THURSDAY, JULY 10, 1873

THE ENDOWMENT OF RESEARCH

II.

IN a recent number attention was drawn to the public importance of original research in the Sciences, and it was insisted that certain funds which lie ready to the hand should be devoted towards the maintenance of those who undertake the national duty of extending the bounds of scientific knowledge.

In this article it is proposed to strengthen those positions by a reference to the already published evidence of the Royal Commission at present inquiring into "Scientific Instruction and the Advancement of Science." The object of the labours of the Commission is twofold, but concerning the former part nothing need now be said, except that regulated activity in independent investigation is the main condition upon which depends successful teaching alike in the individual professor, and the scientific schools of the nation.

The Commission was especially directed to ascertain how far the endowments of the Universities and Colleges might be directed to aid the needs of Science. On this point much valuable evidence was given by several distinguished members of our two wealthy Universities, and there was a general agreement of opinion that so far as Instruction and Examination are concerned, the Universities are showing a praiseworthy disposition to encourage their scientific students. On the other hand, it was universally admitted that the Oxford Science-school, despite the excellent teaching of its professors, is not progressing so well as might be expected, and that the University is lamentably deficient in that part of its functions which is concerned with the promotion of knowledge for its own sake.

Among the Oxford witnesses Sir B. Brodie, who was at the time that he gave his evidence Waynflete Professor of Chemistry, is conspicuous as well for the precision with which he pointed out the causes of the present defects, as for the definiteness of the scheme by which he proposed to remedy them. According to him, "Universities are Institutions of which the object is, in the first place, to promote scientific education and to diffuse scientific knowledge, and in the second place to preserve and to extend scientific knowledge." He was of opinion that "the latter of these duties is at present not sufficiently kept in view, whereas in old days the case had been different." His suggestions were that "the University should establish, on a larger scale than now, museums and scientific collections, for the present ones are organised too much with a purely educational object; and secondly (a point to which he attached by far the most importance), that the means of existence and of scientific study should be provided for certain professors or individuals, by whatever name they may be called, whose chief function should be scientific investigation and the representation and advancement of their various special Sciences."

He further went on to suggest that "these professors should be, to a great extent, separate from the ordinary teaching staff of the University, professors of the Science itself, rather than professors of the teaching of the Science:" that "in their lectures they should give to the public what they have attained for themselves, and have under them a limited number of pupils as assistants in their own original researches." The case of Liebig at Giessen will naturally suggest itself to our readers as an apt illustration of the particular mode of advancing Science here advocated; and from the evidence of Sir W. Thompson before the Commission it may be learnt that both at Glasgow and at Owens College a somewhat similar plan is being energetically carried out.

Sir B. Brodie, however, would appear with characteristic zeal to go even one step beyond this, for he instances as "a capital example of such a foundation as he would desire the Radcliffe Observatory at Oxford, where the observer gives no lectures at all, is not even attached to the University, but solely put there to do astronomical work. The Board of Curators, themselves not necessarily members of the University, having large funds at their disposal, give to the observer whatever he wants, whilst he on his part, as the sole evidence of his industry, makes an annual report on the condition of the observatory and the work done, and publishes certain tables." Here we also think that we have found, so far as the theory of the institution goes, an admirable model of the manner in which the cultivation of Science for its own sake may be endowed with great advantage to the country and without any manifest risk of sinecurism. In the language of the Dean of Christ Church, "we should very much like to see eminent men residing at Oxford only partially employed in teaching, but employing a great part of their time in scientific research."

With reference to the endowment of research here advocated it is necessary that a warning should be explicitly given against dangers which threaten from two different sides. On the one hand it is most important, in England more than in other countries, that the simple pursuit of Science as knowledge should not be confounded with the practical application of scientific truth to the numberless arts of modern civilisation. Applied Science is a profession which promises to become of a highly remunerative character. The analyst, the engineer, and the electrician may require pecuniary help and regulation from the Central Government for their technical schools, but they emphatically do not require to be themselves supported by national endowments. On the other hand, the ordinary scientific teacher at the universities, where not the poor but the rich as a rule are taught, should not in our opinion be regarded *quâ* teacher as the proper recipient of the funds of an endowment. It may very well be that while education in Science is struggling towards recognition, the teachers may claim some sort of aid to put them on a level with those branches of instruction which have the advantage of ancient prestige; it may also be thought advantageous that certain teachers should receive endowments, not for the tuition they give, but for the investigations they are carrying on independently of their other work; yet it must be granted that either of these cases is of an exceptional character.

On all hands are to be seen the disastrous consequences of endowing teaching proper, and of compelling original research to take its chance at the hands of the amateur. It must happen that the professor (so called) will be constrained to give up the whole of his time to the duty which is most expected of him, and that original research will suffer both in quantity and in quality. The most general principles of political economy are sufficient to show that in a wealthy and moderately enlightened country the remuneration of teaching had better be regulated by the equitable standard which impartial competition will not fail to establish. It is for those subjects which, though of essential importance to the welfare of the country, are in themselves naturally unremunerative, that the old endowments for the promotion of education and knowledge, whatever may have been the particular means by which these ends were originally to be attained, are now required. Among these subjects disinterested application to pure Science is manifestly the chief.

In a subsequent article we propose to show that the funds of the Colleges cannot be more consistently applied than to this purpose, and that the progressive well-being of the Universities mainly depends upon the degree to which they are concerned in the advancement of knowledge. C.

THOME'S LEHRBUCH DER ZOOLOGIE

Lehrbuch der Zoologie. Von Dr. Otto Wilhelm Thómé; Pp. 416. (Brunswick: 1872.)

IF Germans wonder, not without reason, who buy our manuals of microscopic mounting, Englishmen may equally wonder for whom such books as Dr. Thomé's are written. We have technical treatises on special branches of zoology, and we have popular natural history books, but a manual like this would find a poor sale in England. It is a school manual, and its existence is explained by the introduction of zoology to some extent into the curriculum of the German gymnasia and much more into that of the Realschule, which more or less correspond to the "modern side" of our public schools, or may be described as answering in intention, though of course immeasurably superior in performance, to English "commercial schools." Whether zoology ought to form a regular part of school work, even where room is made by giving up Greek altogether and Latin more or less, is an important question. As a part of *education* in the proper sense of the word, it is so inferior in exactness, in conciseness, in facility of demonstration, and convenience for observation and experiment to such rivals as botany, physics, and even chemistry, that its claims may practically be ignored. Moreover, looking at school work from another point of view, it is obvious that any scheme of utilitarian *instruction* which is good for much must include ignorance of the greater part of human knowledge, in order to provide for acquaintance with the rest; and the first addition to the indispensable elements of reading, writing, and arithmetic would probably be claimed for geography, political economy, or the rudiments of hygiene, as more useful branches of knowledge than zoology. A boy with a bent for natural history would gain far more good from reading the bits of zoology in such books as the "Voyage of the *Beagle*," the "Malay Archipelago," or "Kosmos," and by collecting bird's eggs or butterflies, than he would by painfully wading through the details of Dr. Thomé's closely printed pages. And when zoology is taken up as a serious study by older students, most teachers will agree that the best plan is for them to begin by a careful study of a particular branch of the subject, with the help of such a handbook as Flowers' "Osteology of the Mammalia."

Looking to the object of the book, the reader will find Dr. Thomé's work fairly done. The first hundred pages are devoted to a popular sketch of human anatomy and physiology, from which all notice of generation and development is excluded. Otherwise it is as complete as the space will allow. The remainder of the book describes the several classes of animals, beginning with Mammalia and following the arrangement into seven types—Vertebrata, Mollusca, Arthropoda, Vermes, Echinodermata, Cœlenterata and Protozoa—which is now generally accepted among German naturalists. A diagram of these types is given, which might serve for a genealogical tree; but no hint of this intention is given. The sub-division into classes and orders is not particularly good. Thus among Mammalia the Sirenia are confounded with the Cetacea, Ray's obsolete distribution into Ungulata and Unguiculata is preserved, and the orders Ruminantia and Pachydermata appear, as if nothing had been done to clear up the real affinities of these groups since Cuvier published the "Regne Animal." The classification of birds is not more unsatisfactory than that of other writers; and in the class of fishes Müller's orders are commendably followed. Tunicata and Bryozoa are of course excluded from Mollusca, and help to fill the lumber-room of Vermes. A very large share is, as usual, given to the account of insects, while marine zoology and the Protozoa receive comparatively little attention.

Three hundred and fifty-eight woodcuts make an important feature of the work. Most of these are good in themselves and well printed. Those illustrating human anatomy and histology are the best, and almost all borrowed from Henle. No indication of this or any other source is given, but it is easy to recognise that some of the figures have been taken from the admirable cuts in Bell's "British Reptiles," others from Forbes, Milne-Edwards, and other well-known works; while some of the Mammalia appear to have been drawn from children's toys. Fig. 350, of a sponge, is a curiously modified reproduction of the original drawing in Grant's "Outlines of Comparative Anatomy" (p. 312). Of the thirty-one figures of birds, twenty-seven represent European species, and of these all but four are copied from Yarrell's British Birds. One excellent addition to each figure is a note of the relation it bears to the actual size of the animal represented, or of the average length of the latter. There are not many figures of anatomical details, but almost all are good, some being taken from Gegenbaur's "Vergleichende Anatomie."

To compare Dr. Thome's book as a whole with serious scientific treatises even of the second class, like that of Claus, would be unfair: but even as a "cram-book" it is inferior to Nicholson's Zoology: and it gives far too little space to descriptions of the habits and character of well-known groups like mammals, birds, and insects, to be really popular. Such books as Knight's "Museum of Animated Nature" are much more interesting and quite as scientific. P. S.

VALENTIN'S QUALITATIVE ANALYSIS

A Course of Qualitative Chemical Analysis. By William George Valentin, F.C.S., Principal Demonstrator of Practical Chemistry in the Royal School of Mines and Science Training Schools, South Kensington. (London: J. and A. Churchill. 1873.)

IT is a good sign of the present activity of scientific study in this country that there should have already been a call for a second edition of a work which only appeared two years back, in the early part of 1871.

The author has, in the second edition, separated the second part of his orignal work, and this, treating entirely of qualitative analysis, forms the volume now before us. The elements which occur in the main as bases are divided into five groups, and the first portion of the book is devoted to a careful study of each element of each group beginning with group V., a method the advantages of which will be seen by a very short study. The first 103 pages are devoted to this matter, and the attention of the student is then devoted to the study of the reactions of the acids. No particular grouping is here attempted, the acids being simply taken under the head of the principal element of each, *e.g.* sulphuric acid is followed by sulphurous acid, and that by hyposulphurous and hydrosulphuric acids. We remark here, by the way, that the polythionic acids are dismissed with the notice that they must be reserved for a more extensive course of study. A few of the more common organic acids are then referred to, and the whole matter treated of is shown in the condensed form as tables. In these we notice no important alterations from those of the edition of 1871, and of them we can, after considerable experience, speak in the highest terms, students soon learning to use them with great accuracy and despatch.

Mr. Valentin has stated in his preface that he purposely omits considering the rarer elements in his tables. In this we cordially agree with him as regards the tables intended for students, but we cannot help wishing that Mr. Valentin had put in the appendix some analytical information with regard to these bodies in a tabular form; as we feel sure that his great experience in the analysis of every possible kind of body would have enabled him to give valuable information to many who are compelled occasionally to make diligent search for elements which are not always met with. Many old students of the College of Chemistry will recognise an old friend on pp. 50 and 51 in the alternative table for group IIIA., it being no other than the old table used there up to the time of the introduction of the newer methods given at the end of the book.

We notice with pleasure that the analytical tables are published in a separate form, printed on De La Rue's parchment paper; this is certainly very good news for chemical students who have to use them. Who does not know the gradual process of obliteration and destruction by acids and alkalies which gradually, but surely, rendered his most carefully prepared and written analytical tables useless. It would be a great boon to all compelled to use books in the laboratory, if some modification of this material could be used for binding them. In conclusion we can strongly recommend the book to anyone desiring either to get or to give a thorough grounding in analytical chemistry; and the only fault we can find with it is that rather too profuse use is made of symbolical formulæ, for they are scarcely required in a book on analytical subjects only, and the first volume gives quite a sufficient amount of information on their use and nature. We hope that Mr. Valentin will some day give us a quantitative analysis.

R. J. F.

OUR BOOK SHELF

Celestial Objects for Common Telescopes. By the Rev. T. W. Webb, M.A., F.R.A.S. Third edition, revised and enlarged. (London: Longmans, Green, and Co, 1873.)

POSSESSORS of what Mr. Webb calls "common telescopes," will be pleased to have another edition of this most useful adjunct to their instruments, with corrections and additions up to the present time. Now that silvered glass reflectors are so cheap, and apertures little below six inches not uncommon in the hands of amateur astronomers, the author's definition of a common telescope is probably too limited, but these limits are extended as we proceed with the book and find mention of objects barely visible with nine inches. The advice on the use of telescopes, and the mode of observation is sound and good, and too much stress cannot be laid on the necessity of a good solid stand; a good telescope will be absolutely useless with an unsteady mounting. The description of the various phenomena to be viewed in the members of the Solar system may lead possessors of small telescopes to expect too much, the separation of Saturn's rings, the markings on Jupiter's satellites, to wit, although mention is made of the apertures required to view the features mentioned; but this may also make the book useful for work with larger instruments. We must take objection to the great contrast of light and shade, as is often the case in other works, in the cuts of Venus and Jupiter's moons, the dark markings on Venus being infinitely too black, they in reality being only just visible, with first-rate instruments, to a practised astronomer. Drawings of this kind only represent position and shape, but it must be remembered that an amateur expects to see through the telescope exactly what he sees in a drawing. One-third of the book is taken up with a selection of double stars and nebula, as in the former editions, with measures of position and distance up to later dates. Altogether the book will be found most useful to every incipient astronomer, but perhaps there may be too strong a tendency to star-gazing induced by it, and we should have been more gratified to have seen directions to readers having telescopes of certain sizes how to make their observations of real use and not a mere pastime. For instance, double image micrometers can be used on less apertures than 6-in. without clockwork; and some instructions in the use of them, and in reducing their observations so as to show the motions of binaries, would be of great service in teaching amateurs to do useful work; a hint, also, on drawing the ever-changing belts of Jupiter, any extraordinary spots on the sun, the larger nebulæ, and last, not least, the star clusters. As soon as amateurs have seen the planets and a few double stars, they should begin to make themselves useful, otherwise they soon get tired of the mere star-gazing and the telescope becomes to them a thing of the past.

G. M. S.

LETTERS TO THE EDITOR

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

Dr. Sanderson's Experiments and Archebiosis

IN last week's NATURE Dr. Sanderson expresses some surprise that I was gratified by the facts recorded in his previou.

letter. My reasons were these. Dr. Sanderson's experiments in the eight successive cases in which he employed the temperature of 100° C. for twenty minutes were entirely confirmatory of my own, and were, moreover, so conducted as to refute the objections which have been urged by Dr. Wm. Roberts and others.

As to the bearing of Dr. Sanderson's experiments with higher temperatures and more prolonged periods of exposure to heat upon the general question of the independent origin of living matter, I wholly dissent from his now expressed conclusions, for the following reasons :—

In the first place his fluids were not kept sufficiently long before they were submitted to microscopical examination. Dr. Sanderson is quite mistaken in supposing that in examining his liquids within 3-6 days after their preparation he was following my method—more especially in cases such as these where the fluids have been exposed to temperatures higher than usual, or to 100° C. for upwards of twenty minutes. Three to six weeks have often elapsed before I thought it judicious to open my flasks (*See* "Beginnings of Life," vol. i. p. 355, p. 441, and Append. C.). In opening all his flasks at the end of 3-6 days, Dr. Sanderson lost the opportunity of watching the changes which might have ensued later in many of his experimental fluids—and hence lost his right to draw any conclusions from these abortive trials.

Secondly these experiments are open to another objection. Dr. Sanderson concludes from them that exposure to a temperature of 101° C. almost always arrests the tendency to fermentation in his experimental fluids. This conclusion I believe to be erroneous, because in the former series of experiments which I performed in his presence, and of which he recorded the results in your pages (NATURE, vol. vii. p. 180), fermentation occurred in the majority of cases in fluids which I have very good reasons for believing to have been raised to a temperature of 103·33° C.* The method recently employed by Dr. Sanderson for superheating his flasks was needlessly complicated, and the exact temperature to which they had been exposed was known only by inference—never by direct thermometric observation.

