THURSDAY, JULY 6, 1876

## A PHYSICAL SCIENCE INSTITUTE

PROBABLY the present generation knows little of the conditions under which the great exhibition of 1851 was organised, or of the important results which followed it. After clearing all the expenses of that enterprise, a large surplus remained, to administer which a Royal Charter was granted to the Commissioners who managed the Exhibition. Since 1852 the Commissioners have held numerous meetings, and quietly done a large amount of work from which the nation has reaped great benefit. Much of the success of the various departments connected with the South Kensington Museum is due to the help they have been able to give, and now they propose a scheme whereby a large proportion of the property at their disposal will be allotted for the benefit of science and art. The Commissioners recently held a meeting, under the presidency of the Prince of Wales, at which their Special Committee reported on various schemes for making use of their funds and property.

The Commissioners started with a clear capital of 186,000*l.* They have given to the Government, for the use of the South Kensington Museum, property valued at 14,000*l.*, and 60,000*l.* in land. They have sold to the Government, at half the value, land for the Natural History Museum, worth 240,000*l.* They have given the site of the Royal Albert Hall, worth 60,000*l.*, and retain property in it to the extent of 80,000*l.* They have invested 100,000*l.* in the galleries lent to the India Museum and Science Loan Exhibition. Notwithstanding these very considerable contributions, the Commissioners still possess out of the Kensington Gore estate, which they purchased with the surplus funds of the 1851 enterprise, landed property of very great value. We believe that the whole of the site of the International Exhibition buildings, including, the Horticultural Gardens, and some adjacent properties are in the trust of the Commissioners. Five schemes have been thought of for the utilisation of this valuable property. By one of these the Commissioners could realise one million sterling, and yet retain a square of ten or twelve acres in the centre of their property. But this they do not think of adopting. The one which they seem to regard most favourably is to lease or sell the ground outside the arcades, called the East and West Annexes, and retain the Horticultural Gardens and Exhibition Buildings, by which means they would realise upwards of 350,000*l.*, free from all liabilities. Whichever scheme is adopted—and the Commissioners seem to think the time is ripe for making the best of their trust in "the interests of science and art"—a very large sum will be at their disposal.

Various objects, all in accordance with the purpose for which they were originally appointed, seem to have suggested themselves to the Commissioners for the appropriation of these funds. Scholarships in science and art, it is suggested, might be founded in connection with central institutions and provincial colleges of science and art, such as those at Manchester, Birmingham, Bristol, Leeds, and elsewhere. It would be a great benefit, it is thought, to these new institutions if their more promising students could be brought up to the laboratories of chemistry, physics, and biology, which are in active work at South Kensington. A portion of the funds might also, it is thought, be devoted to the promotion of museums of science and art throughout the country, and in making grants in aid of the British Section at International Exhibitions; also in supplying several existing wants in connection with the South Kensington Museum, and erecting other buildings on the estate to be devoted to science and art.

The Commissioners are naturally anxious for the welfare of their own child, the South Kensington Museum, and for the proper exhibition of the treasures it contains, and the proper housing of its educational and other libraries. This has engaged much of their attention, more especially as the executors of the late Mr. Dyce insist on the carrying out of the provisions of his will with regard to the display of his bequest. Since the subject, however, has been under the consideration of the Commissioners, Government has made a grant of 80,000*l.* for the purposes of Art, part of which will, no doubt, be devoted to the proper location of the Dyce and other collections, and to some of the other purposes concerning which the Commissioners are naturally anxious. Had they been aware of this grant, no doubt they would have spoken more fully and decidedly of another scheme which appears to have come under their consideration.

The scheme to which we refer was briefly described by Mr. Cross recently in the House of Commons, and has reference to the establishment of "a museum and scientific institute, which would comprise a library of works in science and art, for the use of students at South Kensington, and public examination rooms." From the way in which the library is here mentioned we may consider that it is a matter of secondary importance in the eyes of the Commissioners, and that the main idea is to build a museum and laboratory. We confess we cannot see the immediate appropriateness of attaching a library to a laboratory and museum of this kind. At present no library of science exists, and there will be a library attached to the Natural History Museum which is now being erected on the Commissioners' grounds, and there are various places in London where the best works and serials in all departments of science can be easily consulted. There is at least no pressing need at present for a science library, while the necessity for the organisation of a laboratory and museum was never more urgent. It is known that if only a suitable receptacle were provided, many of those who have contributed to the Loan Collection are willing to leave their apparatus permanently as the nucleus of an English Conservatoire des Arts et Métiers. No better opportunity could be afforded for the commencement of a science museum; but if the Commissioners do not resolve without delay to carry out the scheme that has apparently been engaging their attention, a golden opportunity will be lost that is not likely to occur again soon.

As to the proposal to provide rooms in the Science Museum for examinations in connection with the Science and Art Department, we think the Commissioners would be doing a quite unnecessary and rather mischievous thing in carrying out such a proposal. Government has started these examinations, and is no doubt quite prepared to provide examination-rooms for itself. I needs no leading in this matter, though it certainly does need encouragement to take under its wing a science museum and laboratory. This then it seems to us ought to be the first care of the Commissioners, leaving the examination rooms out of the reckoning, while the library can easily afford to wait for future consideration. If the idea of a library is brought too prominently to the front, we fear the building will come to be known by this and no other name, and come in the end to be mainly, if not only, what its name purports. We believe the Commissioners could spare 100,000*l*. for a Science Museum; and we are sure the great success which has attended the Loan Collection will tend to confirm them in their intentions, and induce them without delay to set about providing a permanent successor. We have no doubt that the Commissioners are quite alive to the value of a Physical Science Museum and Laboratory, and feel strongly the great need there is in this country for such an institution. They have on the whole done their work conscientiously and well, and South Kensington testifies to the highly important and beneficial results which they have accomplished. By erecting an institution for the promotion of physical science, they will show their anxiety to make their work complete in all the departments with which they have had to deal. Twenty years ago they started the Museum of Art at Kensington; if twenty years hence a Museum of Science has made equal progress, the nation will have reason to congratulate itself on the result, and be grateful to the Commissioners for the faithfulness with which they have done their work.

## *WHEWELL'S WRITINGS AND CORRESPONDENCE*

*William Whewell, D.D., Master of Trinity College, Cambridge.* An Account of his Writings, with Selections from his Literary and Scientific Correspondence. By I. Todhunter, M.A., F.R.S., Honorary Fellow of St. John's College. (London: Macmillan and Co., 1876.)

WE frequently hear the complaint that as the boundaries of science are widened its cultivators become less of philosophers and more of specialists, each confining himself with increasing exclusiveness to the area with which he is familiar. This is probably an inevitable result of the development of science, which has made it impossible for any one man to acquire a thorough knowledge of the whole, while each of its sub-divisions is now large enough to afford occupation for the useful work of a lifetime. The ablest cultivators of science are agreed that the student, in order to make the most of his powers, should ascertain in what field of science these powers are most available, and that he should then confine his investigations to this field, making use of other parts of science only in so far as they bear upon his special subject.

Accordingly we find that Dr. Whewell, in his article in the "Encyclopædia Metropolitana," on "Archimedes and Greek Mathematics," says of Eratosthenes, who, like himself, was philologer, geometer, astronomer, poet, and antiquary: "It is seldom that one person attempts to master so many subjects without incurring the charge and perhaps the danger of being superficial."

It is probably on account of the number and diversity of the kinds of intellectual work in which Dr. Whewell attained eminence that his name is most widely known. Of his actual performances the "History" and the "Philosophy of the Inductive Sciences" are the most characteristic, and this because his practical acquaintance with a certain part of his great subject enabled him the better to deal with those parts which he had studied only in books, and to describe their relations in a more intelligent manner than those authors who have devoted themselves entirely to the general aspect of human knowledge without being actual workers in any particular department of it.

But the chief characteristic of Dr. Whewell's intellectual life seems to have been the energy and perseverance with which he pursued the development of each of the great ideas which had in the course of his life presented itself to him. Of these ideas some might be greater than others, but all were large.

The special pursuit, therefore, to which he devoted himself was the elaboration and the expression of the ideas appropriate to different branches of knowledge. The discovery of a new fact, the invention of a theory, the solution of a problem, the filling up of a gap in an existing science, were interesting to him not so much for their own sake as additions to the general stock of knowledge, as for their illustrative value as characteristic instances of the processes by which all human knowledge is developed.

To watch the first germ of an appropriate idea as it was developed either in his own mind or in the writings of the founders of the sciences, to frame appropriate and scientific words in which the idea might be expressed, and then to construct a treatise in which the idea should be largely developed and the appropriate words copiously exemplified—such seems to have been the natural channel of his intellectual activity in whatever direction it overflowed. When any of his great works had reached this stage he prepared himself for some other labour, and if new editions of his work were called for, the alterations which he introduced often rather tended to destroy than to complete the unity of the original plan.

Mr. Todhunter has given us an exhaustive account of Dr. Whewell's writings and scientific work, and in this we may easily trace the leading ideas which he successively inculcated as a writer. We can only share Mr. Todhunter's regret that it is only as a writer that he appears in this book, and it is to be hoped that the promised account of his complete life as a man may enable us to form a fuller conception of the individuality and unity of his character, which it is hard to gather from the multifarious collection of his books.

Dr. Whewell first appears before us as the author of a long series of text-books on Mechanics. His position as a tutor of his College, and the interest which he took in University education, may have induced him to spend more time in the composition of elementary treatises than would otherwise have been congenial to him, but in the prefaces to the different editions, as well as in the introductory chapters of each treatise, he shows that sense of the intellectual and educational value of the study of first principles which distinguishes all his writings. It is manifest from his other writings, that the composition of these text-books, involving as it did a thorough study of the fundamental science of Dynamics, was a most appropriate training for his subsequent labours in the survey of the sciences in their widest extent.

