependencies, and broken trees innumerable, partially obstructing all but the main streets. The cellars of a great many houses were inundated, and a certain amount of valuable goods has been destroyed. There were very few houses in the upper part of the town but were more or less injured; verandahs, kitchens, stables, gates, palings, and such like light constructions having been blown down by the hundreds. The museum at the Royal College was unroofed, but the curiosities it contained have received no damage. The suburbs of the town were devastated, most of the smaller wooden houses, huts, and camps having disappeared. As was unfortunately to be expected, many lives were lost.

THE Royal Academy of Belgium proposes the following subjects for prizes to be awarded in 1875:—(1) To examine and discuss on the basis of new experiments, the perturbing causes which influence the determination of the electromotive force and the internal resistance of an element of the electric pile: to estimate in numbers these two quantities for some of the principal piles. (2) To show the present state of our knowledge on the relations of heat to the development of phanerogamous plants, particularly in respect to the periodic phenomena of vegetation; and, in this connection, to discuss the value of dynamical influence and of solar heat upon the evolution of plants. (3) To make experiments on the development of the *Tunicata*. (4) To show by new researches the composition and relations of albumenoid substances. (5) To describe the coal system of the basin of Liége. Each prize consists of a gold medal, of the value of 1,000 francs for subjects (4) and (5), and of 600 francs for the first three subjects. The papers may be written in Latin, French, or German, and must be sent to the Secretary of the Academy before August 1, 1875.

ON Saturday last the extensive works for the manufacture of telegraphic cables, belonging to the Messrs. Siemens, at Charlton, were thrown open to a select party of visitors, among whom were Lord Bury, Lord Rosse, Baron de Reuter, Professors Abel, Maxwell, Odling, Tyndall, and Williamson, Sir Charles Wheatstone, Mr. C. F. Varley, and Messrs. Culley and Preece, of the Engineering Department of the Postal Telegraph Service. These works comprise nearly every branch of telegraphic manufacture, but public interest becomes mainly centred on that part of the operations connected with the manufacture of submarine cables. The *Faraday*—the new ship to be employed in laying the direct United States cable, and the property of Messrs. Siemens—is undoubtedly a novelty in cable ships. It is an iron ship of 5,000 tons register, but equal to carrying a gross burden of nearly 6,500 tons. She is 360 ft. long, 37 ft. deep, and has a breadth of beam of 52 ft. Her capacity for cable storage is immense, consisting of three tanks, two of which are 45 ft. in diameter, the other 37 ft. in diameter, and each 27 ft. deep. Five thousand tons of cable can be thus stowed away, and it is calculated that this will be equal to about 1,500 miles of the cable, which is now being taken on board.

MR. HENRY WILLETT, F.G.S., has published another letter in reference to the Sub-Wealden Exploration. He says:—"We have now run through about 400 ft. of Kimmeridge clay. Nearly every inch contains numerous fossil shells in various stages of growth, each of which has been born, has grown, and died. Our little 2-inch column has contained several thousands. There is no reason to doubt that this bed of clay extends uninterruptedly beneath Brighton, Chichester, Southampton, Sussex, Hampshire, and Dorsetshire, to Kimmeridge on the west, and beneath Hastings and the English Channel to the Boulonnais district in France, and that throughout the whole of this vast area, the same conditions of birth, life, and death have existed."

A TELEGRAM from Aden to Vienna announces the death of Richard Brenner, the celebrated African traveller, which took place at Zanzibar on March 22.

IN a pamphlet on "Agricultural Schools and Experimental Farms" (Blackwood), Mr. David Milne Home points out very forcibly how immensely far behind all the rest of the world is this country, so far as the teaching and practice of scientific agriculture is concerned. For many years, in Germany and Austria, institutions supported by the state have been at work, not only for giving those who intend to follow agriculture as a vocation a thorough education in the scientific principles of that art, but also for scientific education in the principles and materiel of agriculture in all its branches. Other continental countries are following the example of Germany and Austria, and, more recently, numerous institutions of a similar kind, partly aided by Government, have been established on the best models in the United States. The consequence is that Britain is being out-distanced in a department which used to be deemed peculiarly British; and the only means by which she can regain and keep her place as an agricultural country is by getting Government to take the initiative in founding agricultural institutions similar to those of the countries we have named. "Every civilised country except Britain," Mr. Milne Home tells us, "has its Minister of Agriculture, to look after and promote its agricultural interests."

M. GAUTHIER VILLARS will publish very shortly the 10th volume of the "Annals of the Observatory." This is almost exclusively occupied with a paper by M. Leverrier On the Mutual Actions of Jupiter and Saturn; a paper by MM. Wolf and Andrè, On the black drop, has been reprinted from *Memoirs* of the Academy, and annexed to it. Tome XI. contains a paper On a special theory of Jupiter and Saturn, and secular inequalities; it will also be published very shortly. Tome XII. is nearly all printed; it contains the tables of Jupiter, reduced from M. Leverrier's theory. All the numerical results were obtained at the Bureau de Calculs of the Observatory. The positions of Jupiter were taken from these for 1878 and 1879, and sent to Mr. Hind for publication in the *Nautical Almanac*. It will contain also a paper by M. Rayet, On Magnetical Observations, which have been taken at the Observatory during these last two centuries.