Leaving now the discussion of the experimental facts I come to the examination of Dr. Sanderson's inferences, which seem still more open to objection.

Dr. Sanderson, in common with most others, had up to the date of his witnessing my experiments, admitted that Bacteria and their germs were killed in all fluids with which he had experimented at the temperature of 100° C. (see "Thirteenth Report of Medical Officer of Privy Council, 1871.") It was, indeed, this conviction which inspired himself, and many others, with a strong disbelief in the results which I obtained with previously boiled infusions.

What remains, then, for Dr. Sanderson to do, prior to drawing inferences such as he now expresses, is to ascertain, by direct examination, whether the temperature of 100° C. is or is not fatal to the life of Bacteria. It is upon this that the interpretation of my results can alone depend. I have already contributed my share to the inquiry by several long series of experiments, each of which has led me to the same conclusion, viz., that Bacteria and their germs, when in the moist state, are killed at a temperature of 60° C. (See "Beginnings of Life," vol. i. p. 325-333; "Proceedings of Royal Society," No. 143, 1873; and another paper about to appear in the next number of the "Proceedings.") It is for Dr. Sanderson, or any competent observers who are sufficiently interested, to examine my experiments and results on this part of the subject, or else to devise others for themselves having a similar bearing.

If I am right in believing that 60° C. is the thermal death-point of Bacteria in the moist state, the conclusion which must be drawn from the now admitted results occurring in fluids which have been heated to 100° C. suffice for my argument as to the reality of Archebiosis. The further investigation of the results of raising fluids to higher temperatures for protracted periods is of great interest, but does not at all affect the question of the reality of Archebiosis; and Dr. Sanderson's present experiments have, therefore, none of the significance in the argument which he strangely enough appears to claim for them.

Briefly, having admitted that Bacteria arise in fluids which have been submitted to a temperature of 100° C., it is for Dr. Sanderson to show that they are not killed in fluids at 60° C., as I maintain that they are, before he can attempt with any effect to draw inferences of his own, or to criticise those which I have drawn on the subject of the independent origin of living matter.

H. CHARLTON BASTIAN

University College, July 7

* Dr. Sanderson was not aware of this fact, and says he does not know any means by which the temperature of a fluid boiling briskly in a vessel from which the steam escapes only through a capillary orifice, could be accurately estimated. The method which I adopted some months ago seems to possess this merit. I had a small maximum thermometer made for the purpose, 2½ in. in length, and graduated from 95°-115° C. Having straightened the neck of one of my retorts (capable of holding about two fluid ounces), it was filled with some hay infusion and the thermometer was introduced in such a way that its bulb remained in the midst of the fluid, about three quarters of an inch away from the glass. The long neck of the retort having then been drawn out and broken off (so as to leave the usual capillary orifice) the fluid was boiled for five minutes before the vessel was sealed. The thermometer was found to stand at 103·33° C. The retorts employed in my previous experiments with Dr. Sanderson were of the same size, and their contained fluids were boiled under precisely similar conditions. If larger flasks, containing more fluid, were employed the temperature would doubtless rise to a still higher degree owing to a corresponding increase in internal pressure.

Dr. Bastian's Experiments

REGARDING Dr. Bastian's letter in NATURE of June 26, I am happy to be able to make a note of an experiment which is of interest and importance. I sealed a tube on to a flask of about 100 cc. capacity at right angles to the neck, and drew out the end so as to form a capillary orifice. About 30 cc. of water were put into the flask, and a thermometer in an india-rubber cork was wired into the neck. On boiling the water the steam had not issued during more than half-a-minute, before the temperature was 102° C., and in less than ten minutes it had reached 118° C.; fearing the safety of the apparatus, I did not proceed further, nor indeed did I wish to do more. The joint experiments of Drs. Sanderson and Bastian, then newly published in your paper, led me to this. My view being that Pasteur's experiments on milk, mixed with carbonate of lime, and the liquid known as "Pasteur's solution" mixed with carbonate of lime, conclusively show that liquids which ordinarily develop *Bacteria*, will, if they remain neutral after boiling at 100° C. also develop these organisms: raise the temperature to 110° C. and the *Bacteria* no longer show themselves.

Thus believing, I concluded that the absence of *Bacteria* in some of Drs. Sanderson and Bastian's flasks in which were placed neutral or only slightly alkaline infusions, was probably due to the liquids being heated above 100° C., by boiling in vessels with capillary orifices. That my supposition was correct is more than likely; in fact experiments with infusions confirmed it. That an aqueous solution may so easily be raised to 118° C. is a point in chemical manipulation which will be turned to advantage in the laboratory.

King's College, June 30 WALTER NOEL HARTLEY

Temperature and Pressure

THE climate of the island of Jamaica is remarkably uniform, not only at the sea-level, but also at places having the same elevation, so that the connection between temperature and elevation, or barometrical pressure due to that elevation, is easily obtained; and since the surface of the island is broken up by innumerable radiating and intersecting mountain ranges, among or upon which the houses are scattered, this connection becomes one of the most important features in its meteorology; but what renders it especially interesting, however, is the fact that the rate of the decrease of temperature in ascending the hills in this tropical climate is equal to the average rate of decrease found by balloon ascents made in England, as far as the irregularities of the results obtained from those ascents will allow us to judge.

In order to show that this is the case, let t_0 be the temperature at any place where the pressure is p_0, the temperature being expressed in degrees of Fahrenheit's scale, and the pressure in inches of mercury at 32°; let t and p be the corresponding quantities at any other place above the former; then if λ be constant and equal to 3°·23, the equation

$$t_0 - t = \lambda(p_0 - p)$$

will represent the connection between temperature and pressure; or in words, for every inch the barometer may fall, the thermometer will fall 3°·23.

If we take mean annual values, at Kingston $t_0 = 78°·8$, $p_0 = 29·97$in.; and at Newcastle, the garrison of the white troops, $t = 67°·0$, $p = 26·31$in.; so that $\lambda(p_0 - p) = 11°·8$, which is exactly equal to the observed difference of temperature.

Again at Craigton, the residence of his Excellency the

Governor, which is between the two former places with respect to both position and elevation, $t = 70°·5$, $p = 27·41$ in., from observations kindly made for me by Captain Lanyon, A.D.C.; so that the calculated difference of temperature between Kingston and Craigton is 8°·3, the observed difference; and the calculated difference between Craigton and Newcastle is 3°·55, which is only 0°·05 too large. And since the equation has been found to hold good under different circumstances at lower elevation, we may suppose that it is strictly true for Jamaica.

With regard to balloon ascents, I have before me two tables, one compiled by Sir John Herschel, and the other by Prof. Loomis, from more recent observations, and these are brought into the same form in the following table in order to compare them; the first column contains the fall of the barometer in inches, the second contains the corresponding fall of temperature from Herschel's Meteorology, the third from Loomis's Meteorology, and the fourth contains the mean of the numbers in the second and third, which we shall consider to be the average results obtained from balloon ascents.

1	2	3	4	5	6
$p_0 - p$	H	L	$t_0 - t$	Calc.	Diff.
in.	°	°	°	°	°
2	3·0	10·1	6·6	6·3	+ 0·3
4	6·8	17·3	12·1	12·6	− 0·5
6	11·3	23·2	17·3	18·9	− 1·6
8	16·9	29·0	23·0	25·2	− 2·2
10	23·6	34·7	29·2	31·5	− 2·3
12	31·4	40·5	36·0	37·8	− 1·8
14	40·8	46·3	43·6	44·1	− 0·5
16	51·8	51·7	51·8	50·4	+ 1·4
18	63·7	56·1	59·9	56·7	+ 3·2

Now if we take $t_0 - t = (p_0 - p)$, we shall get nine equations of condition for finding λ; the most probable value of this quantity is 3°·15, which hardly differs from the value found in Jamaica. Again, if we calculate $t_0 - t$ and employ this value of λ, we get the fifth column, and it will be noticed that the differences in the last column between the observed and calculated quantities are very small when we consider the great differences between the second and third column.

Therefore the equation $t_0 - t = \lambda\,(p_0 - p)$ holds good for about two-thirds of the whole atmosphere, and if it holds good for the remaining third, by putting $p = 0$, we shall obtain the difference between the temperatures at the lowest and highest strata of the atmosphere; this difference is about 94°, so when the temperature at the surface of the earth is 50°, the temperature at the superior limit of the atmosphere must be −44°.

Since the temperature falls 3°·15 for every inch the barometer may fall, or for every 945 ft. we may ascend (when that temperature is about 50° and the elevation low), the temperature in England will fall 1° for every 300 ft.; this has been always acknowledged, and we now see that it is a consequence of the more general law which connects temperature and pressure throughout the atmosphere.

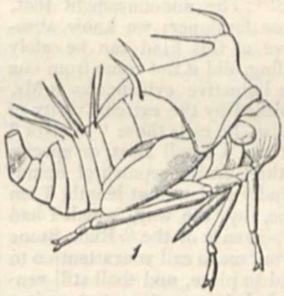
Now though we may suppose that λ has this value for all insular climates, yet it cannot have the same value for continental climates, on account of the higher temperature of the land; but still there is every reason for supposing that, at any given instant of time, λ is constant for all points in the same vertical line; and when it has been determined from the observed temperatures and pressures at any two points in that vertical, our equation becomes especially adapted for the barometrical measurement of the distance between them.

It only remains for me to say that I have already used the equation when making a series of observations among the hills in the north of England, and always found it true when the weather was settled, and sufficient time and care taken in obtaining the mean temperatures of the different strata of air.

Jamaica MAXWELL HALL

Larvæ of Membracis serving as Milk-cattle to a Brazilian Species of Honey-bees

THE connection between the ants and the Aphides has long since been generally known; in the proper season we always find ants very busy on those trees and plants on which the Aphides abound, and if we examine more closely we discover that their object in thus attending upon them is to obtain the saccharine fluid which they secrete from two setiform tubes placed one on each side just above the end of the abdomen, and which may well be denominated their milk (Kirby and Spence, "Introduction to Entomology," 7th edition, p. 335). It has also long been observed and described, that not only do the Aphides yield this repast to the ants, but also the Cocci, and that in the tropical regions of India and Brazil, where no Aphides occur, the ants milk the larvæ of several species of Cercopis and Membracis (Kirby and Spence, p. 336; Westwood, "Modern Classification of Insects," II. p. 434). Recently Prof. F. Delpino, of Vallombrosa, near Florence, observed the same connection



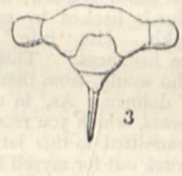


Fig. 1.—Lateral view of larva. Fig. 3.—Front view of head of imago.

between *Formica pubescens* and *Tettigometra virescens* ("Bolletino Entomologico," anno IV. Settembre 1872). But, as far as I know, it has never been observed hitherto that honey-bees also nourish themselves by the secretion of certain hemipterous insects. Hence the following observation, made some months ago by my brother, Fritz Müller (Itajahy, Prov. St. Catherina, Brazil) may be worth publishing.

Among the great number of species of Melipona and Trigona which, in the tropical and subtropical regions of America, as is known, occupy the place of our hive-bee, there is one small species of Trigona which has only once been found by my brother on flowers (of *Sicyos angulata*), and which seems to nourish itself in a very strange manner. He once found a multitude of them spread over the body, already strongly putrifying, of a large toad; the interior of the large open mouth of the toad was filled with these bees, probably sucking the putrid juice of the dead body. On another occasion he saw a great

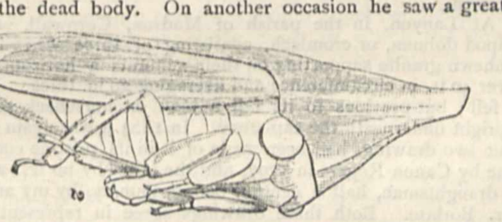


FIG. 2.—Lateral view of imago.

number of the same species of bees in the putrifying intestines of a hen. Repeatedly he saw them sucking the juice flowing out of trees.

In consequence of other observations this same species of Trigona is supposed by my brother to suck the secretion of the larvæ of a certain hemipterous insect belonging to the genus Membracis, or to a closely allied one. As I do not precisely know the name of this supposed milk-cow, I here give the illustration of its larvæ and imago, drawn from specimens sent me by my brother.

He found the pedunculi of the flowers of *Cassia multijuga* pretty frequently occupied by societies of larvæ of this species closely crowded together. Amongst these larvæ there was present a great number of the above-mentioned Trigona, marching all the day long amongst and upon them. When taken between the fingers, the larvæ of Membracis immediately emitted a little drop of a limpid fluid from the upward bent tip of their abdomen—probably a sweet fluid, for the sucking of which the larvæ are visited by the Trigona.

Unfortunately the specimens of this Trigona, enclosed in a letter sent me by brother, arrived here quite broken, so as not to be determinable; but in a future number of this journal I hope to be able accurately to name both the supposed milker and the supposed milk-cow.

Lippstadt HERMANN MÜLLER

Free-Standing Dolmens

MR. LUKIS, in a paper recently read before the Society of Antiquaries, nominally "On certain Erroneous Views respecting the Construction of French Chambered Barrows," but really a method of criticising severely Mr. Fergusson's work on the "Rude Stone Monuments," states that it is an "*error*" to suppose that the Dolmens of that country were ever free-standing; in other words, he lays down the "rule," "there were no free-standing dolmens in France." The announcement that, with regard to monuments of whose fashioners we know absolutely nothing, a universal negative of this kind can be safely laid down as a law, would be startling, did it not come from one who is backed by such extensive inductive evidence as is Mr. Lukis. His "rule" was "established by the extreme rarity of the instances." This being the case, he calls those "in error" who would, from these instances, form a small class, or species of dolmen. As, in an essay on the Cornish sepulchral monuments, which you recently most kindly reviewed at length, I am committed to this latter view—one, by the way, which I had struck out for myself before the appearance of the "Rude Stone Monuments,"—will you kindly permit me to call your attention to one structure which I have ventured to place, and shall still venture to place, in the discarded class? I do so as a protest against the dictum of Mr. Lukis being extended to our British examples, before a careful scrutiny has been made of *every* monument of the kind from one corner of our islands to the other. On this single instance, such as it is, it must be clearly understood that I build no theory; it will be for others to judge whether it does not afford some evidence of the difference in construction and use of the dolmen or table-stone proper, and the kist-vaen cromlech; one thing only I will add, that, limited as my experience is to the monuments of Britain, I shall not be exposed to the temptation of explaining away any observed fact in order to reconcile a doubtful comparison. Without feeling that I am guilty of "dabbling in archæology," or of setting forth "any dogmatic expositions of hypotheses" (!!), or of "establishing my proposition from second-hand information," or in short of being the victim of any very "erroneous view" (all which faults Mr. Lukis finds in those who differ from him), I consider that the following facts justify my statement that the monument I am about to describe always was, as it is now, a free-standing dolmen.

At Lanyon, in the parish of Madron, Cornwall, stands a tripod dolmen, or cromlech, consisting of three slim pillars of unhewn granite supporting on their summits a horizontal stone over 40 ft. in circumference and averaging 20 in. thick. In 1815 it fell; but previous to its fall a man on horseback could sit upright underneath the cap-stone. In 1824 it was again set up; but two drawings had been made of it in its pristine condition, one by Canon Rogers in 1797, and the other by no less accurate a draughtsman, half a century before, namely, by my ancestor, Dr. Borlase. Both these drawings agree in representing the extreme slimness of the pillars; their distance apart; and the great height of the monument; features which render it not unlike a gigantic three-legged milking stool. Then, as now, there was no mound about it, as there is in the case of each and all of the kist-vaen cromlechs. It stood on a low bank of earth, and the area had been often disturbed by treasure seekers. No houses are near it which could have received the stones of a denuded mound. Added to this, it is difficult to see how a kist-vaen, or *septum* of any kind, could have been formed beneath the cap-stone. Had a wall of *small* stones been built up from pillar to pillar the weight of the superincumbent mound must have forced them inwards, a catastrophe which the "dolmen-builders" were always most careful to avoid. Secondly, had *large* stones placed on edge formed the walls of the kist, how is it they are *all* removed, while every other cromlech in the district retains them? But, laying aside this evidence, my strongest proof is yet to come. The interment in this instance was *not in the kist at all*. A grave had received the body six feet under the natural surface of the surrounding soil, and within the area described by the structure. This being the case, of what use could an enclosed kist have been; or why should the cenotaph be covered in at all? Add to this again, that on the southern side of the structure, and so near it that a mound over the monument must inevitably have covered it up, stands a little circular ring cairn of the ordinary type, in the centre of which I found the remains of an inner ring, which, though now rifled, had doubtless contained an interment. Must I then explain away in deference to superior experience or received opinion each and all of the above facts, in order to reconcile this monument with those which seem to be totally different structures, viz., the kist-vaens?* Should I not by so doing be sacrificing a fact to an hypothesis, and is not that hypothesis of such a nature that even a single instance well established must shake it to its foundation? Should I not incur a charge of erroneousness equal to, if not greater, than that which Mr. Lukis brings to bear on all who differ from him?