"It has always appeared to me," says Mr. Todhunter, "that Mr. Whewell would have been of great benefit to students if he had undertaken a critical revision of the technical language of Mechanics. This language was formed to a great extent by the early writers at an epoch when the subject was imperfectly understood, and many terms were used without well-defined meanings. Gradually the language has been improved, but it is still open to objection."

In after years, when his authority in scientific terminology was widely recognised, we find Faraday, Lyell, and others applying to him for appropriate expressions for the subject-matter of their discoveries, and receiving in reply systems of scientific terms which have not only held their place in technical treatises, but are gradually becoming familiar to the ordinary reader.

"Is it not true," Dr. Whewell asks in his Address to the Geological Society, "in our science as in all others, that a technical phraseology is real wealth, because it puts in our hands a vast treasure of foregone generalisations?"

Perhaps, however, he felt it less difficult to induce scientific men to adopt a new term for a new idea than to persuade the students and teachers of a University to alter the phraseology of a time-honoured study.

But even in the elementary treatment of Dynamics, if we compare the text-books of different dates, we cannot fail to recognise a marked progress. Those by Dr. Whewell were far in advance of any former text-books as regards logical coherence and scientific accuracy, and if many of those which have been published since have fallen behind in these respects, most of them have introduced some slight improvement in terminology which has not been allowed to be lost.

Dr. Whewell's opinion with respect to the evidence of the fundamental doctrines of mechanics is repeatedly inculcated in his writings. He considered that experiment was necessary in order to suggest these truths to the mind, but that the doctrine when once fairly set before the mind is apprehended by it as strictly true, the accuracy of the doctrine being in no way dependent on the accuracy of observation of the result of the experiment.

He therefore regarded experiments on the laws of motion as illustrative experiments, meant to make us familiar with the general aspect of certain phenomena, and not as experiments of research from which the results are to be deduced by careful measurement and calculation.

Thus experiments on the fall of bodies may be regarded as experiments of research into the laws of gravity. We find by careful measurements of times and distances that the intensity of the force of gravity is the same whatever be the motion of the body on which it acts. We also ascertain the direction and magnitude of this force on different bodies and in different places. All this can only be done by careful measurement, and the results are affected by all the errors of observation to which we are liable.

The same experiments may be also taken as illustrations of the laws of motion. The performance of the experiments tends to make us familiar with these laws, and to impress them on our minds. But the laws of motion cannot be proved to be accurate by a comparison of the observations which we make, for it is only by taking the laws for granted that we have any basis for our calculations. We may ascertain, no doubt, by experiment, that the acceleration of a body acted on by gravity is the same whatever be the motion of that body, but this does not prove that a constant force produces a constant acceleration, but only that gravity is a force, the intensity of which does not depend on the velocity of the body on which it acts.

The truth of Dr. Whewell's principle is curiously illustrated by a case in which he persistently contradicted it. In a paper communicated to the Philosophical Society of Cambridge, and reprinted at the end of his "Philosophy of the Inductive Sciences," Dr. Whewell conceived that he had proved, *à priori*, that all matter must be heavy. He was well acquainted with the history of the establishment of the law of gravitation, and knew that it was only by careful experiments and observations that Newton ascertained that the effect of gravitation on two equal masses is the same whatever be the chemical nature of the bodies, but in spite of this he maintained that it is contrary not only to observation but to reason, that any body should be repelled instead of attracted by another, whereas it is a matter of daily experience, that any two bodies when they are brought near enough, repel each other.

The fact seems to be that, finding the word weight employed in ordinary language to denote the quantity of matter in a body, though in scientific language it denotes the tendency of that body to move downwards, and at the same time supposing that the word mass in its scientific sense was not yet sufficiently established to be used without danger in ordinary language, Dr. Whewell endeavoured to make the word weight carry the meaning of the word mass. Thus he tells us that "the weight of the whole compound must be equal to the weights of the separate elements."

On this Mr. Todhunter very properly observes :—

"Of course there is no practical uncertainty as to this principle ; but Dr. Whewell seems to allow his readers to imagine that it is of the same nature as the axiom that 'two straight lines cannot inclose a space.' There is, however, a wide difference between them, depending on a fact which Dr. Whewell has himself recognised in another place (see vol. i., p. 224). The truth is, that *strictly* speaking the weight of the whole compound is not equal to the weight of the separate elements ; for the weight depends upon the position of the compound particles, and in general by altering the position of the particles, the resultant effect which we call weight is altered, though it may be to an inappreciable extent."

It is evident that what Dr. Whewell should have said was : "The mass of the whole compound must be equal to the sum of the masses of the separate elements." This statement all would admit to be strictly true, and yet not a single experiment has ever been made in order to verify it. All chemical measurements are made by comparing the weights of bodies, and not by comparing the forces required to produce given changes of motion in the bodies ; and as we have just been reminded by Mr. Todhunter, the method of comparing quantities of matter by weighing them is not strictly correct.

Thus, then, we are led by experiments which are not only liable to error, but which are to a certain extent erroneous in principle, to a statement which is universally acknowledged to be strictly true. Our conviction of its truth must therefore rest on some deeper foundation than the experiments which suggested it to our minds. The belief in and the search for such foundations is, I think, the most characteristic feature of all Dr. Whewell's work.

J. CLERK MAXWELL

## *GOULD'S BIRDS OF NEW GUINEA*

*The Birds of New Guinea and the Adjacent Papuan Islands, including any new Species that may be Discovered in Australia.* By John Gould, F.R.S., &c. Parts I., II., and III. (London: Published by the Author, 1875-76.)

NOT long ago we had the pleasure of recording in these columns the completion of one of Mr. Gould's great series of illustrated works on ornithology. We have now to notice the commencement of another work belonging to the same category, of not less importance, on the origin of which we propose to say a few words. The "Birds of Australia" must be known to most of our scientific readers as one of the most important ornithological works ever produced in this or any other country. Defects it has, no doubt—nothing is perfect in this world—but, whereas before its existence the birds of that great continent were almost unknown to naturalists, the termination of Mr. Gould's labours left us with such a history of the feathered inhabitants of this portion of the globe as hardly any other country at that time possessed. Some years after the completion of his "Birds of Australia," Mr. Gould issued the first number of a supplement to the same work, undertaken for the purpose of illustrating the new species discovered by his various agents and correspondents, as new portions of Australian territory were explored. This was completed in 1869, and gave us an account of 81 species, in addition to 600 already included in the original "Birds of Australia." The work of which the two first numbers are now before us—though a different title is given to it—is, in fact, a second supplement to the "Birds of Australia." New Guinea, as is now well understood by naturalists, in spite of a certain amount of idiosyncrasy, belongs essentially to the same fauna as Australia. Long ago it was known that many peculiarities are common to the animal and vegetable products of these two countries. Since Northern Australia has been explored, and further investigation made of the rich fauna of New Guinea, the many points of contact between the natural productions of these two lands have been greatly augmented, and there can be little question that we have in New Guinea an exaggerated reproduction of many of the chief peculiarities of the Australian type. Looking to the great interest that is now more than ever attaching itself to the products of New Guinea, Mr. Gould has very naturally determined to combine his illustrations of the many wonderful birds of that country with the new additions that he still continues to receive from Australia, and this is, in fact, the object of the present work.

The great feature in the ornithology of New Guinea is, as is well known, the Paradise-Birds, which are mostly confined to that country and the adjoining islands, though some of the members extend far into North Eastern Australia. The splendid metallic colouring of these birds and the ornamental tufts and plumes that adorn the adult males, afford welcome subjects to the artist's pencil, and are naturally objects on which Mr. Gould is desirous of showing his habitual skill. We have not, therefore, to turn over many leaves of his first number, before we come across representations of two of the finest members of this group, namely the Six-plumed Paradise Bird, known to naturalists since the days of Linnæus, and D'Albertis' Paradise Bird, one of the most recent additions to this remarkable group. In the second number Mr. Gould gives us figures of the three species of *Diphyllodes*, another remarkable member of the same family. Some of the splendid parrots of New Guinea are likewise depicted.

In the third part of his work, which has only been issued within these last few days, further illustrations of the magnificent group of Paradise-Birds are given. The singular species of *Diphyllodes*, so remarkable for its bare head, which the late Prince Charles Bonaparte, in his democratic ardour, dedicated to the Republic, is among the most striking forms yet discovered even in this wonderful group, and both sexes are admirably figured in the present number. Although originally described from a single imperfect specimen, this striking bird has recently been discovered by Dr. Bernstein living in the islands of Waigion and Botanta, and no less than ten specimens obtained by this zealous but unfortunate explorer ornament the gallery of the Leyden Museum. The King Bird of Paradise (*Cicinnurus regius*) is another species selected by Mr. Gould for illustration in the present number. Although known to us since the last century, it is only of late years that perfect specimens have reached the collections of Europe. Our countryman, Mr. Wallace, was one of the first naturalists to observe it in its native forests, and his eloquent account of the specimens obtained by him in Aru will be known to many of our readers. Still more recently, the naturalists in the employ of the Leyden Museum and the Italian explorers D'Albertis and Beccari have sent to Europe a large number of specimens of it. Five charming parrots of the most brilliant and strongly contrasted colours, several of which are hitherto unfigured, are likewise depicted in Mr. Gould's third number.

The part terminates with figures of two recent additions to the Avifauna of Australia. Of these the two named *Sternula placens* is perhaps rather a doubtful species as regards its novelty to science, though doubtless new to the Australian list. The second *Glyciphila subfasciata* is one of Mr. E. P. Ramsay's interesting discoveries in Northern Queensland, and is one of the smallest and most plainly coloured of the great and characteristic of the Australian family of Honey-eaters.