THE *Times* New South Wales Correspondent writes that an explanation of the fate of the lost Australian explorer Leichhardt

has been offered, which, however, is considered very unsatisfactory. The Leichhardt expedition set out in 1844 and never returned. Andrew Hume, who was despatched by the Sydney Government in 1872, to recover some relics of the expedition has returned, and reports that he found Classen, Leichhardt's second in command, living with the blacks at the head of the waters of Stewart's Creek; Classen, Hume says, is detained by the blacks as a sort of wonder-man. Classen, according to Hume, states that Leichhardt's party mutinied at the head of Victoria River, and that after the struggle with their leader they left him when pushing on to the north-west coast. During this affair Classen was always seeking for water. When he returned, he says that Leichhardt was insensible, and died five days after the mutiny. The camp had been broken up and the horses taken away by the men. Hume says that he possessed himself of Leichhardt's quadrant and watch, and about seventy-five pages of the traveller's records. He also affirms that he saw the remains of the dead man concealed in a tree. The mutineers, he reports, were all killed at Ayer's Creek. Hume, it seems, has not shown to any one the relics he says he has recovered, and his story, as we have said, is generally discredited. Leichhardt's last letter is dated "Darling Downs, February 22, 1848."

In a report on the trade of Tamsay, China, we are told that the Camphor trees (*Cinnamomum camphora* F. Nees et Eberm.) are not found within the district marked on maps of Formosa as Chinese territory. They occur only within the country of the aborigines, or upon the immediate border. The manufacture of camphor necessitates the destruction of the trees, which are never replanted; as the country becomes denuded the aborigines recede, and the Chinese effect a corresponding encroachment. As a consequence, the border country is in a continuous state of disturbance, and fearful outrages are committed by both sides on every opportunity.

A petition signed by twenty-six Professors in the Universities of Scotland has been presented to the Prime Minister, calling his attention to the treatment of the ladies admitted to matriculate as students of medicine in the University of Edinburgh, and afterwards refused the right to graduate, and urging the Government to take the whole subject of the University education of women into consideration, with the view of devising a remedy for the present anomalies.

The General Local Committee which has been formed in Belfast for the purpose of making arrangements for the ensuing meeting of the British Association is already busy at work, and 3,000*l.* is being raised for the purpose of giving a proper reception to the Association: of this amount upwards of 1,600*l.* has already been collected. It has been arranged to prepare a list of lodgings for members who might not be otherwise accommodated, and other details are being attended to with regard to excursions, &c. The business meetings of the Association will be held in the Queen's College.

Mr. J. H. Lewis of Liverpool proposes to issue twenty sets of British Rubi, if names of subscribers are to hand by June 1. Each set will contain examples of twenty forms. Each example will show two flowering shoots—in flower and in fruit—and two pieces of barren shoot—young and old. In gathering, avoidance will be given to hedgerow-clipped plants, and preference shown, in this fasciculus, to those that exhibit characters corresponding to Prof. Babington's species and varieties, as described in "British Rubi," 1869. Printed tickets will be given containing remarks on most of the forms by Prof. Babington, Rev. A. Bloxam, Mr. Baker, and Hon. J. L. Warren. If encouragement be given to this fasciculus, others will be issued having more regard to intermediate and dubious forms. The price will be 1*l.* per set.

Dr. J. E. Gray has expressed his opinion that so far as he can judge from the description and drawing of the whale taken off Otago Head, New Zealand, in October last, it is a specimen of *Neobalæna*, of which only the skull has been known before. He established the genus *Neobalæna* from drawings of a skull in the museum at Wellington, which had been found at the island of Kawan, and in the An. and Mag. of Nat. Hist., vol vi. p. 156, he wrote, "the difference in skull makes us anxious to have a description of the entire animal and its skeleton, as the animal may prove to be the type of a new family of whales between the true whales and finners." This capture affords an opportunity for the first time of examining an entire skeleton, and a description is promised by Dr. Gray. The measurements taken by Prof. F. W. Hutton, of the Otago Museum, Dunedin, gave the length 16 ft. 2½ in., girth at pectoral 10 ft., pectoral flipper 2 ft. 7 in. long, caudal flipper 1 ft. 6 in. Weight 27 cwt.

The recently issued number of the *Bulletin* of the Geological Society of France contains an abstract of a paper On a Comparison of the Inferior Eocene of the Basins of Paris, Belgium, and England. The paper will appear in full in the fourth volume of the *Annales des Sciences Géologiques*. The correlation adopted is as follows:—

| Paris Basin. | Belgium. | England. |
|---|---|---|
| Sables à nummulites planulata | Panisálien | Lower Bagshot sands |
| Sables sans fossiles | Yprésien supérieur | |
| Gap | Argile d'Ypres | London clay |
| Gap | (?) | Oldhaven beds |
| Argile plastique | Landénien supérieur | Woolwich beds |
| Sables de Bracheux | Landénien inférieur | Thanet sands |

In the same bulletin M. Pouech describes an incomplete humerus, a fragmentary maxilla, and a molar belonging to *Elephas primigenius*, found by him in the ravine of Vicaria, near Pamiers. He believes it to have been contemporaneous with the Troglodytes of Vezère, d'Aurignac, and Clermont. There is also a description by M. Gaudry of the anterior part of the head of *Anthracotherium* found at St. Menoux. A full-size drawing is given showing the teeth of the upper and lower jaws interlocking.