No one can wish more than I do to see errors expunged, and the truth in these matters arrived at; but I must confess that I cannot see how this will be brought about by confronting one hypothesis with another equally dogmatic, and more universally inclusive. WILLIAM C. BORLASE

Castle Horneck, near Penzance

Fertilisation of the Pansy

I AM glad to be able to confirm, to some extent, from observation, Mr. Bennett's theory of the fertilisation of the Pansy, given in NATURE, vol. viii. p. 49. I watched a considerable number of specimens of *Viola tricolor* on a grassy hill-top where the smaller insects were very numerous and busy, and twice saw them entered by a minute fly. In the first case the insect was dusty with pollen when it arrived. It settled on the lower petal and walked up one of the black lines to the gap in the ring of anthers, through which it entered with some difficulty—leaving some of the foreign pollen on the stigma as it passed. When it came out it had still more pollen on it than when it went in, and again in passing the stigma it left some on it. It paused a moment on the lower petal to clean itself, and left a little ball of pollen on the hairs on one side of the stigma. In the second case, the insect alighted first on one of the upper unmasked petals, turned round and round as though seeking the guiding lines, and flew off to the lower petal, where, without hesitation, it followed the guiding lines as the other had done. After it had passed the stigma there was no pollen visible on its surface; but after it had come out, almost the whole of the lower half was covered. In each case the passage through the ring of anthers seemed rather a struggle. There were many bees about, but I did not see any of them visit the Violæ, although they were almost the only flower near. A. T. MYERS

Penrith, June 30

European Weeds and Insects in America

A CANADIAN friend writes to me:—"I have heard or seen it mentioned as a fact that European weeds and insects introduced into America flourish for a while, but after fifty or sixty years gradually disappear: for instance, that the Hessian fly (so called from having been brought over by the Hessian troops in their hay in the war of independence) has died out or ceased to give trouble, though at one time it totally destroyed the wheat crops of New England. I do not know how far the facts have been tested, or how far they are owing to improved agriculture."

This statement, if true, is obviously of great importance. Can any of your correspondents confirm or disprove it?

JOSEPH JOHN MURPHY

Old Forge, Dunmurry, July 4

CHLOROPHYLL COLOURING-MATTERS †

IT would be impossible for me not to look upon the appearance of such a work as the one recently published by Dr. Gregor Kraus with much satisfaction, since the chief object of the author is to call the attention of his countrymen to the value of the spectrum-microscope in studying the colouring-matters of plants. He commences with a description of the instrument, and says that, though originally designed for the examination of microscopical objects, it is not only as useful as any

* The only other tripod dolmen in Cornwall, viz., that at Caerwynen, is also a free standing one (within the memory of man, at least), whereas the *kist-vaens* are *one and all* partially covered by their envelope.

† "On the Chlorophyll Colouring-Matters." ("Zur Kenntniss der Chlorophyllfarbstoffe und ihrer Verwandten"). By Dr. Gregor Kraus. (Stuttgart, 1872.)

larger spectroscope for the study of the absorption of solutions, but indeed in many cases preferable. He describes two different kinds of eye-piece, viz., a simple form made by Merz, and the far more complete Sorby-Browning, with the method of measurement proposed by Mr. Browning, and expresses his regret that the value of such instruments has been almost altogether overlooked by German botanists. In treating on the application of the apparatus, the author very justly points out the great advantage of having a bright illumination, without too much dispersion, and the importance of being able to examine the spectrum of a leaf or any other object in its natural state, in order to ascertain whether the colouring matters dissolved out from a plant by any solvent do really occur in it, or are products of decomposition. I would also myself add that in some cases the difference between the spectrum of a substance in a free state and when dissolved is so considerable that care must be taken not to conclude that there has been actual decomposition, until the character of the spectrum of the solid substance, in a free state, has been ascertained; and even when the spectra are very nearly the same, the position of the absorption-bands may differ sufficiently to make it possible to determine whether a colouring-matter naturally exists in a free state or dissolved in water, or in an oil, according as it is or is not soluble in water. The fact of being thus dissolved or not is in some cases, probably, a question of considerable physiological importance, since the existence of solid particles along with, or even actually surrounded by, a liquid capable of dissolving them, points to a very different origin and relation to structure to those of a substance merely dissolved in the juices of a plant or an animal. The solution of such a colouring-matter is sometimes one of the first changes that occur in decomposition, as if set free from minute cells.

Having explained the general methods employed, and given a list of the chief publications connected with the subject, the author proceeds to the consideration of various colouring-matters found in plants. If I had written this review immediately after the work was published, I should have expressed my agreement with the greater part of the author's conclusions; for they are those to which a most careful experimenter would be led by employing the methods generally known at that time; but during the last year I have devoted myself exclusively to this particular subject and have been led to employ almost entirely new methods of investigation, and the result is that I must now point out a number of particulars in which I think the author's conclusions are not altogether correct. These new methods consist chiefly in the more or less perfect separation of the different substances by means of bisulphide of carbon, alcohol, and water, used in varying proportions, and in a somewhat peculiar manner; in the employment of what I have named *photo-chemical analysis*, or the use of light as a reagent, so as to destroy some constituents, and leave others, which perhaps could not be separated by chemical methods; and in studying and comparing together all classes of plants, especially the lower cryptogamia, when growing in various conditions; and not only in examining them qualitatively but also in determining the relative amount of the different colouring-matters by a method of comparative quantitative analysis. I will not now enter into detail, but refer to a paper recently communicated to the Royal Society, on comparative vegetable chromatology, in which I have given a complete general description of the methods I have used, of the facts I have observed, and of the conclusions drawn from them, which have a very direct bearing on some of the most important questions in biology, and enable us to examine them from a new point of view.

One great value of the author's work consists in its giving a very complete account of the researches of previous investigators, which I have myself found extremely useful; since so much that has been written is difficult of access. At the same time, since the methods employed were often altogether unsuitable, and most of the experiments are now known to have been made with mixtures, many of the results are of very little more than historical interest. The work also contains three excellent lithographed plates of the spectra of the various colouring-matters in a natural or altered condition. The whole subject is treated in an admirable manner, and I trust that no one will think that I wish in any way to detract from the author's merit in taking this opportunity to illustrate the application of the methods which I think should be employed in such researches.

The coloured solutions obtained from leaves are very complicated mixtures. It is not at all unusual for them to contain as many as ten different coloured substances. The progress of our knowledge has to a great extent depended upon the application of improved methods, which have made it possible to distinguish the various constituents of these mixtures. The author has himself pointed this out, and shown that what was at one time called chlorophyll, and looked upon as a single substance, consists of a mixture of a bluer-green substance with a yellow substance. This kind of analysis had however previously been considerably extended. In a very short paper,* containing no description of the methods of experiment, or of the separate colouring-matters, Stokes said that his researches had led him to conclude that the chlorophyll of land plants is a mixture of four substances, two green and two yellow, and in my late paper I have shown that by the newer and improved methods it is easy to prove that there are not only these two green substances, one a blue-green and the other a yellow-green, having perfectly distinct and characteristic properties, though confounded together by nearly all other experimenters, but also four or even five perfectly distinct yellow substances. These various colouring-matters I have named *blue chlorophyll*, *yellow chlorophyll*, *orange xanthophyll*, *xanthophyll*, *yellow xanthophyll*, *orange lichnoxanthine*, and *lichnoxanthine*. They are all insoluble in water, and soluble in bisulphide of carbon, and besides one or two products of decomposition, they must all have been present in what has sometimes been called chlorophyll, and looked upon as a single compound. Now, almost the only points in which I feel compelled to differ from the author are those cases in which the new methods of examination prove that what he regarded as a single colouring matter is in reality a mixture of two or even more, which can be separated, and do occur separately in particular plants. Thus, for example, in Plate II. Fig. 1, he gives a drawing of the spectrum of the blue-green colouring matter of *Deutzia scabra*, showing six absorption-bands. Now, I feel persuaded that this colouring-matter must have been a mixture of three different substances, viz. my blue chlorophyll, my yellow chlorophyll, and the product of the action of acids on blue chlorophyll. The bands numbered 1, 2, 3, and 6 are mainly due to blue chlorophyll. Part of No. 1 and No. 5 are due to yellow chlorophyll, and the band No. 4 clearly indicates the presence of a small quantity of the product of the action of acids on blue chlorophyll. This is almost always present when the preparation is made in the manner adopted by the author, but by neutralising the acid of the juice by carbonate of ammonia, or still better by employing a plant that has an almost perfectly neutral juice, chlorophyll may be obtained which gives a spectrum almost absolutely free from any such band.

In the spectrum shown by Plate III. Fig. 1 of the blue-green colouring-matter of an *Oscillatoria*, the bands of yellow chlorophyll are absent, for it does not exist in such *Algæ*, but the broad band shown at about 500 of the author's scale, not seen in the spectrum of the chlorophyll of *Deutzia*, must have been mainly due to orange xantho-

* Proceedings of the Royal Society, 1864, xiii. p. 144.

phyll, which occurs in considerable quantity in *Oscillatoriæ*, but is relatively almost absent in green leaves, and would not be separated by the method employed by the author in making the preparation. Comparatively pure blue chlorophyll, prepared from olive *Algæ* by the method described in my late paper, gives a spectrum free from absorption over the whole of the green and a considerable part of the adjoining blue. The close resemblance, and yet decided difference, between the spectra of the blue-green colouring matter obtained from the two above-named sources, did not escape the author's notice, but the methods employed were inadequate to prove that both contained the same principal blue-green substance, mixed in one case with one, and in the other case with another colouring matter. I may here say that the relative amount of blue and yellow chlorophyll differs very much in different classes of plants, and even in the same plant, when in different conditions, and the study of this variation leads to results of great interest in connection with vegetable physiology; since, amongst other things, it proves that leaves normally very yellow are quite unlike those that have turned yellow in autumn, but analogous to those which are abnormally yellow owing to absence of light, as though the deficiency of chlorophyll were in both cases due to weak constructive energy; and the comparative absence of yellow chlorophyll in such abnormally weak plants, belonging to the highest classes, causes their colouring to approximate much more closely to that of those of much lower organisation.

I must say that I object to the term chlorophyll being applied, as by the author, to a mixture of the various yellow substances belonging to the xanthophyll group, with one or both of the above-named green substances, The green colour of leaves is due to them, and they are both actually green, one a blue-green and the other a yellow-green, so that the terms blue chlorophyll and yellow chlorophyll appear to me very appropriate. It would be better and extremely convenient to adopt some such word as *endochrome*, to express any mixture of coloured substances contained in the cells of plants, which has no reference to any particular tint of colour.

The very materially different position of the chief absorption-band of chlorophyll when in the leaves of plants and when in solution has been noticed by the author, and likewise the difference in its position when the chlorophyll is dissolved in different liquids. He attributes this entirely to the difference in the density of the liquid, and concludes that in the leaves the chlorophyll may be combined with or dissolved in some dense substance. The difference in the position of the bands of chlorophyll is very small compared with the difference seen in the case of some other colouring-matters, and by carefully studying the question I have come to the conclusion that the position of the bands does not vary directly with the density of the solvent, or with any other general property, but is so independent that it is desirable to look upon it as a special property, and to call it the *absorption-band-raising* power. The extent to which the bands are raised varies much according to the substance; but, as an apparent rule, if the position is altered, they lie nearer to the blue end when the substance is dissolved than when in a free state. In accordance with this view of the subject, it appears as though in the living plants chlorophyll and various other colouring-matters exist in a free state, not combined with or dissolved in any wax, fat, or oil, with which, however, they often combine when the plant is boiled in water, and with which they are combined when a solution is evaporated to dryness, so that the spectrum of such a dried-up material may, and often does, differ most materially from that of the endochrome in the living plants. As an illustration of the opposite case, I may refer to the spectra of yellow flowers, which often show that the endochrome is combined with, or dissolved in, a fat or oil. When not thus combined, the spectra are so different that the colouring-matter might be, and sometimes has been, looked upon as distinct, before the true cause of the difference was known. The microscope alone could not decide this question, since visible granules might not be the free colouring-matter, and, on the contrary, it might be free, and the particles too small to be separately visible.

H. C. SORBY

(*To be continued.*)

RECENT RESEARCHES ON THE PHYSIOLOGICAL ACTION OF LIGHT

THE arrangements by which the mind is brought into relation with the outer world are—(1) a terminal organ, such as the retina, or the intricate structures of the internal ear, or the touch corpuscles of Wagner, for the reception of impressions from without; (2) a nerve, endowed with a special sensibility peculiar to the sense for the conveyance of influences from the terminal organ to the brain; and (3) a sensorium or brain in which, on receiving these influences, changes occur which give rise to the phenomena of consciousness.

Nerves act, therefore, as conductors from the terminal organs to the brain. These terminal organs are specially fitted for the reception of specific stimuli, such as the vibrations of the ether, which, when received by the retina, induce a change which is transmitted to the brain, and gives rise to the sensation of light, or the condensations and rarefactions of the air which cause sound. But though specially fitted for these stimuli, the terminal organs may be affected in other ways. For example, mechanical pressure on the retina produces a sensation of light, and many diseases affecting the auditory apparatus by compression, cause agonising sensations of sound. The nerves in connection with the sense organs are termed nerves of special sense, because they are supposed only to convey influences which are derived from the special terminal organs with which they are connected. These nerves are, however, themselves not affected only by the special stimulus which affects their respective terminal organ. As is well known, the optic nerve is not affected by light—a fact easily demonstrated by Marriot's experiment showing that the retina at the entrance of the optic nerve is insensible to light.

The nature of the specific change produced on the terminal organs by the action of external stimuli has not hitherto been experimentally examined. Let us take the case of the eye. Numerous hypotheses have been advanced. The action of light on the retina has been conjectured to be a mere communication of vibrations, an intermittent motion of portions of the optic nerve, an electrical effect, a heating effect, or a photographic effect like that produced by light on a sensitive surface, but up to this time there has been no experimental evidence in support of either of these views.