In concluding our notice of this important work, we may venture to say that those who are acquainted with the author's failing health, cannot but admire the spirit which he has displayed in commencing it, while every one will, we are sure, heartily join with us in wishing him complete recovery and a successful accomplishment of his arduous task. When one of our Italian friends has recently described fifty-two new species of Papuan birds in a single memoir, even Mr. Gould's well-known energy will have to exert itself considerably in order to keep up with what is going on.

## OUR BOOK SHELF

*Famines in India; their Causes and possible Prevention.* Being the Cambridge Le Bas Prize Essay, 1875. By A. Lukyn Williams, B.A. (London: Henry S. King and Co., 1876.)

WE have in this prize essay a very creditable digest of a mass of blue books touching on a subject of the greatest importance to India, and to ourselves. Mr. Williams has first sought to interest his readers by recalling famines nearer home and their dreadful consequences; he has then divided his subject into two parts, the first occupied with the causes, the second with the possible prevention of famines in India.

The chief causes producing a failure of crops are to be found in the land having too little or too much water,—in the failure of the seasonal rains, or in floods from overcharged rivers; to which must be added the wants due to the difficulty of conveying food from places where it is abundant to those where its production has been destroyed. There can be little doubt as to the common causes of famines in India; the important question is how they are to be prevented.

Is it possible to be prepared for a failure of the seasonal rains, that is, can we foresee by our present knowledge, that a year, half a year, or even three months hence there will certainly be a great deficiency of rain over a given district or country? This, we have to confess, is at present beyond our power. Meteorology cannot yet be called a science; it is a series of fragmentary facts; a mass of undigested observations; a groping after laws through false hypotheses which have gained their position through celebrated names. As long as men like Galileo were satisfied with the hypothesis that nature abhorred a vacuum, all progress in hydrostatics was impossible. Although we have got over that, the spirit which kept Aristotle alive is still above ground, and meteorology will scarcely advance unless facts are studied independently of the views of any master as to their causes. What hereafter may be possible in the way of prediction is too wide a subject for this notice.

Failing the foreknowledge required to be prepared for the want of rain, there remains the very practical process of being provided with water, through canals and aqueducts connected with the many perennial sources of India. Mr. Williams appears to have referred little to the views of Sir Arthur Cotton on this part of the subject, though these are of the highest value. When both rain and aqueducts are wanting, good means of communication with more favoured districts are essential (these are indeed essential in any case), great central railways are required for our hold, and proper government of the empire, but these are too costly to satisfy for many long years the real requirements of such a people and of such a country. Wherever they can be made, canals, which serve as great lines of communication and feeders of aqueducts for irrigation, are apparently best suited to the present wants of India: these, with large reservoirs, which could frequently be constructed at moderate expense, would diminish to a great extent the possibility of famine.

That forests retard the discharge into rivers of the fallen rain, and diminish the height of floods, is a fact now so well known that the planting of trees and the preservations of woods, especially on steep slopes, has been recognised as essential to the protection of every land subject to inundations. Mr. Williams has treated of these and many other matters, including the improvement of agriculture and land tenure, in a way which shows he has mastered the reports of several highly distinguished officers who have studied these questions on the spot; and the essay will give readers interested in its subject a very satisfactory idea of the facts connected with it.

## LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

### Lectures on Meteorology

MOST people conversant with the subject will agree with "Spes" (vol. xiii., p. 169) that meteorology should now be considered as much a separate science as mineralogy or geology, and be taught as such; but I would suggest whether without waiting for the foundation of special chairs in the colleges, immediate steps might not be taken with advantage to bring it before the class of persons not usually to be found in colleges, to whom it is of essential importance, by means of the Science and Art Department Organisation.

Physical Geography, which may be considered as a somewhat kindred science, is, I believe, one of the most popular amongst the candidates for the South Kensington certificates, and by the directory for 1875 it appears that in that year this subject was taught in 686 classes to 17,720 students, thus heading the list of science schools, for the next two subjects in popularity; Elementary Mathematics and Electricity, only number 537 and 485 classes, with 10,502 and 12,515 students respectively.

Dr. Hooker, P.R.S., the learned director of the Royal Gardens, Kew, in arranging the science lessons given during the winter to the young gardeners training in that establishment has, for the past two years, caused a course of lectures on Meteorology to be delivered in addition to the lectures on Botany, Chemistry, &c., and examinations have been held and certificates awarded for proficiency in this science equally with the others.

The movement to spread the knowledge of the principles of meteorology must be a strictly educational one, for experience proves that it is useless to attempt to popularise it by means of lectures to institutions, &c.; for although offered gratis to committees and managers, these are as a rule very reluctant to accept them, as from the absence of brilliant experiments or optical illustrations, they fail to attract large audiences.

The steps taken by the British Meteorological Society during their last and previous sessions, which have resulted in the addition to its ranks of so many officers of health and civil engineers, show that interest is not wanting in the science; and it is only to be regretted that "Spes" has brought forward his proposal so late in the season, that no opportunity can occur for bringing it before the society before their next winter session.

The want of text books on the science now felt would soon disappear, as publishers would at once bring out works on the subject, were a demand for them to arise.

Richmond G. M. WHIPPLE

### The Axolotl

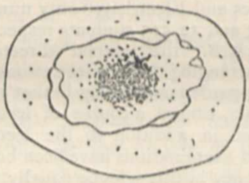
WHEN, in 1873, Mr. Mivart published in your pages, in his papers on "The Common Frog," an account of the Mexican Axolotl, I arrived theoretically at conclusions which are, I think, identical with those reached by Weissmann, whose researches, recorded in the *Zeitschrift für Zoologie*, you published in abstract on the 8th inst. Mr. Mivart says: "Its mature condition was considered to be established by the discovery that it possesses perfect powers of reproducing its kind;" thus seeming to admit that its metamorphosis from the Siredon to the Amblystoma form proves it to have been really a fertile, persistent, larval form. He then used this metamorphosis of a larval into a mature form as a fact in favour of his hypothesis of sudden development; as if the Axolotl and Amblystoma were actually of distinct genera, and not merely the subjects of a mistake arising from partial knowledge, analogous to those by which the larval Nauplius and Zoëa were constituted into genera. Sir John Lubbock's remarks on Chironomus ("Origin and Metamorphosis of Insects," p. 76) are relevant. He says: "It seems to me possible, if not probable, that some larvæ which do not now breed, may, in the course of ages, acquire the power of doing so." Persistent larval forms would seem to have originated from adaptational causes, which, Sir John Lubbock remarks, may act through natural selection; and the power of reproduction to have been in time acquired. Any subsequent cases of perfect development from a previously persistent larval form, such as the metamorphosis in question, would seem, as indicated by the absence of sexual power in the resultant Amblystoma forms, to be analogous to cases of degeneration, or return to an abandoned course of development, rather than to the commencement of a new stage of progress. The adaptational advantages, which caused the larval form to become persistent, ceasing to operate, the Amblystoma form may very possibly, in time, reobtain its reproductive powers and its position as the normally perfect animal of which the Siredon is the larva.

June 28 G. S. BOULGER

### Remarks upon a Hailstorm which passed over Belgaum on April 21, 1876

ABOUT 1.30 P.M., after some light rain, large hail-stones commenced falling one here and there, and gradually thickening for ten minutes, were followed up by a sharp shower of rain.

The first stones which fell were of a compressed oval shape, with sides slightly rounded or bulging, about 1 inch in length and $\frac{3}{4}$ inch in breadth, the centre being about $\frac{1}{3}$ inch thick. The centre or nucleus of the stone was about the size of a large pea, and appeared to consist of a mass of infinitesimally minute air-bubbles. Surrounding this nucleus were two collateral tracings—not rings, for they were far from being round—unlike in form, the one occasionally bulging beyond the other :—



Towards the end of the storm the hail-stones decreased in size and assumed a rounded shape, about $\frac{1}{4}$ inch in diameter, with the same internal conformation, but proportionately small compared with the size of the stones. G. A. NEWMAN

### Williams' (?) Thermometer

AS the Physical Loan Collection at South Kensington includes a new (?) thermometer by Mr. John Williams—I presume the son of the late Secretary of the Astronomical Society—I hereby beg to vindicate my priority therein, as printed in the London *Philosophical Magazine* for January 1850, vol. xxxvi. My communication is dated Dec. 6, 1849, wherein I proposed making the common − 40° F. or C. to be the zero, and the boiling-point of water 1000 ; being 252° F. or 140° C. interval. Also putting zero at − 38° F. to have 250° F. for the extreme difference. This would generally avoid negat. deg. (and even the decimal pointing), merc. freez. − 39 = + 4 or − 4 according to the scale 252 or 250 :—

| | | | |
|---|---|---|---|
| F. 0 = 158·7 | 152 | F. 150 = 754·0 | 752 |
| 32* = 285·7 | 280 | 174 = 849·2 | 848 |
| 39 = 313·5 | 308 | 212* = 1000·0 | 1000 |
| 50 = 357·1 | 352 | 655 = 2758·0 | 2772 |
| 84 = 492·1 | 488 | 672 = 2825·4 | 2840 |
| 98 = 547·6 | 544 | | |

In a tract on the Limits of the Atmosphere, printed in 1840, I showed that the absolute *zero* of cold is unattainable. Pour any fluid substance in a cylinder, and mark the dilatation points for 32° and 212° F., it is obvious that by carrying the scale downwards to the bottom of the cylinder, that the fluid cannot condense to the very bottom of the vessel, else its density would be infinite. At or before this *lowest* degree of the scale the said fluid will therefore remain stationary or begin to expand upwards, as water does at 32°. I enclose copies printed at the time of my said papers. S. M. DRACH

June 26

### The Cuckoo

THERE is a saying in Somersetshire :—

"The Cuckoo sings in April,
The Cuckoo sings in May ;
The Cuckoo sings the day before
But not on Midsummer-day."