M. de Billy, who had been appointed president of the French Alpine Club, has been killed by a railway accident, even before his nomination was notified to him. M. Cezane, an engineer of the Ponts et Chaussès, and one of the most promising members of the National Assembly, has been appointed to fill the vacancy created by the unexpected demise of the learned gentleman. M. Cezane is one of the members for the department of Hautes-Alpes; he has written an admirable work on the "Degradation of Mountains by Waterfalls."

M. A. Fouqué will deliver, at the College de France, a series of lectures on the volcanic emanations of Etna, Santorin, and Açores, where he has been sent by the French Academy to report upon these most interesting phenomena.

The French Association for the Advancement of Science has voted to M. W. de Fonvielle a sum in order to encourage him to recommence his course of systematic balloon ascents. M. de Fonvielle intends to study the differential direction which it is possible to give to an aërostat in varying the altitude for taking advantage of several directions of winds. It is not known yet whether he will practise his method for travelling in Europe or in America.

The eighth number of Mr. Hermann Strecker's work on the Lepidoptera has just been published by him at Reading, Pennsylvania, and upon a closely filled plate are to be found illustrations of eight species of butterflies, one of them but recently described as new by Mr. Strecker.

The annual report of the Academy of Sciences of Philadelphia announces the final completion of the labour upon which Mr.

Tryon and his associates have been engaged for several years past, namely, the arranging, labelling, and mounting of a very extensive collection of shells belonging to the Academy. The total number by actual count is 14,161 species, in something less than 100,000 specimens. The collection is stated to be one of the finest extant.

THE Cambridge Natural Science Club held six meetings during the past Lent term; there are now fourteen members Undergraduates and Bachelors, nearly all of whom were in residence and attended regularly, often bringing friends as visitors. The following were the subjects discussed:—Climbing Plants, introduced by Mr. Stone, St. Peters; the Functions of the Cerebral Hemispheres, introduced by Mr. Bridge, Trinity; Precious Stones, a paper by Mr. Alfred Buxton, Trinity; Zoological Colonies, a paper by Mr. A. J. Jukes Brown, St. John's; Metamorphosis, a paper by Mr. A. M. Marshall, St. John's; Allotropism, a paper by Mr. C. P. Clough, St. John's. The meetings commence again on Saturday the 25th inst., and will be continued during the present term, and through the Long Vacation, should a sufficient number of members be in residence.

AT the last monthly meeting of the Manchester Geological Society, Mr. Plant exhibited a large collection of remains of *Bos priscus* and *Rangifer*, obtained from Castleton, Derbyshire. The largest bones were portions of the skull, with the horn-cones attached, femora, and vertebræ, all much incrusted.

THE additions to the Zoological Society's Gardens during the last week include a Common Crowned Pigeon (*Goura coronata*), hatched in the Gardens; a Prince Alfred's Deer (*Cervus aifredi*) and a Vulpine Phalanger (*Phalangista vulpina*), born in the Gardens; and a Great Kangaroo (*Macropus giganteus*) from Australia, deposited.

## THE METEOROLOGICAL CONGRESS AT VIENNA *

THE Meteorological Congress, which held its meetings in Vienna from the 2nd to the 16th of September last, had its origin in a wide-spread conviction that since meteorology can be prosecuted with success only when it is treated internationally, uniformity of procedure among different nations is indispensable; and it was to bring about this uniformity that the Congress was convened. A preliminary Conference was held at Leipsig in August 1872, for the purpose of preparing the programme for the Congress. The Austrian Government issued invitations to other Governments to send delegates to the Congress. To these invitations every European country, except France, responded, and the United States and China were also represented.

The questions which were discussed, and the names of the delegates, have already appeared in NATURE.† The following is the deliverance of the Congress on these questions:—

1. A decision regarding the best mercurial barometer for stations of the second order was postponed to a future Congress. Aneroids should not be employed at stations where there is no other barometer, but they may be used as interpolation instruments alongside the barometer.

2. It was considered impossible to lay down fixed rules for general adoption in the protection of thermometers, on the ground that regard must be had to local conditions, and that the mode of exposure which is most to be recommended, in a space which is open and accessible to all winds, and at a height of 4½ to 6 ft., cannot be used everywhere.

3. Casella's minimum, and Hermann and Pfister's metallic thermometer, since they are found to become frequently deranged, cannot be recommended for stations at which they cannot be kept in proper order and their errors ascertained. For minimum thermometers, amyl-alcohol is to be preferred to ordinary alcohol, as being less liable to distillation. It is recommended that maximum and minimum thermometers be read at the last observation of the evening, and entered on the day on which they are taken.

4. Reference having been made to the experiments on radiation by Symons, Stow, and Soret, further experiments were recommended to be undertaken by physicists, so that the subject might be brought into the sphere of the regular observations.

5. Lamont's method of observing earth temperatures, which consists of a wooden tube, to the bottom of which the thermometer is let down, and up which it is drawn in order to be read, was recommended as giving more trustworthy results than thermometers with long tubes fixed in the ground. New experiments should be made in different countries, in order to decide the question at what depths observations should be taken.