The result of investigations made by Mr. Dewar and Dr. McKendrick, of Edinburgh, communicated to the Royal Society of Edinburgh, has been to show that the specific effect of light on the retina and optic nerve is a change in the electro-motive force of these organs. They have been able to demonstrate this by the following arrangements:—The eye of a frog rapidly killed by pithing is dissected out of the orbit, so as to leave the sclerotic entirely free from muscle, and a portion of optic nerve intact. This preparation is placed on the cushions of the well-known arrangement of Du Bois-Raymond for collecting electric currents from animal structures, consisting of two zinc troughs, carefully amalgamated on the inner surface, and containing pads of Swedish filter-paper moistened with a solution of pure neutral sulphate of zinc. To protect the eye from the irritating action of the sulphate of zinc, thin films of sculptors' clay, mixed with a weak solution of chloride of sodium, each worked out to a point, are placed on the pads of filter paper. From each of the troughs a wire passes to a key so as to enable the experimenter to stop the current at pleasure, and from thence the current passes to the galvanometer. They then lay the eye on a glass support between the cushions, and carefully adjust the clay-points so that the one touches the cornea and the other the transverse section of the optic nerve, or the one may touch the surface of the nerve and the other its transverse section. On opening the key, a deflection of the galvanometer needle is at once obtained to the extent of about 600° of the galvanometer scale, placed at a distance from the mirror of the galvanometer of about 26 inches. This deflection is a measure of the natural electro-motive force of the eye. The troughs are now covered over with an apparatus consisting of a double shell made of glass, and containing between the walls one inch of water so as to absorb all heat rays, and lastly a wooden box is placed over the whole, having a draw-shutter so as to enable the experimenter to admit light at pleasure. A gas flame is placed before the shutter. The arrangement is now complete. After observing that the deflection indicating the electro-motive force in the dark is constant, the shutter is now withdrawn so as to admit light. At that instant, that is, on the impact of light, a change is perceived in the electro-motive force. There is at first an increase, then a diminution, and on the removal of light there is another increase of the electro-motive force. Occasionally, in consequence of the dying of the nerve, there is only a slight increase, then a diminution, but the rise on the removal of light is always constant. The amount of change in the electro-motive force by the action of light is about 3 per cent. of the total. There has been no difficulty in demonstrating the effect in the eyes of the following animals, after removal from the body: *Reptiles*, Snake; *Amphibia*, Frog, Toad, Newt; *Fishes*, Gold Fish, Stickleback, Rockling; *Crustacea*, Crab, Swimming Crab, Spider Crab, Lobster, Hermit Crab. The greatest effect was observed in the case of the lobster, in the eye of which Messrs. Dewar and McKendrick found a modification in the electro-motive force by the action of light to the extent of about ten per cent. With the eyes of birds and mammals they had great difficulty. It is well known that in these animals the great source of nervous power is an abundant supply of healthy blood. Without this, nervous action is soon arrested. This law, of course, holds good for the retina and optic nerve. When, therefore, they removed the eyeball with nerve attached, from the orbit of a cat or rabbit recently killed, and placed it in connection with the clay points, they found a large deflection which quickly diminished, but all sensitiveness to light disappeared within one or two minutes after the eye had been removed from the animal. This fact of itself shows that what has been observed is a change depending on the vital sensibility of the parts. It was therefore necessary to perform the experiment on the living animal under chloroform. By so fixing the head that it could not move, and by removing the outer wall of the orbit so as to permit the clay points to be applied to the cornea and nerve, the same results have been obtained in the case of the cat, rabbit, pigeon, and owl.

Without going into minute detail, which the space allowed for this short article will not admit of, the results of this inquiry have been as follows:—

1. That the specific effect of light on the eye is to change the electro-motive force of the retina and optic nerve.

2. That this last applies to both the simple and to the compound eye.

3. That the change is not at all proportional to the amount of light in lights of different intensities, but to the logarithm of the quotient, thus agreeing with the psycho-physical law of Fechner.

4. That those rays, such as the yellow, which appear to our consciousness to be the most luminous, affect the electro-motive force most, and that those, such as the violet, which are least luminous, affect it least.

5. That this change is essentially dependent on the retina, because if this structure is removed, while the other structure of the eye lives, though there is still an electro-motive force, there is no sensitiveness to light.

6. That this change may be followed into the optic lobes.

7. That the so-called psycho-physical law of Fechner does not depend on consciousness or perception in the brain, but is really dependent on the anatomical structure and physiological properties of the terminal organ itself, inasmuch as the same results as to the effect of light are obtained by the action of the retina and nerve without the presence of brain.

The method of investigation pursued by Messrs. McKendrick and Dewar is applicable to the other senses, and opens up a new field of physiological research. The specific action of sound, of the contact of substances with the terminal organs of taste, and of smell, may all be examined in the same manner; and we are in hopes of soon seeing results from such investigations.

ON THE FERTILISATION OF FLOWERS BY INSECTS AND ON THE RECIPROCAL ADAPTATIONS OF BOTH

II.

In what manner the hive- and humble-bees obtain the honey of the flowers

IN the last number the use the bee makes of its complex sucking machinery, when emptying the deepest honey-tubes or spurs accessible to it, was stated in detail; we have now to show the different movements and positions the separate parts of the mouth undergo, when the bee is obtaining honey less deeply placed, or when it is about to collect the pollen of flowers, or when it folds together the whole sucking apparatus into the cavity of the head in order to employ its jaws or to rest.

(2) In order to obtain the honey out of tubes or spurs of less depth the bee need not turn the cardines forward; these remain at rest in their backward position, the tongue remains consequently embraced by the maxillæ and labial palpi, and only the base of the tongue is alternately protruded and withdrawn, by which motion the terminal whorls of hairs are alternately immersed into the honey and withdrawn into the sucking-pipe.

(3) While the bee, in order to suck honey, flies from flower to flower, it carries its sucking apparatus stretched forward so as to be able to put it directly into the opening of the honey-tube, but its tongue is perfectly enclosed between the labial palpi and the maxillæ; the delicate whorls of hairs are protected by that from any injury they might receive, when introduced into the flowers, and the terminal joints of the labial palpi are not prevented from serving as feelers. Consequently during the flying from flower to flower the base of the tongue is folded into the extremity of the tubular mentum, the cardines are turned backwards, whilst the lora can be directed downwards (Fig. 4), forwards (Fig. 2) or backwards, in proportion as the bee is about to obtain the honey from shorter or longer tubes.

(4) The parts of the mouth must be held in the very same position when the bee wishes to pierce tender cellular textures by means of the tips of its maxillæ. It executes this sort of process, sometimes in order to obtain the fluids of juicy flowers which do not secrete nectar, as for instance *Hyacinthus orientalis*, *Orchis mascula*, *morio* and *latifolia*, sometimes in order to break open honey-tubes which are too deep to be emptied by the bee in the

regular way. Thus, for instance, *Bombus terrestris*, having of all our humble-bees the shortest tongue, forcibly opens the honey-tubes of *Aquilegia*, *Trifolium pratense*, *Pedicularis sylvatica*, and many other flowers; sometimes by piercing the corolla by the tips of its maxillæ, sometimes by biting through the corolla by means of its jaws, and then steals the honey by guiding its proboscis into the honey-tube through the self-made opening.

(5) When collecting the pollen of flowers the hive- and humble-bees moisten, as is well known, the pollen with honey before stripping it off with the brushes of their feet from the anthers and amassing it on the outside of the posterior tibiæ. During this process the maxillæ and the labium are commonly bent beneath the breast, as in

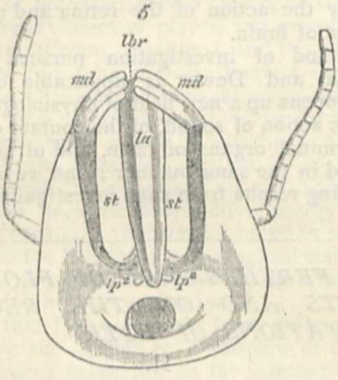


FIG. 5.—The sucking apparatus of a humble-bee (*Bombus hortorum*, L. ♀) placed in the hollow underside of the head, seen from beneath (7 : 1).

inaction, almost as shown in Figs. 5 and 6, the jaws are opened, the labrum is raised, the opening of the mouth is brought near the pollen to be collected, and a drop of honey is spit out upon this pollen; often also the bee before moistening the pollen with honey frees it while still enclosed in the anthers by chewing the anthers with its jaws.

In quite a different manner I saw the hive-bee proceed when collecting the loose, dry pollen of *Plantago lanceolata*, so easily shaken out. By vehement movements of its wings the bee maintains itself, steadily humming, at the same place in the air, close before the anthers, the pollen which it is about to collect; in this position it has its sucking-apparatus stretched forward, but the tongue quite enclosed between the laminæ and labial palpi, and spits out of the sucking-pipe formed by these parts a drop of honey upon the anthers. Then it grasps very hastily, with the brushes of its anterior legs, amongst

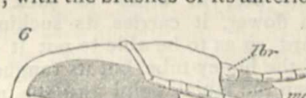


FIG. 6.—Lateral view of the same head.

the anthers, and strips off the moistened pollen from them, while the dry pollen of the neighbouring anthers also shaken out, is disseminated, forming a little cloud of dust. Consequently, also in this case the bee carries the base of its tongue folded into the mentum, and the cardines turned backward, precisely in the same manner as when flying from flower to flower, or when piercing honey-tubes by the tips of the laminæ.

Plantago lanceolata and other plants with equally loose, dry pollen, scattered by the wind, are honeyless; on the other hand the pollen of all honey-flowers is collected by the hive- and humble-bees when holding their sucking organs retracted, whilst the honey of these flowers is obtained by their sucking-organs stretched forward; hence it follows that hive-bees, humble-bees, and all the bees which are in the habit of moistening the pollen before collecting it, can never suck honey and collect pollen at the same time, but are obliged to perform alternately these two actions after having commenced with sucking honey, of which they are in need for moistening the pollen to be collected, whereas all the bees which collect the pollen without moistening it, as, for instance, the Andrena, Osmia, and Megachile, are often observed sucking honey and collecting pollen at the same time.

(6) When the bee is about to employ its jaws, or when it wishes to rest, it rests the whole sucking apparatus in the hollow in the under-side of the head, by

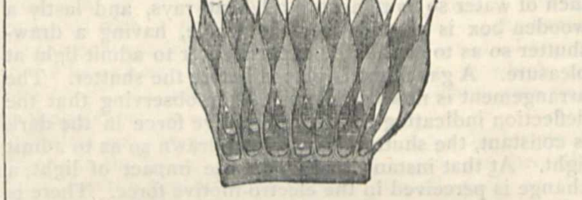


FIG. 7.—Two whorls of scales of the terminal portion of the tongue of a blue Brazilian Euglossa (or Chrysantheda); the scales of each whorl alternating with those of the following one (80 : 1).

effecting all the four foldings above described, and bends beneath the breast those parts which do not find any room in this excavation, viz., the tongue, and the labial palpi and laminæ enclosing it, as shown in Figs. 5 and 6.

Everyone who has observed in nature the activity of the hive- and humble-bees will be surprised by the ease with which the numerous movements just described are effected by them. Nevertheless, when sucking honey out of tubes or spurs, they experience a sensible loss of time by so repeatedly protruding and retracting the tongue. This loss of time seems to be avoided by a very singular contrivance lately discovered in some Brazilian bees by my brother, Fritz Müller. In these bees all the rings of the terminal portion of the tongue, from the tip to the sheath, formed by the labial palpi and laminæ, are provided, as shown in Fig. 7, with whorls of narrow-stalked, broad scales instead of hairs, and these scales, lying closely upon one another, form together a tube around the prominent

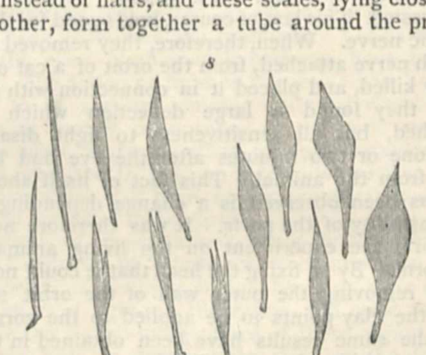


FIG. 8.—Gradations between hairs and scales.

portion of the tongue which probably enables the bee to suck the honey out of the longest flower-tubes accessible to it without needing to retract the tongue.

The first scale-bearing rings within the sheath of the tongue, offering numerous gradations by which hairs and scales graduate into each other, as shown in Fig. 8, indicate precisely the degrees of variability by which natural selection arrived at the broad narrow-stalked scales clothing the prominent portion of the tongue.

HERMANN MÜLLER

ON THE ORIGIN AND METAMORPHOSES OF INSECTS *

VIII.

FOR the next descending stage we must, I think, look among the Infusoria, through some such genus as Chætonotus or Ichthydium. Other forms of the Rotatoria, such for instance as Rattulus, and still more the very remarkable form discovered last year by Mr. Hudson,† and described under the name of *Pedalion mira*,

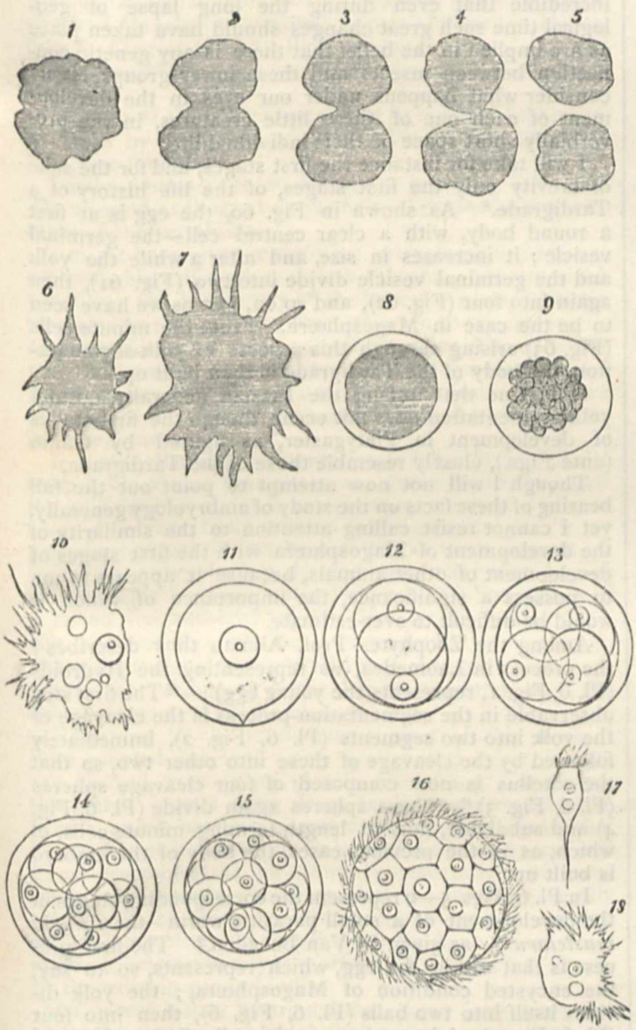


PLATE 5.

Plate 5.—Figs. 1–5, Protamœba. 6–9, Protamyxa Aurantiaca. Haeckel Beit. zur. Monog. der Moneren, Pl. 1. 10–18, Magosphœra planula Haeckel lc., P.l. 5.

seem to lead to the Crustacea through the Nauplius form. Dr. Cobbold tells me that he regards the Gordii as the lowest of the Scolecida; Mr. E. Ray Lankester considers some of the Turbellaria, such genera for instance as Mesostomum, Vortex, &c., to be the lowest of existing worms; that is to say, if we exclude the parasitic groups. Haeckel ‡ also regards the Turbellaria as forming the nearest approach to the Infusoria. The true worms seem, however, to constitute a separate branch of the animal kingdom.

We may take the genus Prorhynchus,§ for instance, as an illustration of such a low type (Fig. 59), which consists of a hollow cylindrical body $1\frac{1}{2}$ to 2″′ long, containing a straight simple tube, the digestive organ.

But however simple such creatures as these may be, there are others which are far less complex, far less differentiated; which therefore on Mr. Darwin's principles may be considered still more closely to represent the primæval ancestor from which these more highly developed types have been derived, and which, in spite of their great antiquity, in spite of, or perhaps in consequence of their simplicity, still maintain themselves almost unaltered.

Thus the form which Haeckel has described * under the name of *Protamœba primitiva*, Pl. 5, Fig. 1—5, consists of an entirely homogeneous and structureless substance, which continually alters its form; putting out, and drawing in again, more or less elongated processes, and creeping about like a true Amœba, from which, however, Protamœba differs in the absence of a nucleus. It seems impossible to imagine anything simpler; indeed, as described, it appears to be an illustration of properties without structure. It takes into itself any suitable particle with which it comes in contact, absorbs that which is nutritious, and rejects the rest. From time to time a constriction appears at the centre (Pl. 5, Fig. 2), the form approximates more and more to that of an hour-glass (Pl. 5, Fig. 3), and at length the two halves separate, and each commences an independent existence (Pl. 5, Fig. 5).

In the true Amœbas, on the contrary, we find a differentiation between the exterior and the interior: the body being more or less distinctly divisible into an outer layer and an inner parenchym. In the Amœbas, as in Protamœba, multiplication takes place by self-division, and nothing corresponding to sexual reproduction has yet been discovered.