This year, the cuckoo sang cheerily on the 24th, and is still singing on the 28th with undiminished vigour. H. M. ADAIR

Taunton

### Geology of Zermatt

BEING about to spend some time in the Zermatt district, I should be much obliged if any of your readers could give me through your pages (as the information would doubtless be serviceable to others) the titles of such works on the geology and mineralogy of that portion of the Alps as they can recommend from their own use of them. VIATOR

## OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF 1878, JULY 29.—On March 26 of the present year an *annular* eclipse passed over British Columbia, the sun being high in the heavens and near the meridian when the annulus was formed. On July 29, 1878, the still more interesting phenomenon, a *total* solar eclipse, will be visible in the same district, the track of the central line passing thence over the western states of America to the Gulf of Mexico. Our American *confrères* will no doubt give a good account of it.

The duration of totality attains a maximum in British Columbia, and the present remarks will be confined to the passage of the total eclipse over this country. Employing the *Nautical Almanac* elements, which as regards the moon's place are in very close agreement with those of the American ephemeris founded on the tables of Prof. Peirce, and making a direct calculation for longitude 123° 30′ W., latitude 53° 30′ N., we find the following particulars :—

| | h. m. s. | | ° | | |
|---|---|---|---|---|---|
| Totality begins July 29, at | 1 32 24 | local M.T. at | 61 | from N.Pt. towards | W. |
| ,, ends ,, ,, | 1 35 36 | ,, ,, | 118 | ,, ,, | E. |

The duration is therefore 3m. 12s. The sun's altitude at the middle of the eclipse is 52°.

A similar calculation gives for the commencement of the partial eclipse 0h. 19m. 47s. local M.T. at 62° from the sun's north point towards the west, altitude 56°.

For any other point not far from the above-assumed position the times of beginning and ending of totality may be deduced from the following formulæ :—

$$\text{Cos. } w = 51{\cdot}5275 - [1{\cdot}84632] \sin. l + [1{\cdot}67405] \cos. l, \cos. (L + 203°\ 44'{\cdot}5)$$
$$t = 9\text{h. } 59\text{m. } 4{\cdot}6\text{s.} \mp [1{\cdot}98350] \sin. w - [3{\cdot}56410] \sin. l - [3{\cdot}86142] \cos l, \cos. (L + 245°\ 6'{\cdot}7).$$

The beginning of the partial eclipse will be given by—

$$\text{Cos. } w = 0{\cdot}98476 - [0{\cdot}19431] \sin. l + [0{\cdot}00582] \cos. l, \cos. (L + 184°\ 34'{\cdot}7)$$
$$t = 10\text{h. } 19\text{m. } 43\text{s.} - [3{\cdot}65657] \sin. w - [3{\cdot}55998] \sin. l - [3{\cdot}88264] \cos. l, \cos. (L + 227°\ 19'{\cdot}4).$$

In the above formulæ $L$ expresses the west longitude from Greenwich taken *negatively*, $l$ the geocentric latitude, and the quantities within the square brackets are logarithms. Upper sign for beginning of totality, lower sign for ending.

The following figures should define pretty accurately the limits of the belt of totality in British Columbia :—

| W. longitude. | N. Limit. | Geographical Latitude of Central Line. | S. Limit. |
|---|---|---|---|
| ° ′ | ° ′ | ° ′ | ° ′ |
| 126 30 | 56 22·1 | 55 11·0 | 54 1·4 |
| 123 30 | 54 42·6 | 53 30·7 | 52 20·5 |
| 122 0 | 53 50·5 | 52 38·4 | 51 27·9 |
| 120 30 | 52 56·9 | 51 44·6 | 50 33·9 |
| 117 30 | 51 5·3 | 49 52·5 | 48 41·4 |

Fort Fraser, it will be seen, is very nearly on the line of central eclipse.

At a point, longitude 121° 37′ W., latitude 52° 27′, just south of Lake Quesnelle, the central lines of the annular eclipse of March, 1876, and the total eclipse of July, 1878, intersect.

At New Westminster, the capital of British Columbia, the eclipse is partial only, commencing at 0h. 30m. and ending at 2h. 59m. local mean times, magnitude 0·95.

BESSEL'S "ABHANDLUNGEN."—The second volume of the reprint of Bessel's astronomical and other memoirs, under the editorship of Dr. Engelmann, of Leipsic, has appeared. The contents relate to the theory of instruments, including the treatises of the great Königsberg astronomer on the heliometer, which in his hands acquired so universal a reputation; to sidereal astronomy, with the memoirs relating to the parallax of 61 Cygni, the measures of the principal members of the Pleiades, to which Dr. Engelmann has added a chart of the group containing stars visible in a telescope of 10·11 cm. aperture, or to "about 10·11 magnitude," the stars not found in Argelander's *Durchmusterung* having a distinguishing mark. Several mathematical essays follow.

MIRA CETI.—Reference is often made in treatises on astronomy to the unusual degree of brilliancy attained by this variable star at the maximum of 1779. From the observations of Bode, Herschel, and Wargentin, we have the following particulars of the augmentation and diminution of brightness in that year.

Aug. 22.—Invisible in an ordinary 2-feet telescope.

Sept. 8.—Seen with the same instrument but very faint.

Sept. 18.—Immediately visible to the naked eye according to Herschel. Bode estimated it 4m.

Oct. 5 and 6.—Already much brighter than Menkar ($\alpha$ Ceti).

Oct. 15-19.—Equal to $\alpha$ Arietis on 15th, and still brighter on the 19th; the light reddish.

Oct. 30.—According to Wargentin, it was equal to Aldebaran and of the same colour, or even of the redness of Mars which was observable the same night. In a 10-feet achromatic Mira shot out vivid red rays. Herschel considered it midway in brightness between $\alpha$ Arietis and Aldebaran.

Nov. 2.—There was even an increase, in the judgment of Herschel.

Nov. 11.—Visible as early as Aldebaran and Mars.

Nov. 20.—As bright as, but not brighter than stars of the second magnitude, according to Herschel, but on the 25th much brighter than Menkar, though less than Aldebaran, according to Wargentin.

Dec. 4.—Only equal to $\alpha$ Arietis.

Dec. 7 and 10.—So much diminished since Nov. 25, that it was now hardly equal to Menkar, and its colour was now whiter.

Dec. 25.—Before the moon rose, equal to $\gamma$ Ceti, or of the third magnitude.

Dec. 29.—Only a little brighter than the fourth magnitude; not equal to $\gamma$ or $\delta$ Ceti.

Argelander gives for the date of maximum 1779, Nov. 6.

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## THE TASMANIANS

THE *historical* period of this singular race of mankind has lasted no longer than a century, for up to one hundred years ago they had unimpeded sway in the island of Van Diemen. Once invaded by Europeans, they had inevitably to succumb, and they gradually but speedily dwindled away, the last of them having died about two years ago, so that now they are completely extinct.

The island when discovered by Tasman contained about 7,000 inhabitants. In the year 1803 it was annexed by Britain for a penal settlement. Hatred, amounting to display of violence, broke out between the aborigines and the criminal occupiers of the soil. The scattered remnants of the native tribes were subsequently gathered together, and provided for by the Government at various retreats, until the last of the race in course of time passed away. Dr. Barnard Davis, F.R.S., the well-known ethnologist, in a recent paper,[1] endeavours to prove by the comparison of a skeleton, and some skulls of an Australian and a Tasmanian, that these two people belonged to two distinct races of man, having been previously erroneously confounded together.

[1] "On the Osteology and Peculiarities of the Tasmanians, a Race of Man Recently become Extinct." Reprint 4to from the "Natuurkundige Verhandelingen der Hollandsche Maatschappij der Wetenschappen." 3rd Verz. Deel II., No. 4. Illustrated by four splendid lithographic plates.

Almost the only relics which the Tasmanains have left behind them are their bones. Fortunately before the entire extinction of the race, men of science had begun to see the importance of the study of craniology, so that a few skulls, but still only a few, have been collected and preserved. One chief reason of the scarcity of crania is the manner of the disposal of the dead—by fire. These were often placed in a hollow tree, surrounded by spears, so that on the occurrence of any bush fire the bones even were certain to be consumed. Two out of the twelve skulls in Dr. Davis' collection have been rescued from fire. Up to the last three years there was not a single Tasmanian skeleton in any European collection. At the present time there are four in England—two, one a male and the other a female, being in the Museum of the Royal College of Surgeons. Two skeletons, also of opposite sexes, are in the Museum of the Royal Society of Tasmania, Hobart Town.

The chief works of art, of which, unfortunately, but few are preserved, consist of beautiful necklaces made by stringing the iridescent shells of *Purpura elenchus* upon thin sinews, also of very rude implements, chippings of a dark-coloured chert, exactly like that used by the Kanakas of the Sandwich Islands, and, lastly, fishing nets. The natives on the south and west coasts make a kind of "catamaran" from rushes. The spears, about ten feet long, are made of the heavy, hard wood of the "tea tree" pointed and hardened in the fire, and straightened by being passed from end to end between the teeth.

For long the Tasmanians and Australians were confounded together, and Europeans who visited the country did not improve matters by calling both races, without distinction, "black," though the colour of their skin was removed from a negroid blackness, being of a "dull dark" colour in the Tasmanian, and "chocolate, coffee-coloured, or nutmeg-coloured" in the Australian.[1] There was, moreover, a striking difference between the two people, the Tasmanian being stout and broad-shouldered, while there was such a degree of lankness in the Australian as to cause the former to appear stout. Prof. Huxley, who visited both countries, says of the former people that they "are totally different from the Australians."