6. The use of the wet- and dry-bulb hygrometer is in the meantime recommended, and the attention of physicists is drawn to the invention of some new apparatus by which the humidity of the air may be more accurately determined. Hair hygrometers can only be used with safety where care is taken to have their indications compared with those of the wet- and dry-bulb hygrometer, so as to determine their corrections, especially near the point of saturation, where the readings are often too low.

7. It was agreed to introduce the English designations of the directions of the wind:—N. = North, E. = East, S. = South, and W. = West, and to give only sixteen directions of the wind; and in the case of intermediate directions being observed, it is proposed to count them alternately to the one or the other. Lambert's formula is not to be recommended in deducing the mean direction of the wind; but, on the other hand, the frequency and mean force of the winds which correspond to the different directions should be given in numbers. In the distribution in the windrose, those winds whose velocity is less than ½ metre per second, or 2½ English miles per hour, are not to be regarded, but counted as calms. The direction of the cloud-drift should be observed and noted.

8. No general scale for the estimation of wind-force is yet recommended, but it is desirable that a gradual advance be made towards giving the velocity of the wind in metres per second.

9. Wild's apparatus for measuring the force of the wind, already in use in Switzerland, Baden, and Russia, was recommended for introduction at stations of the second order. The velocity of the wind obtained by anemometers should be expressed in metres per second, and tables should be prepared for the mutual conversion of metres per second, kilometres per hour, and English miles per hour.

10. The best form for the receiver of the rain-gauge is a circular one with the area of one-tenth of a square metre, that is, having a diameter of about 14 in. The receiver of the rain-gauge should be placed at a height of not less than 1, and better, of 1½ metres above the ground, or at a height of from 3 to 4½ ft. In the published results the height above the ground should be stated. Where it can be done, the measurement of the rainfall should be at the end of the fall; in other cases the first observing hour of the day is recommended, in which case the amount is to be put down to the previous day. It is recommended that the duration of the fall be stated in hours.

11. It was agreed to introduce symbols for the character of the precipitation in the "Remarks" column, and to give in the monthly *résumé* the sum of the days of rain and snow separately; to have two columns, one for the quantity fallen, and one for the depth of the unmelted snow; and to give, in the yearly *résumé*, the maximum fall in twenty-four hours for each month. It was further recommended to state the number of days when the fall is less than 0·04 in. and 0·01 in.

12. Hail is defined to be as a precipitation of frozen water, in which the stones attain such a size that they may be expected to do damage to agricultural products.

13. (*a*) In order to obtain data regarding thunderstorms which admit better of comparison, it is recommended only to count the days of thunderstorms, but this is not intended to prevent individual observers from inserting in the column of "remarks," in addition, the number of the storms, the time of their commencement, their duration, direction of motion, &c.

(*b*) As days of thunderstorm, only those are to be noted on which both lightning and thunder have been observed. If only lightning without thunder has been noticed, the entry for the day should be sheet lightning.

14. As regards evaporation, the evaporating dish should not be less than seven inches in diameter, and it is indispensable that it be absolutely identical as regards diameter and depth at

* "Report of the Proceedings of the Meteorological Congress at Vienna." Protocols and Appendices. Translated from the Official Report. Published by the authority of the Meteorological Committee. London, 1874.

† NATURE, vol. viii. p. 468.

all stations, if comparability is aimed at. The level of the water in the dish must remain constant, for the obvious reason that the evaporation is less the deeper the surface of the water stands under the edge of the vessel. Provision must be made for reading off the quantity evaporated with accuracy. The measurement of evaporation by means of floating apparatus on large surfaces of water should be introduced wherever possible.

15. (*a*) The degree of cloudiness is to be given by the figures 0—10, in which 0 represents a sky quite free from cloud, and 10 an entirely overcast sky. These figures refer only to the extension and not to the thickness of the cloud, the latter being indicated by accompanying expressions, such as "slight," "great," &c.

(*b*) Arbitrary symbols representing rain, snow, fog, &c., were adopted.

16. It was resolved that the institution of observations on atmospheric electricity be recommended only for head observatories. As regards ozone, the existing methods of determining its amount in the atmosphere are insufficient, and the Congress therefore recommended investigations for the discovery of better methods.

17. It was agreed that for observations as well as for publications, the use of the same units of measure is desirable; that among all existing systems of measure the metric has the best prospect of universal adoption; that it is most desirable, if it be not possible to introduce uniform measures at present, to use henceforth only metric and English measures (with Celsius and Fahrenheit scales), and that all action is to be supported which tends to the introduction of the uniform metric system. It was also agreed that the results of observations, or the means, should be published in the metric scale as well as in the original scales.

18. The hours of observation should be chosen which give a close approximation to the true mean temperature of the day. The following are the suitable combinations:—

| h. | h. | h. | h. | h. | h. | | h. | h. |
|---|---|---|---|---|---|---|---|---|
| 6 | 2 | 1 | 8 | 2 | 8 | with min. temp. | 8 | 8 |
| 7 | 2 | 1 | 9 | 3 | 9 | | 9 | 9 |
| 7 | 1 | 9 | 10 | 4 | 10 | | 10 | 10 |
| 7 | 2 | 9 | | | | | | |

Observations should be set on foot at a number of normal stations, especially in Turkey, East Indies, Australia, Southern States, and Brazil, in order to ascertain the corrections for the most important meteorological elements, such as temperature, pressure, and humidity.