Somewhat more advanced, but yet of great simplicity, is the *Protomyxa aurantiaca*, discovered by Haeckel† on dead shells of Spirula, where it appears as a minute orange speck, which shows well against the clear white of the Spirula. Examined with a microscope the speck is seen to be a spherical mass of orange-coloured, homogeneous, albuminous, matter, surrounded by a delicate, structureless, membrane (Pl. 5, Fig. 8). It is obvious from this description that these bodies closely resemble eggs, for which indeed Haeckel at first mistook them. Gradually however the yellow sphere broke itself up into smaller spherules (Pl. 5, Fig. 9), after which the containing membrane burst, and the separate spherules, losing their globular form, crept out as small Amœbæ (Pl. 5, Fig. 6), or amœboid bodies. These little bodies moved about, assimilated the minute particles of organic matter, with which they came in contact, and gradually increased in size (Pl. 5, Fig. 7) with more or less rapidity according to the amount of nourishment they were able to obtain. They threw out arms in various directions, and if divided each section maintained its individual existence. After a while their movements ceased, they contracted into a ball, and again secreted round themselves a clear structureless envelope.

This completes their life-history as observed by Haeckel, who found it easy to retain them in his glasses in perfect health, and who watched them closely. It also coincides very closely with that of the Gregarinæ, another group of singularly egg-like organisms.

As another illustration I may take the *Magosphœra planula*, discovered by Haeckel on the coast of Norway.

In one stage of its existence (Pl. 5, Fig. 10) it is a minute mass of gelatinous matter, which continually alters its form, moves about, feeds, and in fact behaves altogether like the Amœba just described. It does not however remain always in this condition. After a while it contracts into a spherical form (Pl. 5, Fig. 11), and secretes round itself a structureless envelope, which, with the nucleus, gives it a very close resemblance to a minute egg.

* Continued from p. 167.
† "On a New Rotifer." *Monthly Microscopical Journal*, Sept. 1871.
‡ Generale Morphologie. V. ii, p. lxxix
§ Gegenbaur. Grund. d. Vergleich. Anat. p. 210. See also Beitrage Zur Naturg. der. Turbellarien. Dr. M. S. Schultze, 1851. Pl. vi, fig. 1.

* Monographie der Moneren, p. 43.
† Monographie der Moneren, p. 10.

Gradually the nucleus divides itself, and the protoplasm also separates into two spherules (Pl. 5, Fig. 12); these two subdivide into four (Pl. 5, Fig. 13), and so on (Pl. 5, Fig. 14), until at length thirty-two are present, compressed into a more or less polygonal form (Pl. 5, Fig. 15). Here this process ends. The separate spherules now begin to lose their smooth outline, to throw out processes, and to show amœboid movements like those of the creatures just described. The processes or pseudopods grow gradually longer, thinner, and more pointed. Their movements become more active, until at length they take the form of ciliæ. The spherical Magosphœra, the upper surface of which has thus become covered with ciliæ, now begins to rotate within the cyst or envelope, which at length gives way and sets free the contained sphere, which then swims about freely in the water (Pl. 5, Fig. 16), thus closely resembling Synura, or one of the Volvocineæ. After swimming about in this condition for a certain time the sphere breaks up into the separate cells of which it is composed (Pl. 5, Fig. 17). As long as the individual cells had remained together they had undergone no changes of form, but they now show considerable contractility, and gradually alter their form, until they become undistinguishable from true Amœbæ (Pl. 5, Fig. 18). Finally, according to Haeckel, these amœboid bodies, after living for a certain time in this condition, return to a state of rest, again contract into a spherical form, and secrete round themselves a structureless envelope.

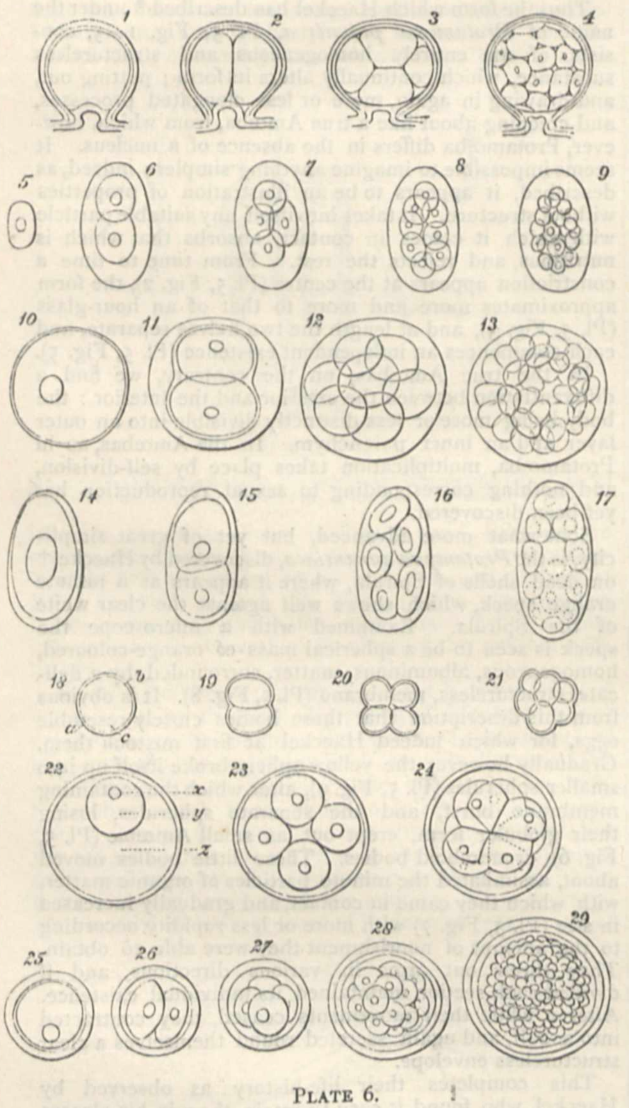


PLATE 6.

Plate 6.—Figs. 1—4, Yolk-segmentation in Laomedea; 5—9, in Filaria; 10—13, in Echinus; 14—17, in Lacinularia; 18—21, in Purpura; 22—24, Amphioxus; 25—29, Vertebrata.

It may be said, and said truly, that the difference between such beings as these and the Campodea, or Tardigrade, is immense. But if it be considered incredible that even during the long lapse of geological time such great changes should have taken place as are implied in the belief that there is any genetic connection between insects and these lower groups, let us consider what happens under our eyes in the development of each one of these little creatures, in the proverbially short space of their individual life.

I will take for instance the first stages, and for the sake of brevity only the first stages, of the life history of a Tardigrade.* As shown in Fig. 60, the egg is at first a round body, with a clear central cell—the germinal vesicle; it increases in size, and after a while the yolk and the germinal vesicle divide into two (Fig. 61), then again into four (Fig. 62), and so on, just as we have seen to be the case in Magosphœra. From the minute cells (Fig. 63) arising through this process of yolk-segmentation, the body of the Tardigrade is then built up.

It is true that among the Insecta generally, normal yolk-segmentation does not occur, though the first stages of development in Platygaster, as figured by Ganin (ante Figs.), closely resemble those of the Tardigrada.

Though I will not now attempt to point out the full bearing of these facts on the study of embryology generally, yet I cannot resist calling attention to the similarity of the development of Magosphœra with the first stages of development of other animals, because it appears to me to possess a significance, the importance of which it would be difficult to over-estimate.

Among the Zoophytes Prof. Allman thus describes† the process in Laomedea, as representing the Hydroids (Pl. 6, Fig. 1, represents the young egg):—"The first step observable in the segmentation-process is the cleavage of the yolk into two segments (Pl. 6, Fig. 2), immediately followed by the cleavage of these into other two, so that the vitellus is now composed of four cleavage spheres (Pl. 6, Fig. 3)." These spheres again divide (Pl. 6, Fig. 4) and subdivide, thus at length forming minute cells, of which, as in the previous cases, the body of the embryo is built up.

In Pl. 6, Figs. 5—9 represent the corresponding stages in the development of a small parasitic worm—the *Filaria mustelarum*—as given by Van Beneden.‡ The first process is that within the egg, which represents, so to say, the encysted condition of Magosphœra,; the yolk divides itself into two balls (Pl. 6, Fig. 6), then into four (Pl. 6, Fig. 7), eight, and so on, the cells thus constituted finally forming the young worm. I have myself observed the same stages in the eggs of the very remarkable and abnormal *Sphærularia bombi*.§

Among the Echinoderms M. Derbès thus describes the first stages (Pl. 6, Figs. 10—13) in the development of the egg of an Echinus (*Echinus esculentus*):—"Le jaune, commence à se segmenter, d'abord en deux, puis en quatre et ainsi de suite, chacune des nouvelles cellules se partageant à son tour en deux."‖ Sars has observed the same thing in the starfish.¶

* See, for instance, Kauffmann, Uber die Entwickelung und systematische stellung der Tardigraden. Zeits. f. Wiss. Zool. 1851, p. 220.

† Monograph of the Gymnoblastic or Tubularian Hydroids, by G. J. Allman. Ray. Soc. 1871, p. 86.

‡ V. Beneden, Mem. sur les Vers Intestinaux, 1858.

§ Natural History Review, 1861, p. 44.

‖ Derbès, Ann. des Sci. Nat. 1847, p. 90.

¶ Fauna Littoralis Norvegiæ, pl. viii.

In the Rotatoria, as shown by Huxley in Lacinularia,* and by Williamson in Melicerta,† the yolk is at first a single globular mass, the first changes which take place in it being as follows :—"The central nucleus becomes drawn out and subdivides into two, this division being followed by a corresponding segmentation of the yolk. The same process is repeated again and again, until at length the entire yolk is converted into a mass of minute cells." Among the Crustacea the total segmentation of the yolk occcurs among the Copepoda, the Rhizocephala, and Cirripedia. Sars has described the same process in one of the nudibranchiate mollusca ‡ (Tritonia), Muller in Entochocha,§ Haeckel in Ascidia,|| Lacaze Duthiers in Dentalium.¶ Figures 18 to 21, Pl. 6, are taken from Koren and Danielssen's ** memoir on the development of *Purpura lapillus*.

Figs. 22-24 show the same stages in a fish (Amphioxus) as given by Haeckel, and it is unnecessary to point out the great similarity.

Lastly, figures 25 to 29, Pl. 6, are given by Dr. Allen Thomson,†† as illustrating the first stages in the development of the vertebrata.

I might have given many other examples, but the above are probably sufficient, and show that the processes which constitute the life-history of the lowest organised beings, very closely resemble the first stages in the development of more advanced groups ; that, as Allen Thomson has truly observed,‡‡ "the occurrence of segmentation and the regularity of its phenomena are so constant that we may regard it as one of the best established series of facts in organic nature."

It is true that yolk segmentation is not universal in the animal kingdom ; that there are great groups in which the yolk does not divide in this manner,—perhaps owing to some difference in its relation to the germinal vesicle, or perhaps because it has become one of these suppressed stages in embryological development, many instances of which might be given, not only in zoology, but, as I may state on the authority of Dr. Hooker, in botany also. But however this may be, it is surely not uninteresting, nor without significance, to find that changes which constitute the life-history of the lowest creatures, form the initial stages even of the highest.

Returning to the immediate subject of this work, I have pointed out that many beetles and other insects are derived from larvæ closely resembling Campodea, that other insects come from larvæ more or less like Lindia, and it has been shown over and over again that in many circumstances the embryo of the more specialised forms resembles the full-grown representatives of lower types. I conclude, therefore, that the Insecta generally are descended from ancestors resembling the existing genus Campodea, and that these again have arisen from others belonging to a type represented more or less closely by the existing genus Lindia.

Of course it may be argued that these facts have not really the significance which they seem to me to possess. It may be said that when Divine power created insects, they were created with these remarkable developmental processes. By such arguments the conclusions of geologists were long disputed. When God made the rocks, it was tersely said, he made the fossils in them. No one, I suppose, would now be found to maintain such a theory, and I believe the time will come when it will be generally admitted that the structure of the egg, and its developmental changes, teach us as truly the course of organic development in ancient times, as the contents of rocks teach us the past history of the earth itself.

JOHN LUBBOCK

* Trans. of the Microsc. Soc. of London, 1851.
† Quarterly Journal of Microsc. Science, 1853.
‡ Wiegmann's Archiv., 1840, p 196.
§ Ueber die Erzeugung von Schnecken in Holothurier. Berlin, Bericht, 1851. Ann. Nat. Hist, 1852, v. ix. Muller's Archiv., 1852.
|| Ann. des Sci Nat. 1853, p. 89
¶ Ann. des Sci. Nat, 1857, pl. vi.
** Naturliche, Schöpfungsgeschichte, pl. x.
†† Cyclopædia of Anatomy and Physiology. Art. Ovum, p. 4.
‡‡ Thomson, l.c. Article, Ovum p. 139.

NOTES

SIR CHARLES WHEATSTONE has been elected a Foreign Associate of the French Academy of Sciences in place of the late Baron Liebig.

MR. COLE'S retirement from public service is now completed, and the Treasury have awarded him the full pension usually granted to officers who have completed fifty years of public service. Although Mr. Cole quits the South Kensington Museum, he will continue to assist in promoting the diffusion of Science and Art applied to productive industry as the Acting Commissioner for the estate purchased out of the surplus funds of the Exhibition of 1851. This estate at present comprehends the Horticultural Gardens, the buildings of the Annual International Exhibitions, and the Royal Albert Hall. Measures are in progress for forthwith commencing the National Training School for Music. A meeting of those interested in the Testimonial which it is proposed to present to Mr. Cole, will be held in Willis's Rooms to-morrow at 3 o'clock. Those who know best how much Mr. Cole has done for the encouragement and advance of Science, will, we are sure, be the most ready to take part in this well-deserved testimony to the value of his services to the public.

AFTER the alarming rumours that have recently found their way into the newspapers, it is a great relief to receive what appears to be really authentic news of the safety of Sir Samuel and Lady Baker. It appears, from the message received by the *Daily Telegraph*, that they arrived at Khartoum on the 29th of June. It is stated that the party had been as far south as a place called Mosindi, near the chief village of Kamrasi, the King of Unyoro, which would be in about 1°·45′ N. lat., and about 80 miles to the east of the shores of the Albert Nyanza. Here Sir Samuel is said to have been attacked by a chief named Kabriki, and, on his retreat, by a party of slave-hunters. He seems to have established another Egyptian station at a place called Fatiko, somewhere to the south of Gondokoro. The story about the Albert Nyanza and Lake Tanganyika being one, which forms part of the news published by the *Daily Telegraph*, is certainly very startling news, and must at present be received with great caution, though the *Telegraph* correspondent declares he received it direct from the lips of the Emancipator of Central Africa himself.

MR. AUBERON HERBERT'S Select Committee on the Wild Birds Protection Act has met three times, and examined a good many witnesses. It would not be fair to take the report, published in the *Field*, of what passed at those meetings as strictly correct, but if it be at all true, the doubt, before expressed in these pages (NATURE, May 1, 1873), as to any real good resulting from the inquiry, can hardly be otherwise than justified. The questions put by the chairman indicate, as far as we perceive, that he has a very hazy idea of the bearings of the whole subject, and no one of the other members appears to have sufficient knowledge of any part of it to follow home by cross-examination any of the evidence offered in reply. By many of the witnesses birds are regarded as divisible into two groups—the useful and the noxious—a simple classification which will be amusing to naturalists. Such witnesses also think that the destruction of the latter should be encouraged and the former protected—being quite innocent of the fact that no laws in the world will make most "useful" birds more numerous than they already are. It seems to us that the only way in which an inquiry of this kind could be satisfactorily conducted would be by a Royal Commission, in which the scientific element, so unhappily lacking in a Parliamentary Committee, should be adequately represented. The birds which suffer a perfectly preventible persecution to such an extent that their extermination may shortly be expected, appear to be thought hardly worthy of the Committee's consideration, though it was to save them that the British Association's efforts were chiefly directed.

THE Highland and Agricultural Society of Scotland have taken a praiseworthy step in memorialising Government to do what is undoubtedly their duty to the country, appoint a Commission of competent scientific men to inquire into the causes of the ever-recurring potato-disease, a disease which is a national calamity. How far advanced is the American Government in matters concerning the national welfare is well shown by the memorialists, and even Portugal is far enough ahead of us to appoint a Government Commission to inquire into the vine-disease.

THE Executive Committee of the Fund for erecting a memorial to the late John Stuart Mill have resolved that a portion of the funds raised be devoted to erecting a bronze statue of Mr. Mill in some public situation in the City of Westminster, which he for a time represented in Parliament, the remainder to the foundation of Scholarships, open to the competition of candidates of both sexes, in Mental Science and Political Economy; subscribers to the fund being invited to say to which of these purposes they wish their subscriptions to be devoted.