The Tasmanians were rather short, being below the average of Europeans in stature. The mean height of twenty-three men was found to be 5 ft. $3\frac{1}{4}$ in., or 1,618 mm.; that of twenty-nine women was only 4 ft. $11\frac{1}{4}$ in., or 1,503 mm. There are, however, instances, as in other races, of tall stature among the Tasmanians, for several have been found to be 6 ft. in height by measurement. The Australians are a taller people. Out of thirteen Shark's Bay natives who were measured twelve were 5 ft. 10 in. in height, but "there seems," observes Mr. Oldfield, "as much variation among these savages as there is among civilised nations, the mean height being no greater than it is in England." The Tasmanians differed strikingly from the Australians in being robuster; and that this is no superficial character, but one of race, can be proved by reference to their bones. A question, now unfortunately too late to solve, is—What was the amount of difference between the different tribes of Tasmania? For it is known that there were tribes in the island differing to the extent of the possession of dialects mutually unintelligible. With regard to the Australians, some ethnologists maintain that they have physical characters so distinct as to admit of being divided into a woolly-haired and a flowing-haired race.

There is, moreover, a striking difference in the structure of the hair in the two races respectively; that of the Australians growing in flowing ringlets, while the hair of the Tasmanian, being excentrically elliptical on section, has a tendency to twist, and thus comes to grow in small

[1] It is to be hoped that in future, in order to avoid such vagueness of terminology, travellers will adopt M. Broca's useful colour-types. *Vide* the British Association's "Anthropological Notes and Queries."

corkscrew locks. This peculiarity allowed them to load their hair with red ochre, so that it hung down in separate ringlets. In colour it is of a very dark brown, popularly called black, approaching in tint to No. 41[1] of Prof. Broca's "Colour Types." It was difficult to investigate the hair of the women, as, from an idea that it added to their charms, they shaved their heads either with a sharp stone or with broken bottles, on the advent of civilisation! The women among the Mincopies of the Andaman Islands have the same custom. It is a curious coincidence also that the latter race, as did the Tasmanians, were in the habit of carrying fragments of the bones of their relations, as a mark of affection, suspended necklace-wise round their necks. The peculiar growth of hair in spiral tufts is *natural* to these races, which have peculiar crisp excentrically elliptical hair, and is no work of art, being of spontaneous growth, contrary to the assertions of those whose ideas of race are founded on missionary models. The hair on all the other parts of the body, of which there was no deficiency, was of the same character, there being even on the borders of the whiskers little pellets of hair on the cheeks, "like pepper-corns." The nose of the Tasmanian was not elevated, but very broad across the alæ. The upper lip was long, and the mouth wide, but of a pleasant, calm expression. In the strength of the jaws, moreover, the size of the teeth, and the large area of the grinding surface of the molars, the Tasmanians agree with the Australians, and contrast strikingly with European races.

There is a peculiarity in the physiognomy of the Tasmanians which is difficult to describe to others, but which is obvious to those, who, like Dr. Davis, have long studied their crania. It consists in "a particular roundness, or spherical form, which manifests itself in all the features." Dr. Paul Topinard, too, states ("Etude sur les Tasmaniens," Mém. de la Soc. d'Anthrop. de Paris, iii. 309) that there are certain marks in the cranium which would "enable him to recognise it anywhere."

The thickness and density of the bones of the skull, even in women, is very striking, and "constitutes a decided peculiarity of the race." The frontal and parietal bones, for instance, of a small woman's skull, from which the calvarium had been sawn off, was 0·4 inch, or 6 millimetres, in thickness. The orbits in the Tasmanian skull are, according to Dr. Topinard, small. He says, moreover, that the skull has a sinister expression, while, on the other hand, Dr. Davis regards the countenance of the Tasmanian as a "benevolent, if not mild," one.

With regard to prognathism, both in superior alveolar and in inferior alveolar, or *mental* prognathism, the Australian cranium much exceeds that of the Tasmanian.[2] This is well seen in Dr. Davis's plates (Tab. II. III.).

Touching cranial capacities, Dr. Topinard concludes that "the anterior lobes of the brain have *nearly the same* relative development in the two series of skulls, *i.e.*, the Tasmanians and others" [that is, Parisian and Breton skulls taken for comparison]. "The anterior part of the posterior cerebral lobes is a *little less* developed in the Tasmanians. The posterior part is *much less* developed. The cerebellum is more voluminous in the Tasmanians, by a quantity approximately equal to the loss which the posterior cerebral lobes undergo."

On examining the skeleton of a Tasmanian it will be observed that the bones have the usual robustness seen in European skeletons, differing thus quite from those of the Australian, which are slender. In two skeletons each belonging to one of these races, the last rib was in both three inches long, while in those of an Australian woman described by Prof. Owen this rib was but little more than one inch in length. The ilia are decidedly more everted in the Tasmanian than in the Australian. The patellæ are also larger in the former. There is no olecranon foramen in the humerus of either skeleton. The tibiæ are, moreover, straight in both, and not of sabre form.

In twenty-four Australian skulls of both sexes, there was a mean weight of brain of 41·38 ounces, or a mean internal capacity of 81·1 cubic inches, while in eleven Tasmanian skulls of both sexes the mean cerebral weight was 42·25 ounces, or a corresponding cranial capacity of 82·8 cubic inches. From this it may be deduced that the Tasmanian excels the Australian in having a brain ·87 oz., or twenty-four grammes heavier, or an internal capacity of skull superior to the extent of 1·7 cubic inch. This squares with Dr. Topinard's observations.

This being the case, we should suppose that the inventive powers of the Tasmanians would exceed those of the Australians; but this, possibly owing to some extra stimulus to the invention of the latter race, is not the case. It seems, indeed, probable that it was the abundance of food in Tasmania which was the cause of the non-invention of two of the implements so necessary to the Australian when engaged in the chase, to wit, the "boomerang" and the "wommera," or throwing stick, by which spurs were hurled, both of which are indigenous to Australia, not being known elsewhere. The Tasmanian had, indeed, the "waddy," a short stick of hard wood, which they threw with a rotatory motion so as to kill a bird on a tree, but this was a far less elegant weapon than its Australian representative, the boomerang. As evidence that the invention of implements is not commensurate, wholly and simply, with cerebral development, we must bear in mind that the bow and arrow, so useful to the Asiatics, Pacific Islanders, and American Indians, was never discovered either by the Tasmanian or Australian.

A surprising deficiency among the Australian and Tasmanian tribes is a total absence of pottery, and this among many races that had no substitute in the pericarp of fruits. This is a hard fact for those who would fain believe in the derivation of Australian and Tasmanian from other races. In some parts of Australia where long drought has been suffered the natives have actually used the dried calvarium of a deceased person, cementing the sutures with a vegetable gum, upon which they stick the shell of an oyster to protect the resin from being rubbed off. The Tasmanians were further quite unacquainted with the shield. Nothing is so demonstrative of the complete isolation of the Tasmanians as the fact that, though separated from Australia by a strait but little more than 300 miles wide, there had been no intercommunication from either side between the two countries until the advent of Europeans. This fact tells strongly against those who believe in the almost universal spontaneous diffusion of races. The Tasmanians further had no native dogs, nor was the practice of circumcision known among them, facts tending further to prove the isolation of the two races. Neither this race, moreover, nor the Australians of the south, were in possession of boats, so that even the intermediate islands in the straits were quite uninhabited. There is reason, however, to believe that, like the Australians, some tribes of the Tasmanians were accustomed to punch out the front teeth. This rests only on osteological evidence, as no account has ever been given of the prevalence of the custom among this race.

Finally, "all that can be said with truth is that the Tasmanians are not Australians, they are not Papuans, and they are not Polynesians. Although they may present resemblances to some of these, they differ from them substantially and essentially." From this it may be concluded that the Tasmanians were one of the most isolated races of mankind which ever existed. They have been one of the earliest races to perish totally by coming in contact with Europeans, and "their record now belongs wholly to the past."

J. C. G.

[1] The darkest.

[2] In a skull, however, of a male Tasmanian about thirty years o age, belonging to Dr. Davis, the prognathism, both mental and supra-alveolar, is greater than in that of an Australian youth about twenty years old.

## THE KINEMATICS OF MACHINERY

THE study of pure mechanism, a branch of kinematics, in general consists of the solution of the following problems :—Given the mode of connection of two or more points or bodies with each other, required their comparative motion, and conversely given their comparative motion to find their proper connection. Now the comparative motion of two points is determined, as laid down by Willis, when (1) the velocity ratio or the proportion which their velocities bear to each other, and (2) their directional relations, are known ; the latter requiring for its complete determination (*a*) the angle between the directions compared, (*b*) the angle which the plane containing the two directions makes with a plane fixed in space, and (*c*) the angle the intersection of the two planes makes with a fixed line on the latter plane. In "Kinematics of Machinery," the English translation by Prof. A. B. W. Kennedy of Prof. Reuleaux's "Theoretische Kinematik,"[1] the study is confined within narrower limits, causing the translator not a little difficulty, as he expresses in his preface, to translate the word kinematic, carrying as it does a more extended signification here than on the Continent. Starting with the condition that the change of position is definite at each instant, and determined by the form and connection of the fixed and moving parts, Prof. Reuleaux proceeds to investigate the directional relations of the motion and the arrangements of the parts by which the motion is best brought about without any reference to the idea of velocity.