19. As units of time should be chosen (1) the mean solar day of the place of observation, reckoned from midnight to midnight; (2) the civil year; (3) the civil months everywhere, the calculation of the monthly means being simply arithmetical; and (4) Dove's 5-day means (73 in the year) for a selected number of stations of each country. It is proposed to count the first 12 hours of the day, from 1 to 12, as forenoon; and the following 12 hours, from 1 to 12, as afternoon; thus counting 12 o'clock midnight as the end of the day, and 12 o'clock noon as the close of the forenoon.

20. It is resolved to choose, as the periods for calculation of normal values, intervals of five years to be called *Lustra*, so that the next Lustrum will begin with January 1, 1876; and that as regards the more important data, old observations should be calculated in accordance with this proposal.

21. The existence of a system of weather telegraphy is, for all countries, considered to be a necessity; in addition to the direction and force of the wind, the barometric gradients at the time of observation should also be added. For purposes of storm warnings, the reduction of the barometer readings to mean sea-level for places not above 1,000 feet in height is admissible. For greater heights, the gradients are to be referred to the mean normal heights of the barometer at the stations. The relations of temperature, moisture, rain, cloud, and state of the sea and tides to storms, are recommended for investigation. As regards storm warnings, each director should give his opinion on the probable course of atmospheric disturbances which are expected, or have already commenced, not as prophecies, but as *probabilities*. Only wind-force of 8, and upwards, of Beaufort's scale should be announced.

22. As regards maritime meteorology, it is desirable that each country should, if possible, collect all its meteorological observations at one place, and that the Institute for Maritime Meteorology should be established as near as possible to the sea, and that this institute might best be placed under the general management of the chief institute of the country. The convening of a maritime meteorological conference was declared to be desirable, and the preparation for this conference is entrusted to the permanent committee appointed by the Congress.

23. It is necessary that in every country, at least one but in case of necessity several central institutions should be established for the management, collection, and publication of meteorological observations.

24. The verification of all instruments supplied to meteorological stations, and the inspection of stations yearly, but at least once in the course of every five years, is necessary. With regard to instrumental errors detected on verification, or inspection, corrected results only should be published. It is intended that the Permanent Committee prepare, in conjunction with the other members of Congress, instructions for the institution and discussion of meteorological observations.

25. As regards standard barometers and thermometers, each central office is recommended to adopt a real standard barometer, *i.e.* an instrument which allows of the determination of atmospheric pressure according to its definition in absolute measure, and to prepare a standard thermometer on scientific principles.

26. The publication of observations at stations of the first order should be entirely separated from those of stations of the second order. It is handed over to the Permanent Committee to prepare, in conjunction with members of Congress, a form of publication suited for international purposes.

27. It is desirable to organise, on the model of the Smithsonian Institution at Washington and the Central Bureau at Haarlem, a similar office for the exchange of publications in every country.

28. A Permanent Committee of seven, with the right of increasing their number to nine, was appointed, with Dr. Buys Ballot as president. The duty of this committee is to care for the carrying out of the decision of the Congress, and arrange for convening a future Congress; and it shall place the delegates of the Congress in cognisance with its action and proceedings.

For the extension of meteorological knowledge it was recommended that stations provided with self-registering instruments be established on high mountain-tops; that experiments on the possibility of continuous meteorological observations with captive balloons be instituted; that stations be established in the North Polar regions, and also in the high southern latitudes; on the north coast of Africa; that the organisation of the stations in Turkey be made more complete, especially the Central Observatory at Constantinople, and that the meteorological station at Athens be maintained.

29. The establishment of an International Institution for the Advancement of Meteorology was declared to be really useful and desirable, and it was remitted to the Permanent Committee to prepare a detailed scheme for this purpose for the consideration of a future Meteorological Congress.

(*To be continued.*)

## SCIENTIFIC SERIALS

*Poggendorff's Annalen der Physik und Chemie*, No. 1, 1874.—In this number M. Holz communicates an account of experiments on bar-magnetism which he made in Prof. Helmholz's laboratory. They had reference to the effect produced on magnetic moment of bars, when these were subjected to the corrosive action of dilute muriatic acid for twenty-four hours. He finds (among other things) that the amount of magnetic moment of a steel bar, with regard to quality, depends on the structure of the iron, and the carburet of iron (*Kohleneisen*) united with it; that it increases per unit of weight, through abstraction of magnetised iron, and decreases through abstraction of magnetised carburet of iron; also, that particles of carburet of iron remaining after solution of the iron are magnetisable, and receive permanent magnetism.—M. Lehnebach gives a determination of the emissive power of dark bodies, by the ice-calorimetric method. The principle is briefly this: Suppose a thin glass sphere filled with ice, and placed within a larger sphere, whose temperature is above 0°, and constant; also that the former has an arrangement for showing the amount of ice melted in a given time, and a vacuum can be made within the spheres; then the increase of heat received by the inner globe may be measured calorimetrically. The apparatus is said to prove very serviceable for measuring emissive power.—M. Braun investigates some points connected with elastic vibrations, the amplitudes of which are not infinitely small; and M. Meyer studies the theory of elastic effects.—A method of graphic representation of absorption spectra is described by M. Vierordt, and the curves are given for