THE Council of University College, London, has determined to throw open to women next session another of its ordinary classes, that of jurisprudence, conducted by Prof. Sheldon Amos.

WE are glad to see from a circular which has been sent us, and which we would recommend to the attention of all teachers, and to all interested in science-teaching in schools, that the Charterhouse School of Science has met with signal success during the past, its first, session. There is an excellent staff of scientific lecturers, which we are glad to see is to be increased, the training is thorough and practical, and a large and well-fitted chemical laboratory, besides other scientific apparatus, is to be added to the School. The School is in connection with the Science and Art Department, and we hope that during next session, which commences on September 20, the attendance will be as satisfactory as during the past. Attached to the circular is a form to be filled up by intending students, and accompanying it is a well-drawn up time-table. The fees are remarkably low.

AT a meeting of the Council of the Royal School of Mines, held on Saturday, July 5, the following gentlemen received the diploma of Associate of the Royal School of Mines:—Mining and metallurgical division—E. Jackson, J. A. Griffiths, C. Law. Mining division—A. G. Phillips. Metallurgical division—J. W. Westmorland, S. W. Davies, J. C. Jefferson, H. S. Bell. Geological division—G. Smith. The following Scholarships and Prizes were also awarded:—The two Royal Scholarships of 15*l*. each, for first year's students, to Mr. H. Carter and Mr. A. J. Meeze. To second year's students: H.R.H. the Duke of Cornwall's scholarship of 30*l*. for two years, to Mr. C. Lloyd Morgan, and the Royal Scholarship of 25*l*. to Mr. S. A. Hill. The Edward Forbes' medal and prize of books, for Natural History, to Mr. G. Smith. The De la Beche medal and prize of books, for mining, to Mr. Edgar Jackson. The Murchison medal and prize of books, for geology, to Mr. C. Lloyd Morgan.

SIGNOR AUGUSTO RIGHI, Demonstrator of Physics in the University of Bologna, has just published an elaborate memoir "On the Composition of Vibratory Motions" (*Tipi Gamberini e Parmeggiani, Bologna*). The memoir is of a high order, and is worthy the attention of all physicists specially interested in acoustics. The subject is mathematically treated, and is illustrated by twenty-one admirable plates.

MR. W. CARRUTHERS has just issued his official Report for 1872, of the Department of Botany in the British Museum. The additions to the Herbarium during the year are spoken of as large and important, rendering more and more pressing the necessity of increasing accommodation for the arranged Herbaria. The species included under several of the natural orders, both in the General and in the British Herbarium, have been entirely re-arranged during the year; and much use has been made of the Herbarium by botanists preparing monographs for a number of different publications. Numerous interesting additions have also been made to the Structural Series, both in the Fruit, the Fossil, and the General Collection.

WE have received "Lecture Extra, No. 8" of the *New York Tribune*, containing twelve lectures by Prof. Louis Agassiz, on various important subjects connected with animal life; besides a lecture on "Vestiges of Antiquity," by Dr. A. Le Plongeon, "The Art of Dyeing," by Prof. Chandler, a long article on the Fossil Man of Mentone, and a detailed account of Prof. Marsh's discoveries in the Rocky Mountains. All these lectures and articles are copiously illustrated and well printed, and the whole is a marvellous pennyworth. The *Tribune* deserves the greatest praise for the important part allotted to science in its programme.

IN the just published number of the *Journal of Anatomy and Physiology* there is a valuable paper by Prof. Rutherford, of King's College, on the cause of the retardation of the pulse which follows closure of the nostrils in the rabbit, in which he shows that this retardation is not the direct effect of reflex action, as previously supposed, but is due to the arrest of respiration which necessarily attends the blockage in the air-passage; for the retardation does not commence directly the nostrils are closed, but is delayed for about four seconds, and if the trachea is kept open it does not occur at all. Ammonia applied to the nose produces similar effect, because the animal ceases to breathe for a time, as it closes the nostrils in order to prevent the entrance of the irritating fumes. Prof. Rutherford finds that after the vagi have been divided, the arrest of respiration does not cause the pulse to become slower, which is in favour of the supposition that the retardation which normally occurs is produced by the action of the impure blood on the cardio-inhibitory centres in the medulla oblongata.

THE *Journal of Botany* records the death of two British botanists of reputation, Mr. James Ward, of Richmond, Yorkshire, one of the most active and experienced botanists of the North of England, and Mr. James Irvine, of Chelsea, who wrote a "London Flora" in 1838, and was one of the editors of the old *Phytologist*.

A FLORA of Cheshire is shortly to appear under the superintendence of the Hon. J. L. Warren.

WE have to record the following earthquakes this week:—THE Imperial Meteorological Observatory of Constantinople reports that on June 20 there were several smart shocks of earthquake at Bagdad at night, and again on the 21st at noon. A strong shock of earthquake was felt at Alpago, Italy on July 3. A volcanic eruption, accompanied by discharges of hot cinders, is stated to have commenced at Farra. The waters of the Lake Santa Croce, a few miles south-east of Belluno, were boiling. Three shocks of earthquake were felt at Buffalo, U.S., on the morning of July 6, causing the buildings and shipping to rock.

THE Synopsis of Laboratory Work in Practical Organic Chemistry at the Teachers' Training Class at South Kensington for July, contains seventy practical problems in chemistry, with directions for their solution.

A GREAT International Exhibition is to be held at Philadelphia in 1876.

IN the *Weekly Salt Lake Tribune* of June 7, a lecture is reported on the Sandwich Islands by Dr. Winslow, who resided there for several years. The light in which he represents the natives of Hawaii to regard the death of Captain Cook will be new to many of our readers. "The natives were astonished and distressed at their own barbarity, and they treated the remains of Cook as they did those of their highest chiefs and as if he had been a god. They dissected the big bones from his legs and arms, as a mark of the highest honour they could confer on their own beloved dead. They exposed the rest of his remains before their great idol in the temple, and sacrificed hogs and dogs to his memory and to appease the gods for his and their own sins. His entrails had been placed carefully in a calabash and left aside, in order for burning in some subsequent ceremony, when a boy (an intelligent old man of some 75 or 80 years in 1845, with whom the Doctor had conversed), supposing them to be the entrails of a hog, cut off a piece and roasted it on coals and ate it. When the officers of the ships, in their subsequent intercourse with the natives to recover the remains of Captain Cook, earned that nothing was left of them but the big bones, which were delivered up to them, they fancied his flesh had been devoured by the savages, and a howl went up from the British public and the Christian world that the newly-discovered Hawaiians were natives and cannibals. Such was not the case at first, and has never been the case. Their first experience with a Christian people was a bitter one, and the cup for them has been bitter from that time to this. The facts attending Captain Cook's death, and the treatment of his remains, the Doctor received from the mouth of an honest old native named Keha, on the island of Maui, a clear-minded man, and one of the hereditary historians of the Kings or Chiefs. The natives always regretted Cook's death."

THE German Arctic Navigation Society of Hamburg city has received a telegram from Tromsöe, dated July 6, according to which eighteen Norwegians who had passed the winter in Spitzbergen, have been found dead by the society's schooner *Tromsöe*, Captain Mack. They have been buried by the latter's direction.

THE latest novelty in literature is a farthing daily paper, in the shape of *The Penny-a-Week County Daily Newspaper*, a single copy of which may be had for a farthing, but which, by a little arrangement, will be supplied to any subscriber for a penny a week. It is intended as an organ for sowing broadcast the principles of the Conservative party, who, if they really have the welfare of their country at heart, ought to make use of this splendid opportunity for elevating the classes whom they want to influence, by serving up a daily modicum of useful knowledge methodically arranged,—*i.e.* Science.

WE have received from A. Ernst his careful paper on the Meteorology of the Carácas, based on three years' observations by Señor Agustin Aveledo.

THE "Transactions of the Royal Society of Arts and Sciences of Mauritius" for 1871, which has just reached us, shows that that body is in excellent working order, and is quite alive to the interests of Science in that hybrid colony, especially in the department of Natural History. The curious mixture of French and English in the volume is significant of the history of the island and the mixed nationality of the colonists. The longest, and one of the most valuable and interesting papers in the volume, is Colonel Pike's account (in English) of a visit he paid to the Seychelle Islands, containing important details on the natural history of this remote and little-known group. The Society has been the means of successfully introducing into the Mauritius the cultivation of the silkworm, and an association has been formed for the manufacture of textile fabrics from native plants, especially from the *Agave*.

THE "Fourth Annual Report of the State Board of Health of Massachusetts," deserves the attention of all who are interested in the public welfare so far as sanitary matters are concerned. Detailed reports on all subjects connected with public health are given, and some humiliating and curious revelations made as to adulteration of food and drink, which seems to be nearly as universal in Massachusetts as in our own enlightened and very moral country; as is also ignorance of the use and preparation of food. Reports such as these show how lamentable and wide-spread is ignorance of the science of living, and with what a host of adverse influences in the way of adulteration, bad drainage, and such like, civilised man is surrounded.

WE have received Memoirs, by Prof. Asa Gray, of the late Mr. John Torrey and Mr. W. S. Sullivant, written for the American Academy of Arts and Sciences.

PART I. of vol. ix. of "The Journal of the Royal Agricultural Society of England and Wales," contains many statistics and papers of great value connected with the subject of Agriculture. Besides a variety of statistics as to grain, Cattle, Sheep, Pigs, Dairy Produce, Prices, &c., the Journal contains the following papers: On the Characters of Pure and Mixed Linseed-Cakes, by Dr. Augustus Voelcker, F.R.S.; Report of the Judges on the Trials of Portable Steam-Engines at Cardiff; Report of Experiments on the Growth of Barley for Twenty Years in succession on the same Land, by J. B. Lawes, F.R.S., and J. H. Gilbert, F.R.S.; Record of Rainfall at Rothamsted (parish of Harpenden) and Harpenden Village, near St. Alban's, Herts, in 1872 and the 19 preceding years; Report on the Trade in Animals, and its Influence on the spread of Foot-and-Mouth and other Contagious or Infectious Diseases which affect the Live Stock of the Farm, by H. M. Jenkins, F.G.S., Secretary of the Royal Agricultural Society; Further Report by the Judges on the Competition for Prizes for Plans of Labourers' Cottages in connection with the Cardiff Meeting, 1872; The Potato Disease, by William Carruthers, F.R.S., Consulting Botanist to the Society; On Dodder, by W. Carruthers, F.R.S.; Annual Report of the Consulting Chemist for 1871; Quarterly Report of the Chemical Committee, December, 1872; Quarterly Report of the Principal of the Royal Veterinary College.

THE death of Mr. J. A. Gordon, Superintendent of the Crystal Palace Gardens, is announced. Mr. Gordon was in part trained under Sir Joseph Paxton, and was well known as a contributor to the *Gardener's Magazine*.

MR. J. L. HADDEN, C.E., superintended the electric light arrangements on the occasion of the late *fêtes* at Constantinople for the Sultan's accession. The next morning on awaking he found himself quite blind. The medical men had hopes of his restoration to sight.

THE additions to the Zoological Society's Gardens during the past week include a Rock-hopper Penguin (*Eudyptes chrysocoma*), from the Falkland Islands, presented by Mr. J. M. Dean; a tuberculated Lizard (*Iguana tuberculata*), from the West Indies, presented by Mr. J. B. Spence; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*), from Australia, presented by Mr. R. Dean; four black-necked Swans (*Cygnus nigricollis*) hatched in the Gardens; a Beaver (*Castor canadensis*), born in the Gardens; two crimson-faced Waxbills (*Pytelia melba*), from Africa; a Tawny Eagle (*Aquila naevioides*), purchased; a black-tailed Antelope (*Nanotragus nigricaudatus*), an Ariel Toucan (*Ramphastos ariel*), and a West India Rail (*Aramides Cayennensis*), deposited.

ON THE GERM THEORY OF PUTREFACTION AND OTHER FERMENTATIVE CHANGES.*

AFTER some introductory remarks referring to the various other theories which had been entertained on this subject, viz., the oxygen theory, the theory of spontaneous generation, and that of chemical ferments, the author stated that the researches of Pasteur had long since made him a convert to the germ theory, which attributes the alteration experienced by exposed organic substances to the development within them of minute organisms springing, like larger living beings, from parents like themselves; and that this belief had been since continually strengthened by the results of the antiseptic system of treatment in surgery, which he had founded on that theory as a basis.

But his attention had been afresh directed to the subject about a year and a half ago by a remarkable paper by Dr. Burdon-Sanderson,† in which experiments were recorded, leading to the conclusion that Bacteria, unlike the spores of fungi, are deprived of vitality by mere desiccation at a moderate temperature, so that while a drop of water from ordinary sources or the contact of a moist surface is sure to lead to Bacteric development and consequent putrefaction in an organic substance susceptible of that change, the access of dust from exposure to the atmosphere induces merely the growth of fungi and comparatively insignificant chemical alteration.

If this were true it would be needless to provide an antiseptic atmosphere in carrying out the antiseptic system of treatment; and all that would be requisite in the performance of a surgical operation would be to have the skin of the part about to be operated on treated once for all with an efficient antiseptic, while the hands of the surgeon and his assistants and also the instruments were similarly purified; a dressing being afterwards used to guard against the subsequent access of septic material. Thus the use of the spray might be dispensed with, and no one would rejoice more than himself in getting rid of that complication.

Such being the practical importance of the conclusion referred to, he determined to subject it to a searching experimental test.

The material first employed was urine, not boiled, as it had commonly been in previous investigations, but obtained, by a very simple antiseptic process, perfectly uncontaminated in its natural condition, in which it proved a far more favourable nidus for the development of organisms than in the boiled state, as indeed might have been anticipated, since it contains unaltered the complicated organic substance termed the mucus, which has been sometimes regarded as a chemical ferment of urine. Nevertheless, when a wine-glass, together with a small porcelain evaporating dish, to serve as a cover, had been heated, like the vessels used by Dr. Sanderson, far above the boiling-point of water, and allowed to cool (a process conveniently designated by the term "heated"), and afterwards charged with the unboiled urine, and placed under a glass shade as an additional protection against dust, it was found that the fluid remained free from organic development or putrefactive change for months, till at last it dried up into a saline mass. On the other hand, if a glass so charged was exposed to the air by removing the shade and cover for a while, organisms appeared in it of various kinds, and among the rest, in several instances, Bacteria. Thus it was shown on the one hand that Bacteria might arise from atmospheric exposure, and on the other hand that a porcelain cover and glass shade afforded absolute security against the introduction of organisms from without. If, therefore, the exposure of such a glass for a limited period chanced to lead to the introduction of any one organism unmixed with others, the opportunity was afforded of studying the behaviour of that organism, either in the same medium for a protracted period or in other media in similar glasses, inoculated by means of a heated pipette or glass rod. For it was found as a matter of experience that exposure for the few seconds or fractions of a second necessary for performing the inoculation or withdrawing a little fluid for examination did not involve any considerable risk of accidental contamination.

Early in the investigation it was ascertained that the putrefaction of urine might take place without the occurrence of Bacteria, in presence of minute granules in irregular groups, in such numbers as to make the liquid milky; their organic nature being clearly proved by fissiparous generation observed to take place in them, though in a different manner from that which is seen in Bacteria. To this form of organism the name "Granuligera" has been provisionally applied.

In one of the experiments related, two drops of water from the tap having been added to a glass of Pasteur's solution, the result was not in the first instance the general opalescence due to Bacteria in a liquid, but a deposit which proved to be a minute filamentous fungus producing abundant spores (conidia) on its branches. These spores after separation often produced young plants like their parents; but there were also seen in abundance precisely similar spores multiplying by pullulation like a Torula (to retain the old use of the name as applicable to organisms like the yeast plant).* And there were also present multitudes of more slender filaments which were seen to break up into Bacteria, while in several instances these filaments were observed springing from spores undistinguishable from those of the fungus.