On turning to the Appendix, pp. 585–589, we find a most interesting historical collection of the definitions of

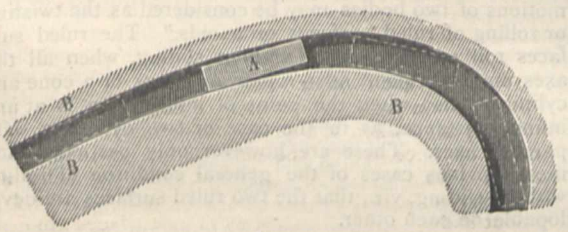

FIG. 1.

a machine, one of which definitions we remark includes equally an adhesive fly-paper and the red-hot poker of the clown; that given by Reuleaux, p. 35, is more concise and certainly nearer the point than most of these. "A machine is a combination of resistant bodies so arranged that by their means the mechanical forces of nature can be compelled to do work accompanied by certain determinate motions."

Thus the prevention, by the resistance of the different parts, of all motion other than that desired, as well as the conversion into useful work of as much of the energy expended as its *efficiency* permits, is the function of the machine. "Those parts of a machine transmitting the forces by which the moving points are caused to limit their motions in the definite and required manner, must be bodies of suitable resistant capacity; the moving parts themselves must belong also to similar bodies." But the determination of the suitable form and sectional area of the resistant parts, though indispensable in the construction of the machine, belongs to another part of the study of machine design, and cannot be included in the kinematic discussion.

We now come to the conception of a pair of elements.

In order that a body B (Fig. 1) may prevent all other motion in the body A than that desired, A being assumed to move in a plane, B must be given a form such that it always remains in contact with A in all its required positions ; when that has been done no other motion can be given to A with respect to B. This geometrical form of B is called the envelope of A, and it is plain that the motion of B with respect to A, considered fixed, is the same as that of A with respect to B, and that no other motion of B with respect to A is possible ; that is, A is also the envelope of B. The relation is thus seen to be reciprocal. A combination of this sort is called a pair of elements, and a machine consists solely of such elements, corresponding reciprocally in pairs. "The shaft and the bearing, the screw and the nut are examples of such pairs of elements. We see here that the kinematic elements of a machine are not employed singly, but always in pairs, or, in other words, that the machine cannot so well be said to consist of elements as of pairs of elements. If a kinematic pair of elements be given, a definite motion can be obtained by means of them if one be held fast or fixed in position. The other element is free to be moved, but only in the one particular way allowed by the constitution of the pair."

In order to combine two pairs of elements *a b* and *c d*, we must unite each element of one pair with one of the elements of the other pair. If this is effected as in Fig. 2, no new motion is obtained, as also when they are in the same straight line; but if *a* and *d* are united in such a manner as not to be parallel or in one straight line, the motion is entirely altered, and any points between *b* and *c* will describe a curve. In either of these two cases having united *a* to *d* and *b* to *c*, we have only two resistant bodies each limiting and determining the relative motion

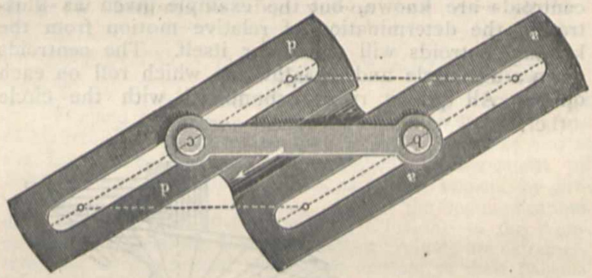

FIG. 2.

of the other ; thus the two pairs of elements are reduced to one pair, in one case with the same, in the other with a different motion.

"Accordingly, the reciprocal combination of the elements of two pairs gives us again a pair of elements which may differ from either of the single pairs of which it is composed." Again, a combination of three, four, or more pairs of elements may be made, each element of each pair being combined with one element of another pair, thus forming a linkage returning upon itself, or a so-called closed kinematic chain. Fig. 3 shows this combination. As a good example of this, the beam, connecting rod and crank of a beam-engine may be taken ; *a* and *b* are the Plummer blocks of the crank shaft and main centre rigidly connected together by the bar *a h*, which represents in the engine the rigid connection of these two by the frame, supports, and bed ; *b* the crank-shaft rigidly connected by the crank with the crank-pin *c* ; *d e* the connecting rod rigidly connecting the crank pin *c* with the gudgeon *f*, and lastly, the beam *e h* rigidly connecting the gudgeon *f* with the main centre *g*. In this closed chain of four pairs of elements the only motions of each part with respect to *a h* regarded as fixed are readily seen. Thus we are led on to the result that "the mechanism is a closed kinematic chain ; the kinematic chain is compound or simple, and consists of kinematic pairs of elements ; these carry the envelopes required for the motion which the bodies in contact must have, and by these all motions

[1] "The Kinematics of Machinery: Outlines of a Theory of Machines." By F. Reuleaux, Director of and Professor in the Königlichen Gewerbe-Akademie in Berlin, Member of the Königl. technischen Deputation für Gewerbe. Translated and edited by Alex. B. W. Kennedy, C.E., Professor of Civil and Mechanical Engineering in University College, London. (London: Macmillan and Co., 1876.)

other than those desired in the mechanism are prevented." When one of the mechanical forces of nature, such as that of falling water, moving air, or expanding steam, is applied to one of the movable links in such a manner as to cause it to change its position, mechanical work is performed accompanied by certain determinate motions, and the whole is called a machine. The relative motion of two bodies in a plane is next considered, and the conceptions of the instantaneous centre and of centroids


FIG. 3.

introduced. At each instant of the motion in a plane of one body with respect to another considered as fixed, the motion can be accurately represented by a rotation in the plane about a fixed point, which, however, in each succeeding instant may occupy a different position; this point is called the instantaneous centre, and the positions it occupies in successive instants trace the centroid. Space will not permit us to show the formation of the reciprocal centroid, or how the motion of the moving body can be represented at each instant by the rolling on one another of the centroids, and the motion of any points connected rigidly with the moving body determined when the centroids are known, but the example given as illustrating the determination of relative motion from the known centroids will speak for itself. The centroids given are a circle and straight line which roll on each other. All points rigidly connected with the circle

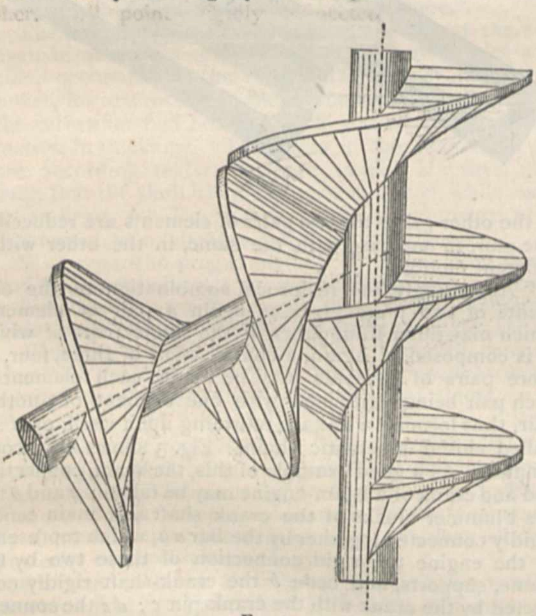

FIG. 4.

describe trochoids, the line being regarded as fixed; all points rigidly connected with the straight line describe involutes, the circle being considered fixed, and all these paths are determinate, and can be constructed if the position of the moving point with respect to the moving element, circle or line, and the centroids, the line and circle are given.

From motion in a plane and the determination of centroids we pass to motion in space. If the position of three points in a rigid body not in the same straight line are known, the position of any other point in it may be determined from them, and if the three points are fixed in space the body is also fixed. Thus, to determine the relative motion of two rigid bodies in space, we have only to consider the motion of two triangles fixed one in each of them; or the motion of one triangle fixed in the moving body with respect to the other reduced to rest. The change of position of the moving triangle may take place in many ways, but it may in every case be effected by its translation parallel to itself in a line joining the old and new positions of one of its angular points, and then by a rotation about an axis through the new position of that angular point. Thus any change of position of a rigid body may be effected by a simple translation and a simple translation about an axis. The simplest case is when the translation takes place along a line parallel to the axis of rotation, when, if the change of position of the moving body be taken indefinitely small, the instantaneous axes of rotation along which sliding simultaneously takes place become indefinitely near each other; the motion is then a simple twist.

"Consider a pair of bodies having conical rolling, in which both cones have a motion of translation in space. The rotation then takes place through the conical rolling, and the sliding through the translation of the pair of bodies." Next "consider the consecutive positions of the axes as forming a pair of ruled surfaces, one for each body, so that the motion is reduced to the rolling of the two ruled surfaces upon each other with a simultaneous endlong sliding upon each other of the generators which are in contact. The surfaces of these solids being the loci of the axes, are called axoids. Thus all relative motions of two bodies may be considered as the twisting or rolling of ruled surfaces or axoids." The ruled surfaces roll on each other without sliding, when all the axes meet in a point as in a pair of cones or a cone and cylinder; also when the point of intersection is at any infinite distance, as in the case of two cylinders with parallel axes. These are, however, only particular and more obvious cases of the general condition of rolling without sliding, viz., that the two ruled surfaces are developable on each other.

## *APPARATUS FOR REGISTERING ANIMAL MOVEMENTS*[1]

THE registering apparatus which have enabled us to carry so far the investigation of the functions in living animals are applicable to the analysis of movements of every kind in health and in disease. It is to this important application that I desire to draw your attention at the present time.

Most of the movements whose various phases we have to estimate must be transmitted to a distance, preserving at the same time all their characteristics. It is by the medium of the air that this transmission is effected, and its principle is as follows:—

Upon the organ (muscle, artery, heart) whose movements are to be investigated an apparatus called the exploring drum is applied. It is a small metal basin closed by a caoutchouc membrane, and communicating by a longer or shorter tube with a similar drum, upon the membrane of which is supported a recording lever. The pen with which the extremity of this lever is provided inscribes the curve of the movement impressed on the membrane of the first drum on a cylinder covered with smoked paper and turning on a horizontal axis.