some ten different substances. The curves are very regular and characteristic, and he considers that with those spectra, in which the absorption continuously increases from one end to the other, a measurement of the light intensity at six or eight parts of the spectrum is quite sufficient, in order to construction of the whole absorption curve, and determining the relation of absorption to the wave-length of the light.—Attention is directed to some new physical phenomena: thus M. Kundt has observed a well-marked dichroism in certain substances (such as caoutchouc and gutta-percha) on stretching. Examined with a dichroscopic lens a thin strip gave two images, one dark brown, the other nearly straw-yellow; the ray whose vibrations are in the direction of stretching is the most absorbed.—M. Antolik studies what he calls the "gliding" of electric sparks; a phenomenon which is had, if *e.g.* a spark be made to strike a soot-smeared glass ball. The path-trace left by the spark shows two light parallel lines, and a dark one between; the former are due to thrusting aside of the soot, and, in the dark band, the soot seems compressed, for, on washing the globe, the soot remains there after the rest has gone. The outer edge of the light band shows, in the microscope, a number of dark and light triangles, apparently produced by induction.—M. Obermayer describes phenomena presented by the dispersion of some solutions of aniline colours in water.—M. Edlund rejects, as inadequate, a recent experimental investigation, by Prof. Roiti, of the question: Is the galvanic current an ether current? and M. Reye replies to M. Zöllner on the subject of sun-spots and protuberances.—A Japanese toy-bird is the topic of a note by M. Erdmann. The bird is placed with its back on a board, by means of which it is thrown forward; and after rising 8 ft. or 9 ft. in a parabolic curve, it returns, head foremost, to the thrower.—M. Nordenskjold furnishes some particulars as to the nature of cosmic dust which had been observed to fall, with atmospheric precipitates, in the neighbourhood of Stockholm.—Among the matter selected from other serials we may note an account of M. Wiedemann's researches on the elliptical polarisation of light, and its relation to the surface colours of substances; and remarks on the arrangement of a *dispersiometer*, by M. Mousson.

## SOCIETIES AND ACADEMIES

### LONDON

**Royal Society**, April 23.—Note On the minute anatomy of the alimentary canal, by Herbert Watney, M.A., Cantab. Communicated by Dr. Sanderson, F.R.S., Professor of Practical Physiology, University College.

**Zoological Society** (anniversary), April 29.—Viscount Walden, F.R.S., president, in the chair.—The report of the council, which was read by the secretary, Mr. P. L. Sclater, F.R.S., stated that the number of ordinary members of the Society on January 1 last was 3,173, of foreign members 25, and of corresponding members 196.—The total income of the Society in 1873 was 28,099*l.*, being 1,371*l.* more than that of 1872, and exceeding the income of any previous year, even those of the years 1851 and 1862, when the Great and International Exhibitions were held, which have hitherto been regarded as exceptional years. The total ordinary expenditure of 1873 had been 22,721*l.*, and 4,945*l.* had been likewise devoted to extraordinary expenditure, leaving a balance of 1,384*l.* to be carried forward for the benefit of the current year. The assets of the Society on December 31, 1873, were calculated at 10,530*l.*, while the liabilities were reckoned at 5,490*l.* The reserve fund consisted at the close of the year of a sum of 8,000*l.* reduced three per cents., but it had been resolved to increase this fund by investing the interest of it from time to time, and by purchasing a further sum of like stock to the amount of 500*l.* every year. The scientific publications of the Society for 1873 had consisted of the usual octavo volume of "Proceedings," and of three parts of quarto "Transactions." The most important work undertaken in the Society's gardens in 1873 had been the rebuilding of the main refreshment-room in the South Gardens at a total cost of 2,096*l.* The total number of visitors to the Society's Gardens in 1873 had been 713,046, being 64,958 more than the corresponding number in 1872, and exceeding that of any previous year since the Gardens had been open to the public. The number of animals in the menagerie on December 31, 1873, was 2,187. Many of the accessions during the year had consisted of specimens of rare or little known animals, of which full particulars were given. The report concluded with a long list of donors and their several donations to the menagerie. The adoption of the report was moved by Mr. J. Stewart Hardy, M.P., seconded by Prof. Tennant, and carried unanimously. The meeting then proceeded to elect the new members of council and the officers for the ensuing year, and, a ballot having been taken, it was found that Viscount Walden, F.R.S., had been elected president, Mr. Robert Drummond, treasurer, and Mr. P. L. Sclater, F.R.S., secretary to the Society. The new members of council elected were Robert Hudson, F.R.S., the Marquis of Ripon, K.G., Lord Arthur Russell, Osbert Salvin, F.R.S., and Lord Walsingham.