The view that some filamentous fungi may give origin to both toruloid and Bacteric forms was soon afterwards confirmed by another experiment. † A "heated" wine-glass was taken into the open air during a drizzling rain, and the cover being lifted, some rain-drops were allowed to fall into it, after which uncontaminated urine was introduced. The result was the production of a pullulating delicate Torula, totally different from the yeast plant; forming a granular deposit on the sides of the glass, and an abundant scum, both in the urine and also in Pasteur's solution on repeated inoculations. Portions of both liquids containing this organism having been set aside under circumstances permitting only very slow evaporation, they were examined again eight months later, when a delicate filamentous fungus was found in both, bearing conidia resembling the cells of the Torula, while similar spores were seen multiplying by pullulation, and some of the buds were in a slender form undistinguishable in character from the Bacteria which in the case of the urine were observed swimming in the liquid.

An organism which in the first instance was observed for weeks together growing as a mere Torula having thus, as it appeared, developed into a filamentous fungus, after remaining for months in the same solution, hopes were excited that a corresponding observation might be made with regard to the yeast-plant, and this led to a careful examination of a low white mould, referable to the genus Oidium, which was observed in a glass of Pasteur's solution to which yeast had been added several weeks previously. The hope was disappointed, but some interesting facts were elicited: for the fungus was found to vary remarkably according to the quality of the medium in which it grew, having sometimes the aspect of an Oidium with fructifying filaments, sometimes a purely filamentous structure, sometimes a loosely-jointed growth producing abundant oval spores destitute of nuclei, and often pullulating like a Torula, and lastly a purely toruloid form of an entirely different aspect, composed of spherical nucleated cells, occurring in urine, and operating as a powerful putrefactive ferment upon that fluid. Yet totally dissimilar as the different forms of this fungus might appear, their identity was demonstrated by observing with the microscope the actual growth of one from another when transferred to a new medium on a slide of thick glass excavated round a central island, so as to provide a sufficient supply of oxygen to last the growing fungus for a long period. The slide and its thin covering glass were heated between metallic plates to diffuse the heat and prevent cracking of the glass, so arranged as to guard against the entrance of dust during cooling, and all instruments, such as forceps and needles, employed in the subsequent manipulations, were "heated" before being used, the thin covering glass being luted down with melted paraffin applied with a hot steel pen. "Glass gardens" of this construction stocked with various organisms in various media proved extremely useful means of investigation. Samples of the organism introduced were sketched with camera lucida immediately after introduction, and their subsequent development observed with perfect precision. In this way, in the case of the Oidium, spherical nucleated cells of

* Abstract of a communication made to the Royal Society of Edinburgh, April 7, 1873, by Prof. Joseph Lister, F.R.S.

† See 13th Report of the Medical Officer of the Privy Council.

* The toruloid pullulation of spores of some minute filamentous fungi had been previously observed by De Bary. *See* "Morphologie und Physiologie der Pilze," &c., von. Dr. A. de Bary, p 183.

† This view has been expressed by various other authors, but has been hitherto incapable of demonstration in consequence of the uncertainty whether things which seem to grow from one organism may not be merely the result of the accidental presence of others.

the toruloid form of the organism were observed to sprout into beautiful filamentous fungi, and these again, as the fluid became vitiated by the growing fungus, were found to reproduce as conidia the spherical toruloid cells.

Among other media inoculated with this Oidium was a solution of albumen obtained by treating a fresh-laid egg with a solution of carbolic acid, to destroy any organisms adhering to the shell, and then breaking it with carbolised fingers into a "heated" vessel containing water that had been boiled and allowed to cool protected from dust, the solution being afterwards cleared by passing it through a boiled filter in a "heated" funnel with "heated" cover. This fluid had remained during the half-year which had since elapsed, free from putrefaction or any other change, except where organisms had been introduced, although the air had free access to it;* a fact which indicates pretty clearly that the putrefaction of eggs, which has been regarded as a stumbling-block in the way of the germ theory, must somehow or other be brought about by the penetration of ferments through the shell and membrane. This, indeed, becomes intelligible enough if we admit that Bacteria may be formed from fungi, and remember how the filaments of some parasitic fungi perforate the epidermis of leaves.† In a glass of this albuminous fluid the Oidium grew very slowly and feebly, but its development was accompanied by a remarkable alteration in the liquid, which, in the course of six weeks, changed from the colourless purity of spring water to the dark brown, almost black, appearance of porter. Yet the dark brown liquid remained perfectly free from smell, proving, what the author had long suspected as the result of experience in antiseptic surgery, that an albuminous fluid may undergo fermentation with odourless products.

Another experiment given in full detail was performed with milk upon the same principle as those with urine and albumen, in the hope of removing another stumbling-block in the path of the germ theory. For, according to the high authority of Pasteur, milk forms an exception to organic liquids in general, in the circumstance that a greater elevation of temperature than the boiling-point of water is required to kill Bacteria contained in it.‡ But the advocates of the theory of spontaneous generation reply that any Bacteria present would be certainly killed by boiling, and therefore the subsequent appearance of living Bacteria in the boiled milk in Pasteur's experiments is proof of their spontaneous evolution from the chemical constituents of the liquid. If, however, by the use of antiseptic means, milk could be obtained uncontaminated from the cow, there being no organisms to kill, boiling might be dispensed with, and the milk, like the unboiled urine, should remain free from organic development or fermentative change, if kept protected in "heated" vessels. Accordingly, five flasks with glass caps, and six test-tubes with wider test-tubes to cover them, having been heated, and allowed to cool under glass shades in the stable where the experiment was performed, the udder and adjacent skin of a cow were well washed with a strong watery solution of carbolic acid, which was also applied with a small syringe to the outlets of the milk ducts, the teat being held in the finger and thumb to prevent the entrance of the solution into the udder, and a milkman with his sleeves tucked up, and his hands and arms washed with the antiseptic lotion, was directed to milk into the glasses as their covers were successively raised. The cow did not give milk at all freely, and a considerable time was occupied in charging the flasks, but the small quantity required for each test-tube was got by a single squirt from the teat, with almost momentary exposure. Yet not only in all the flasks but in all but one of the test-tubes organisms made their appearance. In one of the test-tubes, however, the unboiled milk had hitherto (for a quarter of a year) remained entirely unaltered. One such success was as clear evidence against the hypothesis of spontaneous evolution of organisms as if all the glasses had remained free from them, and their occurrence in the other ten proved a most fortunate circumstance. For no two of them were alike in the organisms they contained, and in several instances there was apparently only some one species unmixed with others, so that the opportunity was afforded of studying various different organisms as modified by other media, and as regards any fermentative influence which they might exert upon those media. Among the organisms in the milk glasses were Bacteria of different species, to judge from their size and other appearances, as well as numerous kinds of fungi; and when they were introduced into a series of glasses of the albuminous liquid before described, it was found that while some of the fungi grew in it others refused to do so, and while Bacteria obtained by adding a drop of water to urine throve in the albuminous fluid, not one of four inoculations of Bacteria from four milk glasses was followed by any result. Thus was afforded, it is believed, for the first time, distinct physiological proof of real differences among Bacteria. But what was still more unexpected was the fact that when the inoculation was practised in a series of glasses of urine, two of the Bacteria refused to grow even in that liquid, which had been previously regarded as a peculiarly favourable nidus for Bacteric development. This fact, besides serving still more clearly to differentiate the various species of Bacteria, suggested a possible explanation of the failure of experiments with milk in the hands of others. For if organisms thrive in milk which cannot grow in urine at all, milk must be a more difficult fluid to work with in experiments which aim at excluding organic development. Hence it seemed worth while to try again the effect of boiling milk, but in doing so to adopt more rigorous precautions against the entrance of organic germs. There could be little doubt that the organisms which appeared in the various milk glasses of the experiment above related entered during the cooling, which though it took place just as in the successful experiments with urine, led to failure in the case of the milk, partly from the favourable nature of that liquid for organic development, and partly no doubt from the atmosphere of the stable being much more loaded with organic germs than that of the author's study. The new precautions adopted were in the main these. The small wine glasses (liqueur glasses) into which the fluid was to be decanted were covered, together with their glass caps, while still very hot, with cotton wool secured by fine iron wire tied tightly round below the cap, so as effectually to filter the air that entered during cooling; after which the cotton was carefully removed and the glass placed under a small glass shade on a separate piece of plate glass. For heating the flask in which the milk was to be boiled a very high temperature was requisite to ensure destruction of all life in the considerable volume of air which it contained; and this was arranged for by binding asbestos with wire round the junction of the neck of the flask and the glass cap, and then roasting the flask over a large Bunsen's burner. The asbestos, which proved as good a filter as cotton wool, was removed after cooling, and the cap being lifted, a long "heated" funnel was passed quickly into the flask and the milk poured in through it after wrapping a piece of carbolised rag round the funnel and neck of the flask to exclude septic dust: scrupulous care being taken to avoid touching the neck of the flask with the moist end of the funnel as it was withdrawn. By this means security was obtained against the presence of any living organism inside the flask except in the fluid at the bottom of the vessel. The cap was then re-applied and carbolised cotton wool tied over it to filter regurgitant air during the boiling. The necessity for the air-filter was made very manifest during ebullition from the great tendency of milk to froth, involving the necessity of frequently removing the flame, fresh air entering on every such occasion: another peculiarity of milk which served further to explain the failure of previous experiments. But the efficiency of the means employed was shown by the appearance of the flask as exhibited to the Society. For although seven weeks had passed since it was filled, the milk was seen to be perfectly fluid and with no appearance of alteration.

All trouble occasioned by frothing, involving constant watching to prevent the froth from wetting the cotton, was afterwards avoided by acting on the suggestion of Mr. Godlee, of University College, London, who happened to be assisting the author at the time, and immersing the flask in boiling water above the level of the liquid, instead of applying the flame directly. This method had the further advantage of avoiding any risk of "burning" the milk, and also any loss by evaporation. A second flask "heated" and charged with milk like the other and similarly covered with cotton wool, was kept in this way at 212° F. for an hour, and, after cooling, its contents were decanted off into twelve "heated" liqueur glasses, and in these it had remained during the seven weeks that had since passed perfectly free from change except when organisms had been intentionally introduced. To illustrate this the author drank, before the Society, the contents of one of the uninoculated glasses, which proved perfectly sweet and good.

It was a curious circumstance that on the morning following

* Dr. Burdon-Sanderson had previously preserved unboiled white of egg unchanged for six months in a "heated" tube containing air, hermetically sealed.

† See De Bary, op. cit., page 216.

‡ See Annales de Chimie et de Physique, 1862, p. 60.

the night on which the liqueur glasses were thus charged with boiled milk, the author received from Dr. Roberts, of Manchester, a copy of his paper describing how he had got over all the difficulties, as regards milk, by a different and very simple method.* But beautiful as Dr. Roberts's method was, and perfectly conclusive against the theory of spontaneous evolution, it would not have answered the author's purpose, as it was essential for his investigations that the liquid should be decanted from the flask into the liqueur-glasses. The decanting was effected by means of a "heated" syphon, with special precautions against the entrance of living organisms, as was fully explained to the Society.

The same plan of "heating" the vessels and decanting was afterwards followed with turnip infusion and with urine; and in proof of the security of the method, flasks containing the residual stock of these fluids after decanting into twelve glasses from each nearly six weeks before, were shown to the Society quite unchanged. And as further evidence of the trustworthiness of the system pursued, it was mentioned that out of six series of wine-glasses with about twelve in each series, containing albuminous fluid, urine (in two series), Pasteur's solution, boiled milk and turnip infusion, although portions of the contents had been often removed for investigation or inoculation, only two instances were known to have occurred in which any organism (a filamentous fungus) had made its appearance which had not been arranged for either by inoculation or prolonged exposure.

(*To be continued.*)

SCIENTIFIC SERIALS

Ocean Highways for July is a very interesting number. The first article, on the "Voyage of the *Polaris*," accompanied by six small maps, shows that notwithstanding the disastrous results of Captain Hall's venture, it proves more strongly than ever that a well-equipped Arctic expedition, taking the route of Smith's Sound, would be attended with results of the highest value. "In the present day," the writer concludes, "when the true methods of exploring are well known, and men of science have clearly enumerated the important problems that will be solved, and the numerous valuable results that will be derived fron the labours of an Arctic Expedition, the reasons for despatching one have acquired tenfold force." This is followed by a long and extremely valuable and interesting account of "Personal Experiences of Venomous Reptiles and Insects in South America," by Mr. Richard Spruce, who has spent fifteen years in Equatorial Africa for the purpose of investigating the natural history of that region. The author's account of his experiences gives a vivid idea of the many dangers and trials to which devotees of science are exposed, in their endeavours to add to the sum of human knowledge. We would strongly recommend Mr. Spruce's interesting article to all who take an interest in the subject, on which, our readers may remember, there was recently some correspondence in NATURE. H. H. Giglioli contributes two very valuable letters from Dr Beccari on his explorations in Papuasia, which are likely to be attended with very important results. Other papers in this number are "On Settlements on the Gold Coast," with a map; a paper on Khiva, by Rev. G. P. Badger, consisting of a catena of extracts from several eminent Arabic writers; the "Footpaths of London," a sort of popular geological lecture, by Mr. H. P. Malet; and the second part of Prof. H. Mohn's article on the Meteorological Institute of Norway.

Bulletin de la Société de Geographie, May. The first article in this journal is by M. Charles Maunoir, on the work of the French Geographical Society, and the Progress of the Geographical Sciences during the year 1872.—Mr. W. Huber contributes an interesting paper on the telegraphic network of the globe, with a map showing at a glance how much has already been done in this way to annihilate distance, and how much remains to be done to complete this important work.—This is followed by the conclusion of M. Balansa's paper on New Caledonia, the present instalment treating specially of the Loyalty Islands.—M. Edouard Sayons gives an abstract of the contents of M. Hunfalvy's very interesting work on the Finnish Provinces of the Baltic; the work is published in Hungarian, and is an account of the author's explorations in the districts mentioned in the year 1870.

* See NATURE, Feb. 20, 1873.

SOCIETIES AND ACADEMIES

Royal Society, June 19.—"On a newly discovered extinct Mammal from Patagonia (*Homalodotherium Cunninghami*)," by William Henry Flower, F.R.S., Hunterian Professor of Comparative Anatomy, and Conservator of the Museum of the Royal College of Surgeons.

The author describes the complete adult dentition of a new genus of Mammal, founded on remains discovered by Dr. Robert O. Cunningham in deposits of uncertain age, on the banks of the River Gallejos, South Patagonia. The animal appears to have possessed the complete typical number of teeth, *i.e.* twenty-two above and below, arranged in an unbroken series, and of nearly even height, and presenting a remarkable gradual transition in characters in both jaws, from the first incisor to the last molar. The molars more clearly resemble those of the genus *Rhinoceros* than any other known mammal; and, judging by the general characters of the teeth alone, the animal would appear to have been a very generalised type of Perissodactyle Ungulate, allied through *Hyracodon* (a North-American Miocene form) to *Rhinoceros*, also more remotely to *Macrauchenia*, and, though still more remotely, to the aberrant *Nesodon* and *Toxodon*. The generic name *Homalodotherium* was suggested for this form by Prof. Huxley in his Presidential Address to the Geological Society in 1870.

"The Diurnal Variations of the Wind and Barometric Pressure at Bombay," by F. Chambers. Communicated by Charles Chambers, F.R.S., Director of the Colaba Observatory, Bombay.

The object of this paper is to bring to notice a remarkable relation that has been found to exist between the diurnal variations of the wind and the barometer at Bombay.

The observations made use of are the records of a Robinson's anemograph during the first three years of its performance, viz. from June 1867 to May 1870, and the corresponding hourly observations of the barometer and the dry- and wet-bulb thermometer, made at the Government Observatory, Bombay.

The mean results for each hour of the day during the whole period, and the mean diurnal relations of each element are tabulated and graphically represented by figures. The diurnal variation of the wind is then investigated, the most influential part of which is attributed to the land- and sea-breezes which blow from E.S.E. and W.N.W., and are shown to follow mainly the same law of progression as the temperature of the air, thus affording confirmatory evidence of the truth of Hadley's theory of the trade-winds as applied to land- and sea-breezes.