1. Let us at once apply the process of analysis to the muscular movements of man. For this purpose we may either grasp the muscles of the ball of the thumb between the flattened jaws of the pincers which I show you, or apply to the fleshy substance of any muscle an exploring drum, the knob of which rests upon the muscle. When by means of electricity we cause a contraction or tetanus of the muscle to be studied, the curve of the contraction or that of the tetanus is recorded at a distance upon the revolving cylinder.

This apparatus shows the thickening which a muscle undergoes

[1] Paper read in the Biological Section at the Loan Collection Conferences, by Prof. Marey.

during contraction, and it furnishes results identical to those obtained by investigating the shortening of the muscle during contraction in living animals. We are then quite authorised to interpret in the same way the curves obtained in both cases.

It is needless to insist on the numerous services which the myography of man may render to physiology and medicine. The study of the forms of movement, of the latent period, of muscle, and perhaps even the rate of transmission of impulses along motor nerves, by means of this apparatus may be as easily pursued in healthy or unhealthy men as in animals.

2. Without quitting the investigation of muscular movements, let us examine that of the respiratory movements, and we shall obtain valuable information as to the means by which the important function of respiration is effected. We apply to the chest this apparatus formed of an elastic plate and furnished with two lever arms, to the extremity of which is attached a band which surrounds the thorax. Each dilatation of the chest causes the spring to bend, and it resumes its position during respiration. This double movement is accompanied by a rising and falling of the membrane of the drum which forms part of the apparatus, and which therefore becomes a regular bellows, causing the elevation and depression of the inscribing lever placed beside the cylinder.

The respiratory curves thus obtained present certain normal characteristics susceptible of being greatly modified when any obstruction interferes with the respiratory functions either by impeding the entrance or the exit of the air, or even by opposing its passage in both directions. In all these cases the curves have a special physiognomy, and their simple inspection enables us to recognise the seat of the obstacle to respiration. Clinical research will yet discover here many points for investigation.

3. But above all there are the phenomena of circulation, which have been minutely investigated both in man and animals. The apparatus by means of which we can completely analyse the movement of the heart, the arterial pulse, &c., have already rendered great service; we are, however, right in expecting yet more from it, by making use of it in clinical investigations.

Of various cardiographs, that on which I wish to dwell differs little from the explorer of which I have already spoken. The knob with which it is provided is applied to the region of the apex of the heart, and each beat of the organ is transmitted to the recording lever. There is seen in this pulsation of the heart the same elements which the physiological cardiograph has revealed in the higher animals. This beating of the heart is then a complex act, and the numerous details which have been discovered by graphic analysis have each a considerable importance from the point of view of functional investigation. One part of the tracing shows us how the ventricle is emptied into the artery; another enables us to appreciate the play of the auricle, the beating of the sigmoid valves, &c. You will easily see that the precise diagnosis of affections of the heart, already carried so far, thanks to auscultation, will be greatly improved by the application to man of the cardiograph applied to the study of the pulsation of the heart.

The arterial pulse cannot be separated from the pulsation of the heart in the study of the phenomena of circulation in man. Already numerous researches have been undertaken by means of the direct sphygmograph; but much more may be expected from the use of the air sphygmograph (*sphygmographe à transmission*).

I place this apparatus upon my wrist, and the artery raising a spring connected with the membrane of the exploring drum, transmits its movement to a distance by means of the tube filled with air, which enables this sphygmograph to communicate with the drum to which the recording lever is attached. By recording simultaneously the traces of the pulse and those of the heart much information may be obtained and many errors avoided.

4. I shall present to you, in conclusion, a new method of investigating the peripheral circulation. This method is based on the principle that the variation of the calibre of the blood-vessels in any part of the body is faithfully indicated by the variations of the volume of that part. Without dwelling on the history of these investigations, I may tell you that they originated many years ago, Dr. Piégu, of Paris, having pointed out in 1846 the alternate expansion and contraction of the tissues in connection with the dilatation and contraction of the blood-vessels. Since that time Chelius and Fick in Germany, Mosso in Italy, Franck at Paris, have carried on and extended these researches.

The recording of the movements of a column of water inclosed in a tube communicating with a receiver filled with water and into which the hand and forearm is plunged, was first effected by Fick by means of a float armed with a pen. Ch. Buisson hit on the happy idea of transmitting to a distance, by means of tubes filled with air, the oscillation of the column of water, and it is with his apparatus that M. Franck, in my laboratory, has executed a series of researches. You see the apparatus in action. The hand is plunged into this jar filled with water and hermetically closed. A vertical tube, furnished with a bulb to avoid the effects of the speed acquired by the liquid, serves to transmit to a recording lever the oscillation of the column of water. You will remark that these oscillations are rhythmical with the heart, and if we record them by the side of the cardiac pulse registered by the transmitting sphygmograph, we can establish the identity of the variations in size or, as we may term them, the pulsations of the hand and of the pulsations of a single artery. With this apparatus we may perform numerous experiments on the mechanical effects of compression of the arteries or veins, the action of the vaso-motor system of nerves, direct or reflex, &c.

I shall not explain to you by the side of this method of investigation, that which we owe to Mosso, of Turin. His plethysmograph, which ought soon to be presented to you, permits the estimation of changes of volume of the hand, and, assuredly, the combination of these two processes ought to lead to important results in the investigation of the phenomena of peripheral circulation.

I have sought to submit to you some of the points more immediately applicable to man, without dwelling on the investigation of the movements among animals. But these two orders of researches complement each other. We may say that most of the data furnished by experimentation on animals are now susceptible of rigorous verification on man, healthy or unhealthy. This verification we owe to investigation by means of precise apparatus and to the recording of the smallest movements, thanks to the registering instruments, the principal specimens of which are shown in this Collection.

## DREDGINGS OF THE "CHALLENGER"

PROF. WYVILLE THOMSON had not set foot long in Old England before presenting in person a preliminary quota of his results to the learned bodies. Two papers read by him at the Linnean Society on June 1, embodied observations on Echinodermata, a group to which, as is well known, he previously had paid much attention. One of the communications described some new living Crinoids belonging to the Apiocrinidæ. Of deep-sea forms the stalked crinoids are extremely rare, and have a special interest on account of their palæontological relations; it was therefore with satisfaction that near St. Paul's rocks at 1,850 fathoms, the trawl brought up, among other things, an entire specimen of a new crinoid, *Bathycrinus Aldrichianus*, and fragments of another, *Hyocrinus bethellianus.* At other stations and on different occasions, were obtained another species of *Bathycrinus* (*B. gracilis*) and an undetermined beautiful little species of *Hyocrinus*, besides examples of the *Rhizocrinus lofotensis* of Sars; all of these being referable to the Apiocrinidæ. In pointing out their structural peculiarities and alluding to *Bathycrinus*, he mentioned that the stem barely enlarges at its junction with the cup, the ring formed by the basals is very small, and the first radials are free from the basals and often free from one another, while the oral plates are absent. This genus appears to possess an assemblage of characters in some respects intermediate between *Rhizocrinus* and the pentacrinoid stage of *Antedon*. *Hyocrinus bethellianus* has much the appearance, and in some prominent particulars it seems to have very much the structure of the palæozoic genus *Platycrinus* or its sub-genus *Dichocrinus*. The stem is much more rigid than that of *Bathycrinus*; the cup consists of two tiers of plates only, the lower is to be regarded as a ring of basals, and the upper consists of fine spade-shaped radials. There are five arms which are pinnulated. The proximal pinnules are very long, running on nearly to the end of the arm, and the succeeding pinnules are gradually shorter, all of them, however, running out to the end of the arm. Distally the ends of the five arms, and the ends of all the pinnules meet nearly on a level. This arrangement is unknown in recent crinoids, although we have something close to it in species of the fossil genera *Poteriocrinus* and *Cyathocrinus*; with this, however, their resemblances end. *Rhizocrinus* finds its ally in the cretaceous genus *Bourgueticrinus*; *Bathycrinus* and *Hyocrinus* are evidently related to the former, but the characters of the Apiocrinidæ are nevertheless obscure in the two latter. In his second paper Prof. Wyville Thomson drew attention to peculiarities in the mode of propagation of certain Echinoderms of the Southern Sea. He passed in review examples of the Sea-cucumbers (*Holothuroids*), Sea Urchins (the circular *Cidaroids*, and heart-shaped, *Spatangoids*), Star-fish (*Asteroids*), and the Brittle Stars (*Ophiuroids*). In allusion to their phases of development he stated the majority of these pass from the egg without the intervention of a locomotive pseudembryo. Among other data in support of this view he said, that while in warm and temperate seas "plutei" and "bipinnari" were constantly taken in the surface-net; yet during the southern cruise between the Cape of Good Hope and Australia, only one form of Echinoderm pseudembryo occurred, and which was considered with some little doubt as the larva of *Chirodota* from the presence of dermal, calcareous, wheel-shaped spicules. Furthermore Prof. Wyville Thomson described in detail the almost constant occurrence among the majority of the foregoing groups a curious, receptacular pouch wherein the young are carried until arriving at a certain maturity. This marsupium is situated on the dorsal portion of the body, is composed of a series of plates which meet centrally and permit of the young creeping about and returning to it for shelter. The young derive no nutriment from the parent while contained in the "nursery," other than it may be a mucous secretion.

## THE U.S. WEATHER MAPS[1]

IN this fourth contribution to meteorology, Prof. Loomis discusses certain points of a miscellaneous nature which have been either very slightly or not at all examined in his three previous contributions. The movements of areas of high barometer, which are of so great importance in their relations to weather and climate, have been examined with the result that while the average track of areas of low pressure across the United States is nine degrees to the north of east, the track of areas of high barometer advance toward a point several degrees south of east, and with a velocity somewhat less than the former.