**Anthropological Institute**, April 28.—Prof. Busk, F.R.S., president, in the chair.—Mr. H. H. Howorth read a paper, entitled Strictures on Darwinism; part 3, on Gradual Variation. The paper was in continuation of a series in which the author endeavoured to show that Mr. Darwin's main conclusion is not supported by the evidence of the changes of type that can be examined. Mr. Darwin differed from the older naturalists in assigning, as the cause of variation, a struggle between the individuals of a class for existence by which a favoured individual and its progeny eventually survive. They, on the contrary, argued that variation is induced by a change in the external conditions of climate, food, &c., which operate upon the whole class together and make it change, as a whole, in a certain definite manner and direction, that is in one which can be actually predicted. So that if any individual of a class or any number of individuals of a class be subjected to a certain alteration of conditions, a certain definite and uniform change will be produced in the individual or the class. Again if the new conditions were annihilated, the object of the experiment is reverted to its original surroundings. The author supported that argument by a large number of facts, and in doing so was constrained to conclude that the operating cause of variation in man, as in the case of plants and animals, is the working of external causes; and that an individual with its progeny is not so much better fitted for enduring the new conditions that it eventually supplants the rest, but rather that the whole class is moulded together into a new shape, which is called a new variety. Some facts were drawn from the experience of history showing that where the conditions have been uniform, as in Egypt, although there has been a considerable mutual pressure among the individuals of a class for food, &c., yet there has been no variation, while a transplanting of similar individuals, as in the case of European emigration to America, has been followed by almost immediate change. The illustrations that might be drawn from the cases of man, as in the changes that have ensued in both the Aryan and the black emigrants to North America, of the Dutch to the Cape, of the Portuguese to South America, &c., were notable and telling instances of the operation of the law argued for by the author, inasmuch as changes of type of a marked character have occurred where there has been neither time nor opportunity for the creation of a fresh type by the successive amelioration or change in the idiosyncrasies of the descendants of a common ancestor, but where the change has undoubtedly occurred in the whole class together over a very wide area.

### DUBLIN

**Royal Irish Academy**, March 16.—Rev. J. H. Jellett, B.D., president, in the chair.—The minutes of the previous meeting having been read and confirmed, Dr. Ingram, secretary to the council, read the annual report, which referred to the work done by the Academy during the previous session, the state of the museum, &c. Seven members were lost by death during the year.—At the conclusion of the report, a ballot took place for the election of president and council. Dr. Stokes, F.R.S., was declared duly elected president, and the following officers were elected:—J. R. Garstin, LL.B., treasurer; E. Perceval Wright, M.D, secretary; J. T. Gilbert, librarian, and Dr. R. M'Donnell, F.R.S., secretary of foreign correspondence.

April 13.—Dr. Stokes, president, in the chair.—A paper was read by M. Donovan On some Improvements of a Comparable Self-acting Hygrometer.—John Casey LL.D., read a paper On a new method of finding the Equation of the Squares of the differences of the roots of a Biquadratic, given by its general equation.—Mr. H. W. Mackintosh read a paper On the Anatomy of the Coatimondis and Marten. During the summer of last year two species of the coatimondi (*Nasua narica* and *N. fusca*), and two specimens of the common species of marten (*Martes foyna*), which formed part of the collection in the Dublin Zoological Gardens, having died, were obtained for the Dublin Uni-

versity Museum, and through the kindness of Dr. Macalister I had the opportunity of assisting him in dissecting them. *Nasua narica*, as doubtless many are aware, has a very long and flexible snout, and hence we found the facial muscles correspondingly better developed in it than in the others. Trapezius, which is tripartite in all, is remarkable in *N. fusca* for sending from its clavicular portion a slip to the humerus and also for being joined to brachialis anticus. Omohyoid was completely absent in the Coatis, but represented by a fine muscular band in Martes. Teres major is remarkable in Martes for being inserted into the humerus free from the tendon of the latissimus dorsi. Pectoralis major has the usual band from the presternum to the humerus; in *N. fusca*, besides the two laminæ from the whole sternum, and from the mesosternum respectively to the pectoral ridge, and greater tuberosity of the humerus, there was a third portion arising from the abdominal parietes and inserted below the humeral tuberosity. The clavicle being rudimentary, the subclavius, as is generally the case amongst carnivores, had disappeared. Acromial deltoid in *N. narica* has some of its fibres continuous with those of brachialis anticus. There was a perfectly separate prescapular slip of subscapularis in *N. fusca*, but not in the other two pronater radii teres passes in all to be inserted below the distal half of the radius. The extensor of the little finger sends tendons to the third and fourth, as well in *N. fusca* and Martes; but in *N. narica* there is a separate extensor *quarti et tertii digiti*. In the hind limb, sartorius has a double insertion into the tibia and into the patella and femoral condyle, the former segment being fused with gracilis. *N. narica* has a distinct agitator caudæ, which is represented in the marten by the caudal origin of the biceps femoris. Bicipiti accessorius is distinct in the Coatis, but inseparable from triceps in Martes, in which also gastrocnemius externus and plantaris are fused. Tibialis anticus is double in Martes, one part arising anterior to the other and being inserted beside and separate from it.—Dr. Collins read a paper On accessory Lobes of the Human Lung. The specimen exhibited presented an accessory lobe of the right lung, lying above the root, and invested by a pleural duplicature, which contained in its lower free margin the azygos vein, and in its external border the superior intercostal. Reference having been made in detail to seven similar cases noticed in different parts of Europe, special stress was laid upon a unique case detailed by Wrisberg of a lobe having similar relations upon the left side, as conclusively establishing the mode of origin of the lobe in connection with the development of the azygos, and superior intercostal venous systems. The author regarded these as the only true accessory lobes yet described in man. Mention was made of other so-called accessory lobes, particularly one described by M. Pozzi, below the right bronchus, from its apparent homology to the mammalian lobus impar, and a similar one upon the left side, described by Prof. Recktorzik. These, however, the author regarded as merely higher developments of pulmonary notches, which in not a few instances are normally to be found. The paper, which was illustrated by the recent specimen and by drawings, concluded with an allusion to accessory bronchi in their connection with the subject.