Some peculiarities of the curve representing the land- and sea-breezes are then pointed out, and these the writer concludes are due to the superposition of another distinct variation having two maxima and two minima in the twenty-four hours like the barometer variation; and he supports his views by a reference to the variation of the east components of the wind in the months of July and August, when the land- and sea-breezes have almost disappeared. This is found to exhibit a decided *double* period. The north components of the land- and sea-breezes are then approximately eliminated from the north components of the whole variation, and the variation which then remains exhibits a very decided *double* period in this direction also. These variations with double periods are regarded as indicative of the existence of a double diurnal variation in the general movements of the atmosphere. Upon this hypothesis typical diurnal variations of the wind are deduced for north and south low latitudes; that for north latitudes exhibiting a double diurnal right-handed rotation, and that for south latitudes a double diurnal left-handed rotation, and from these the diurnal variation of the barometer is deduced.

The movements of the wind-vane at Bombay are then analysed, and the writer concludes that the greater part of the excess of "direct" over "retrograde" rotation of the vane at Bombay is due to the *diurnal variation* of the wind.

Extracts are given from observations made at St. Helena, Toronto, and Falmouth, showing the character of the diurnal wind-variations at those places, and their greater or less agreement with the deduced typical curves. The writer maintains that these variations afford independently a possible, if not a probable explanation of that movement of the air which Dové had called the "Law of Gyration;" and in conclusion he points to the extent of their applicability in deducing weather probabilities, and to the method of discussing storms.

A postscript is added, giving the mean diurnal variation of the wind at Sandwick Manse, Orkney, and pointing out its general conformity with the results deduced from the Bombay wind-observations.

"On the Mathematical Expression of Observations of Complex Periodical Phenomena, and on Planetary Influence on the Earth's Magnetism," by Charles Chambers, F.R.S. and F. Chambers.

"Observations of the Currents and Undercurrents of the Dardanelles and Bosphorus, made by Commander J. L. Wharton, of H.M. Surveying Ship *Shearwater*, between the months of June and October, 1872." From a Report of that Officer to the Hydrographer of the Admiralty. Communicated by Admiral Richards, C.B., V.P.R.S.

Geological Society, June 25.—Joseph Prestwich, F.R.S., vice-president, in the chair. The following communications were read:—"On six Lake-basins in Argyllshire," by his Grace the Duke of Argyll, F.R.S., president. The author referred to the part ascribed to glacial action in the formation of lake-basins, and described the basins of six lakes in Argyllshire, the characters presented by which seemed to him inconsistent with their having been excavated by ice. Among these lakes were Loch Fyne, Loch Awe, Loch Leckan, and the Dhu Loch.—"Description of the Skull of a dentigerous Bird (*Odontoperyx toliapicus*, Owen), from the London clay of Sheppey," by Prof. Richard Owen, F.R.S. The specimen described by the author consisted of the brain-case, with the basal portion of both jaws. The author described in detail the structure and relations of the various bones composing this skull, which is rendered especially remarkable by the denticulation of the alveolar margins of the jaws, to which its generic appellation refers. The denticulations, which are intrinsic parts of the bone bearing them, are of two sizes—the smaller ones about half a line in length, the larger ones from two to three lines. The latter are separated by several of the smaller denticles. All the denticles are of a triangular or compressed conical form, the larger ones resembling laniaries. Sections of the denticles show under the microscope the unmistakable characters of avian bone. The length of the skull behind the fronto-nasal suture is 2 inches 5 lines; and from the proportions of the fragment of the upper mandible preserved, the author concluded that the total length of the perfect skull could not be less than between 5 and 6 inches. The fossil seems to approach most nearly to the Anatidæ, in the near allies of which, the Goosanders and Mergansers, the beak is furnished with strong pointed denticulations. In these, however, the tooth-like processes belong to the horny bill only, and the author stated that the production of the alveolar margin into bony teeth is peculiar, so far as he knows, to *Odontopteryx*. He concluded, from the consideration of all its characters, "that *Odontopteryx* was a warm-blooded, feathered biped, with wings; and further, that it was web-footed and a fish-eater, and that in the catching of its slippery prey it was assisted by this pterosauroid armature of its jaws." In conclusion, the author indicated the characters separating *Odontopteryx* from the Cretaceous fossil skull lately described by Prof. O. C. Marsh, and which he affirms to have small, similar teeth implanted in distinct sockets.—"Contribution to the Anatomy of *Hypsilophodon Foxii*, an Account of recently acquired Remains of this Dinosaur," by J. W. Hulke, F.R.S. The author communicated details of its dentition, the form of its mandible, and that of the cones of the shoulder and fore limb, and of the haunch and hind limb, hitherto imperfectly or quite unknown. The resemblance to *Iguanodon* is greater than had been supposed, but the generic distinctness of *Hypsilophodon* holds good.—"On the Glacial Phenomena of the 'Long Island,' or Outer Hebrides," I., by James Geikie, F.R.S.E., of H.M. Geological Survey of Scotland. The author commenced by describing the physical features of Lewis, which he stated to be broken and mountainous in the south, whilst the north might be described as a great peat moss rising gradually to a height of about 400 ft., but with the rock breaking through here and there, and sometimes reaching a higher elevation. The north-east and north-west coasts are comparatively unbroken, but south of Aird Laimisheader in the west and Stornoway in the east, many inlets run far into the country. The island contains a great number of lakes of various sizes, which are most abundant in the southern mountain tract and in the undulating ground at its base. The greater part of Lewis consists of gneiss, the only other rocks met with being granite and red sandstone, and conglomerate of Cambrian age. The stratification of the gneissic rocks is generally well marked; the prevalent strike is N.E. and S.W. with S.E. dip, generally at a high angle. The author described in considerable detail the traces of glaciation observed in the lower northern part of Lewis, and inferred from his observations that the ice passed from sea to sea across the whole breadth of this district, and that it not only did not come from the mountainous tract to the south, but must have been of sufficient thickness to keep on its course towards the north-west undisturbed by the pressure of the glacier masses which must at the same time have filled the glens and valleys of that mountain region. After describing the characters presented by the bottom-hill in the northern part of Lewis, the author proceeded to notice those of the lakes, some of which trend north-east and south-west, while those of the mountain district follow no particular direction. The lake-basins of the first series he regarded as formed at the same time and by the same agency as the *roches moutonnées* and other marks of glacial action; they are true rock-basins or hollows between parallel banks wholly of till, or of till and rock. The N.E. and S.W. lakes coincide in direction precisely with the strike of the gneiss; and the author explained their origin by the deposition of till by the land-ice in passing over the escarpments of the gneiss facing the north-west. The lakes of the mountain district are regarded by the author as all produced by glacial erosion. The author considered that the ice which passed over the northern part of Lewis could only have come from the main land. Referring to the glaciation of Raasay, he showed that the ice-sheet which effected it must have had in the Inner Sound a depth of at least 2,700 ft., and taking this as approximately the thickness of the *mer de glace*, which flowed into the Minch, which is only between 50 and 60 fathoms in depth, no part of this ice could have floated, and the mass must have passed on over the sea-bottom just as if it had been a land surface. Ice coming from Sutherland must have prevented the flow of the Ross-shire ice through the Minch into the North Atlantic, and forced it over the low northern part of Lewis; and the height to which Lewis has been glaciated seems to show that the great ice-sheet continued its progress until it reached the edge of the 100-fathom plateau, 40 or 52 miles beyond the Outer Hebrides, and then gave off its icebergs in the deep waters of the Atlantic.—"Notes on the Glacial Phenomena of the Hebrides," by J. F. Campbell, F.G.S. The author stated that, on the whole, he was inclined to think that the last glacial period was marine, and that heavy ice came in from the ocean, the local conditions being like those of Labrador. The author regarded most of the lake-basins of the Hebrides as formed by ice-action, and considered that the ice by which those islands were glaciated came from Greenland.—"On Fossil Corals from the Eocene Formation of the West Indies," by Prof. P. Martin Duncan, F.R.S. The specimens were collected from limestone and coral conglomerates, which are covered by, and rest upon volcanic *débris* and ejectmenta in the island of St. Bartholomew. The determination of the forms of the associated Mollusca and Echinodermata permit the following deposits being placed on a general geological horizon—the limestone and conglomerate of St. Bartholomew, the dark shales beneath the Miocene of Jamaica, the beds of San Fernando, Trinidad. These were probably contemporaneous with the Java deposits, the Eocene of the Hala chain, the great reefs of the Castel Gomberto district, the reefs of Oberberg in Steiermark, and the Oligocene of Western Europe. The affinities and identities of the fossil forms with those of contemporaneous reefs in Asia and Europe, and the limitation of the species of the existing Caribbean coral fauna, point out the correctness of the views put forth by S. P. Woodward, Carrick Moore, and the author, concerning the upheaval of the isthmus of Panama after the termination of the Miocene period.—"Note on the Lignite-deposit of Lal-Lal, Victoria, Australia," by R. Etheridge, jun., F.G.S. The lignite is almost entirely composed of remains of coniferous plants not now existing in Victoria; and the author considered that it is nearly of the same age as the lignite deposit of Morrison's Diggings, which has been regarded as Miocene.

Entomological Society, July 7.—Henry T. Stainton, vice-president, in the chair. Mr. Weir exhibited specimens of *Agrotera nemoralis*, taken near Lewes.—Mr. McLachlan exhibited a remarkable instance of hermaphroditism in a specimen of a fly (one of the *Syrphidæ*) taken at Black Park.—Mr. Trovey Blackmore exhibited specimens of a gall found on oaks near Tangier, which were taken possession of for a habitation by a species of ant (*Crematogaster scutellaris*, Oliv.)—Mr. William Pryer exhibited some fine species of Lepidoptera from

China.—Sir S. S. Saunders communicated a paper "On the habits and economy of certain Hymenopterous Insects which nidificate in briars; and their parasites." The insects were exhibited at the last meeting, and Sir Sydney Saunders further exhibited a specimen of a *Raphiglossa*, which he had suffocated with cyanide of potassium, whilst asleep, showing the remarkable position of the insect during repose, as described in the paper.—Mr. Butler communicated a list of the species of *Galeodides*, with description of a new species in the British Museum.

PHILADELPHIA

American Philosophical Society, March 7.—Hector Orr made a communication on the microscopic slide of Mr. Holman.—Dr. Leiler exhibited a modification of apparatus for showing the vibration of molecules in light.—Prof. J. P. Lesley presented a map of the subterranean portions of the collieries of Wilkesbarre, Pennsylvania.—Prof. P. E. Chase read a paper on Planetaxis, the relation of the rotation of the sun and interior asteroids to the sun-spot period, and on the relative velocities of light and gravity.

March 21.—Prof. P. E. Chase pointed out the precise acordance of the wave-length of the Fraunhofer F line with the wave-length of the F note in the 26th musical octave. The other Fraunhofer lines also correspond very closely with the musical notes which are designated by corresponding letters. If this accordance indicates that the luminiferous æther is a material medium, it appears that Winnecke's estimate of the sun's distance is the most accurate of those that have been based on astronomical observations.—Prof. Persifor Fraser exhibited an apparatus for the better manipulation of the lime-light.—Mr. Holman exhibited a slide for the microscope, designed for the better observation of substances suspended in fluids, especially the different corpuscles of the blood. The slide contained two concavities on its face, which were connected by a groove, and covered by a thin plate of glass. It was highly sensitive to changes of temperature.—A resolution was adopted recommending the passage of a bill by the Legislature of Pennsylvania, inaugurating a new Geological Survey of the State.

April 4.—Prof. P. E. Chase showed that, by making the differences symmetrical at each extremity of the planetary series, the supposed failure of Bode's law in the case of Neptune was only apparent, and that it gave the rule a higher generality. He also gave two new planetary series, based, like his modification of Bode's law, on laws of oscillation. If the mean distance of Neptune be divided by successive powers of the ratio of a circumference to its diameter, the points of division will fall in alternate planetary orbits, Saturn, Asteroid, Earth, Mercury. The last term of this first series brings us to the orbital axis of the centres of gravity of the sun and Jupiter. The second series is in regular harmonic progression. Taking Jupiter's perihelion distance as the unit,

$$\tfrac{1}{3}, \tfrac{1}{5}, \tfrac{1}{7}, \tfrac{1}{9}, \tfrac{1}{11}, \tfrac{1}{13}, \tfrac{1}{15},$$

respectively designate orbital positions of Mars, Earth, Venus, ?, Mercury's aphelion, Mercury's mean, Mercury's perihelion. Saturn, Uranus, and Neptune are also in harmonic progression beyond Jupiter. If we express this spheral harmony by musical intervals, they are generally such as to produce chords between any two adjacent planetary positions. But where quarter tones occur, the discordant vibrations seem to have broken up or disturbed the tendencies to planetary aggregations, thus aiding in producing the asteroidal belt, giving Mars and Mercury their diminutive masses and great eccentricity, and obliterating the theoretical planet between Mercury and Venus.—Prof. W. C. Kerr, State Geologist of North Carolina, communicated a paper on Topography of the Earth's surface, as affected by the rotation on its axis. He pointed out that the rivers of southern and eastern North Carolina flowed towards the ocean in a south-easterly direction, and that their south-western banks are elevated and bluffy, while the north-eastern descend very gradually to the water. They flow through, yielding materials of the cretaceous and tertiary formations, and have apparently undergone change of location, in the course of which they have excavated their south-western banks.—Prof. Kerr exhibited some mathematical reasons why this change might have been effected by the earth's rotation.—Prof. E. D. Cope read a paper on the flat-clawed carnivora of Wyoming. This group embraced two genera, *Mesonyx* Cope, and *Synoplotherium* Cope, which bore some resemblance in dentition to *Hyacnodon*. In both the claws were broad, flat, and fissured above, and without projecting endinous insertion below, and hence little prehensile use. In *Mesonyx* the astragalus has two distal facets; in *Synoplotherium* the scaphoid and lunar bones were distinct. The genera were thought to be of aquatic habit.

PARIS

Academy of Sciences, June 30.—M. de Quatrefages, president, in the chair.—During the meeting the Academy proceeded to elect a Foreign Associate in the place of the late Baron Liebig. Sir Charles Wheatstone obtained 43 votes, M. d'Omalius d'Halloy, 2; Sir C. Wheatstone was therefore declared duly elected.—The following papers were read:—Reflexions on Lagrange's memoir on the problem of three bodies, by M. J. A. Serret.—A comparison of the refraction indices of several isomeric compound ethers, by MM. Pierre and Puchot. The authors have found these indices sensibly the same when calculated for temperatures equally distant from the respective boiling points of the bodies in question.—On the analytical theory of the satellites of Jupiter, by M. Souillart.—Researches on the reflexion of solar heat at the surface of Lake Leman, by M. L. Dufour.—On the transplantation of the marrow of bones in sub-periosteum amputations, by M. Félizet.—New observations concerning the presence of magnesium round the entire disc of the sun, by M. Tacchini.—On the want of agreement between the old theory of the thrust (*poussée*) of earth and experiment, by M. J. Curie. This was a paper dealing with fortification.—Note on magnetism, by M. J. M. Gaugain.—On the cooling and freezing of alcoholic liquids and wines, by M. Melsens.—On the decomposition of metallic carbonates by heat, by M. L. Joulin.—On the calculus of the moments of inertia of molecules, by M. G. Hinrichs.—On the production of glycerin starting from propylene, by MM. Friedel and Silva.—On a glycerin of the aromatic series, by M. E. Grimaux.—On the estimation of sugar by Barreswil's method, by M. Loiseau.—Erythrophenic acid, new reaction of phenol and aniline, by M. Jacquemin.—On crystallised mercurous iodide, by M. P. Yvon.—A summary of the state of silk culture in 1873, by M. E. Guérin-Méneville.

DIARY

FRIDAY, JULY 11.

QUEKETT CLUB, at 8.

SATURDAY, JULY 12.

BOTANIC SOCIETY, at 3.45.

TUESDAY, JULY 15.

BRITISH HOROLOGICAL INSTITUTE, at 8.30.—Anniversary.

PAMPHLETS RECEIVED

ENGLISH.—Official Guide-Book to the Brighton Aquarium: W. Saville Kent, F.Z.S.—Third Annual Report of Devon and Exeter Albert Memorial Museum Schools of Science and Art.—Quarterly Weather Report of the Meteorological Office, Part III., July to September, 1871.—Reports and Proceedings of the Miners' Association of Cornwall and Devon for 1872–3.

AUSTRALIAN.—Notes on the Climate of Victoria: Robert L. J. Ellery.—Record of Results of Observations in Meteorology, Terrestrial Magnetism, &c. taken at the Melbourne Observatory during February 1873: Robert L. J. Ellery.

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