## PARIS

**Academy of Sciences**, April 27.—M. Bertrand in the chair.—The following communications were read:—Fourth memoir on chemical dynamics, by M. Becquerel, a continuation of the author's electro-chemical researches.—On freezing mixtures, by M. Berthelot. The author concluded, from his researches, that by application of the resources indicated by theory, a much lower temperature ought to be obtained than has hitherto been reached.—Study and experiments upon sulphides: alkaline sulphides, by M. Berthelot, a continuation of the author's thermo-chemical researches.—M. Kronecker contributed an algebraical paper on quadratic and bilinear forms.—Note on the decomposition of the work done by forces, M. A. Ledieu. The author gave a rigorous enunciation of Luca's theorem relating to the division of the work done by forces in a material vibrating system.—The production of gum in fruit trees considered as a pathological phenomenon, by M. E. Prillieux. Trees affected by this malady were stated to be cured by making longitudinal incisions in the branches.—On unicursal curves, a geometrical memoir by M. Painvin.—Orbit of the double star γ Virginis, by M. C. Flammarion. This system offers the unique case of an elliptical orbit facing us in a plane exactly perpendicular to the line of sight, so that no distortion of the ellipse due to perspective is perceived.—On the conclusions to be drawn from the application of thermo-chemical theorems to explosive bodies in general and to gunpowder in particular, by M. F. Castan.—On the thermal conductivity of rocks and of bodies in general, by M. E. Jannettaz. The law which regulates the propagation of heat in crystals appears to the author a particular case of the general law that heat is propagated most easily in the direction of least cohesion.—Determination of the age of the human embryo by the examination of the evolution of the dental system, by M. E. Magitot. The results are likely to be of great service in medico-legal cases.—M. E. Combescure presented a note on a theorem concerning simultaneous partial differential equations.—Direct construction of the radius of curvature of the curve of apparent contour of a surface projected orthogonally on a plane, by M. A. Mannheim.—On the limit of the degree of the primitive groups which contain a given substitution, a mathematical note by M. C. Jordan.—Elements and ephemerides of the planet (127), by H. Renan.—On the elementary law of electrodynamic actions, by M. J. Moutier.—Observations on Tyndall's experiments on the acoustic transparency and opacity of the atmosphere, by M. Baudriment. The author stated that the given explanation of the phenomenon of acoustic extinction might be true, but did not seem sufficiently demonstrated to be admitted without submission to a special inquiry, and concluded by stating that the observations were made to be considered by Prof. Tyndall only as means offered to him for the verification of facts of such great importance.—Study of the properties of explosive bodies, by F. A. Abel.—On the employment of oxygen mixed with atmospheric air in respiration, by M. A. Gaudin. The author confirmed the results obtained by MM. Crocé-Spinelli and Sivel in their last balloon ascent.—On a burying-place of the ancient Troglodytes of the Pyrenees superposed upon a (funeral) hearth containing human remains associated with sculptured teeth of the lion and bear, by MM. L. Lartet and Chaplain-Duparc.

## BOOKS RECEIVED

BRITISH.—Physiology for Practical Use. 2 vols. Edited by James Hinton (H. S. King & Co.).—A Treatise on Food and Dietetics: Dr. Parry (Churchill).—Sanitary Arrangements for Dwellings: W. Eassie (Smith, Elder & Co.).—Thorpe's Qualitative Chemical Analysis (Longmans).—Principles of Mechanics: Goodeve (Longmans).—Year Book of Facts: Timbs (Longmans).—Surface Zones of the Globe: Keith Johnston (W. & A. K. Johnston).—Lectures on Experimental Chemistry: Prof. Reynolds (Hodges, Foster & Co.).—Mechanics: Willson (Thacker).—Pickering's Physical Manipulation (Macmillan).—Physiology: F. de Gros. Clark (S.P.C.K.).—Geology: T. G. Bonney (S.P.C.K.).—Africa: A. Gruar Forbes (Low & Co.).—Proceedings of the Royal Society of Edinburgh.

AMERICAN.—The Constants of Nature. Part I. (Smithsonian Institute). Compiled by F. W. Clarke, S.B.—A History of American Birds: S. F. Baird, T. M. Brewer, and R. Ridgway (Little, Brown & Co.).—The Unity of Creation: F. K. Kingston (Trübner).

COLONIAL.—General Report of the Great Trigonometrical Survey of India during 1873: Col. J. T. Walker (Dehra Doon).—Geological Survey of Canada. Report for 1873: (Dawson).—Report of the Secretary for Agriculture, Victoria.—Transactions of the Royal Society of Victoria.

FOREIGN.—Statique des Liquides. 2 vols. J. Plateau (Gauthier Villars).—Association Française. 1st session. Comptes Rendus.—Histoire de la Creation: E. Haeckel (Reinwald, Paris).—Schriften der Naturforschenden Gesellschaft in Danzig. 1873.—Les Explorations Sous-Marines.—Elements de Geologie et de Palæontologie: Ch Contejean (Bailliére).—Principes de Geologie: Gustave Dollfas (Savigi, Paris).—Verhandlungen Zoologisch Botanishen Gesellschaft in Wien, Band xxiii.

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