As regards the conditions under which the monthly minima of temperature occur, it is shown that these conditions, viz., winds very light, sky clear, and pressure above its mean height, are substantially the same at Jakutsk, Siberia, as at New Haven. Prof. Loomis is of opinion that it is true universally that periods of unusual cold are generally accompanied by a barometer above the mean, and by a descent of air from the upper regions of the atmosphere. These areas of high barometer have a broader significance than is here implied. It is the still, clear, and dry atmosphere accompanying them, *and its relations to terrestrial and solar radiation*, which afford the conditions of extreme temperatures. The monthly minima of the cold months of the year and the maxima of the warm months both frequently occur under the conditions afforded by areas of high pressure. On the other hand, in North-western Europe it is often observed that the minima of temperature during the warm months repeatedly occur within areas of low pressure where very light easterly and northerly winds prevail. In discussions of the relations of temperature and pressure, it is seldom kept steadily in mind that the given temperature is merely the temperature observed within a few feet of the earth's surface, which, as regards areas of high pressure, will nearly always mislead if it be used as a basis from which to estimate the temperature of the higher strata vertical to it; the surface temperature being abnormally low in winter from contact with the cooled surface, and in summer abnormally high from contact with the heated surface of the earth.

The examination of storm paths in America, the Atlantic, and Europe is important from the bearing of the subjects on climatology and weather-forecasting. Some interesting results of such an examination are given by Prof. Loomis in the average paths marked on the chart accompanying the paper. The results, however, are not calculated to be practically useful until the average paths be laid down for each month in the year, owing to the very great differences in these paths as regards different months. Thus, in North-western Europe, during the spring months, when east winds are most prevalent in Great Britain, many storm tracks, or the course of barometric depressions, are more southerly, and during the winter months more northerly than that indicated on the chart. If the track of storm-centres in winter generally took the line of The Channel, our winters would, on the average, be much more severe than they are, owing to the greater frequency of easterly and northerly winds, which would necessarily follow. But open winters are the rule in these islands, and even as far north as Faroe, where, during winter, southerly and westerly winds largely preponderate, thus showing that the central tracks of the majority of our winter storms lie to the north of Faroe. The exact determination of the average monthly tracks and the more marked deviations from them would throw light on several important questions affecting the climatology of the whole of North-western Europe.

Since the average velocity of storms over the United States as deduced by Prof. Loomis from 485 cases, is twenty-six miles per hour, and over the Atlantic, as deduced from 134 cases, is 19·3 miles per hour, and the average velocity of European storms as deduced by Prof. Mohn is 26·7 miles per hour, it follows that storms travel less rapidly over the ocean than over continents. If further inquiry confirms this result, we have here a valuable contribution to the theory of storms which will likely lead to a clearer insight into the causes which regulate their rate of propagation over the earth's surface, accelerating it in some cases, and in others retarding it as is frequently seen off the coast of Newfoundland and in the Bay of Biscay.

[1] Results derived from an examination of the United States Weather Maps and other sources. By Prof. Elias Loomis, Yale College. Fourth Paper. From the *American Journal of Science and Arts*, vol. xi., Jan. 1876.

## NATURAL SCIENCE AT CAMBRIDGE

THE Cambridge Natural Science Tripos has just entered upon a new phase of existence. The recent examination is the first in which a division into two parts, elementary and advanced, is carried out, the former being held in June and the latter in December. Candidates who do not satisfy the examiners in the first part are not permitted to compete in the second. The final class-list is to be based on the alphabetical principle, but the first class will consist of two divisions, each arranged alphabetically, and the subject or subjects for which a man is placed in the first class are to be indicated, while a special mark will reward superior proficiency. This system removes some of the worst faults of the competitive system, and is of especial benefit to the more able men. One subject will not be pitted against another as regards marks, an accumulation of cramming in several subjects will not serve an inferior man, and clear testimony will be given that a man has a competent knowledge of a subject, or that he is specially proficient in it. With such arrangements, the value of the examination will largely depend upon the wisdom of individual examiners. It will be obvious that there should be at least two examiners in each subject instead of one. Also the pittance they receive should be transformed into fair remuneration, which will, no doubt, be done as soon as the University has more funds at its disposal.

It was to be expected that a new system, by which no man receives any credit in a subject unless he shows satisfactory knowledge of it, and by which the examination is limited to three days, would produce a large number of failures to attain honours. The number of candidates in June was forty-four, a large increase; of these only thirty-one obtained honours, while ten others received the ordinary degree. On scrutinizing the papers, it appears that there is a difficulty in equally adjusting the questions which probably have affected the result. Two questions in each subject, except human anatomy, are given in every paper; one question only is set in human anatomy, which is introduced for the first time. I will quote some of the questions in geology and in physiology, giving fair samples; and it will be plain that they are not equivalent in difficulty, and that students of moderate ability and reading might gain honours by answering the former much more easily than the latter.

"In which of the three great divisions of stratified rocks do fossils of the genera Ichthyosaurus, Phacops, Calamites, Voluta, Terebratula, Ostrea, and Micraster respectively occur?" "Volcanic rocks have been divided into two classes, acidic and basic. Give the name and mineralogical composition of a common rock of each class." "To what conditions of deposit do fossils of the following groups of genera respectively point?—1. Unio, Paludina, and Cyrena. 2. Nautilus and Globigerina. Illustrate this by reference, in each case, to a British example."

"Explain what is meant by 'arterial tonus.' State generally what is the origin, course, distribution, and mode of termination of the nervous channels by which the brain and spinal cord influence arterial tonus." "Describe the rhythmical respiratory movements of the glottis in mammalian animals, referring to the mode of action of the most important muscles which are concerned in their production."

I only wish to point out the contrast in difficulty between the above sets of questions, without offering any opinion as to the suitability of either. In zoology and comparative anatomy the following question seems rather unusual for such an examination.—"Briefly describe the internal economy of a beehive, and the mutual relationships of its inmates." Here is a question in geographical distribution:—"In what countries are the following animals found—the orang-utan, vampire-bat, tapir, leopard, elk, emu, and python? State what principles of zoogeography are deducible from their distribution." It seems to me that a knowledge of the distribution of all the more important species is far beyond the pass qualification for an honours' examination. In admitting men to such a qualification, tests should rather be applied which every student of a subject ought to be able to respond to; but it is questionable whether we can yet expect every student of zoology and comparative anatomy to "state concisely the doctrine of evolution as employed in biology."

It is not stated in how many subjects a candidate must pass in order to obtain honours; nor are any named as essential. There is a strong feeling that elementary chemistry and physics should be made compulsory on all, and that students should be allowed to present themselves in these subjects at an earlier period of their course.

G. T. BETTANY

## NOTES

WE are glad to learn that upwards of 1,000*l*. has been subscribed towards the Chemical Society Research Fund, so that the Council are now in a position to accept Dr. Longstaff's generous offer of 1,000*l*. to form a permanent fund. We only hope that the fund may still be largely increased.

THE Albert Medal of the Society of Arts for "distinguished merit in promoting Arts, Manufactures, and Commerce," has this year been unanimously awarded to Sir George B. Airy, K.C.B., the Astronomer Royal, for "Eminent Services rendered to Commerce by his Researches in Nautical Astronomy, and in Magnetism, and by his Improvements in the Application of the Mariner's Compass to the Navigation of Iron Ships." A prize of a Gold Medal was awarded to Mr. Hearson for the best "Revolution Indicator," which should accurately inform the officer on deck, and the engineer in charge of the engine, what are the number of revolutions of the paddles or screw per minute without the necessity of counting them. For papers read before the Society medals have been awarded as follows:—To Mr. Clements R. Markham, C.B., for his paper "On the Cultivation of Caoutchouc-yielding Trees," Mr. W. T. Thornton for his paper "On Irrigation Works in India," Mr. E. Hutchinson for his paper "On the Development of Central Africa," Mr. W. Valentin for his paper "On Dextrine-Maltose, and its use in Brewing."

MR. H. N. MOSELEY, M.A., has been elected to an Extraordinary Fellowship at Exeter College, Oxford, tenable for five years under a special ordinance sanctioned by the Visitor. Mr. Moseley, who was educated at Exeter College, proceeded to his B.A. degree in 1868, having obtained a "first class" in natural science in Trinity term of the same year. He was elected in 1869 Radcliffe Travelling Fellow, and has recently been one of the scientific staff of the expedition of H.M.S. *Challenger*.

M. WADDINGTON intends to establish Fellowships in the several French Academies in imitation of the Fellowships of the English Universities. The French Fellowships are to hold good only for a limited period, and will not be subject to the restriction of celibacy. The credits will soon be asked for from the French Assemblies.

IN the University of London D.Sc. Examination Mr. Thomas Carnelley and Mr. Frank Clowes have passed in Inorganic Chemistry, Mr. James Gordon MacGregor in Electricity (treated experimentally), Mr. Edward Bibbins Aveling in Vegetable Physiology, and Prasanna Kumár Ráy in Logic and Moral Philosophy.

ON Thursday last the master and other members of the London Clothworkers' Company visited Leeds, in order to inspect the working of the Textile Industries' department of the Yorkshire College of Science, which was founded and endowed by the munificence of the Company. The visitors expressed their satisfaction with the results of the endowment, and the master, Mr. Wyld, in replying to the toast of the Company, showed that he had an unusually high idea of the duties which devolved on the London Companies as trustees of the large funds which belonged to them. While placing a high value on technical education, moreover, he expressed the opinion that any special education divorced from, or not based on, wide general culture, would be defective and inefficient.

MR. LLOYD, the president of the trustees of the Fisk donation for the construction and fitting up of the San Francisco Observatory, arrived in Paris at the end of June. His first visit was to M. Leverrier, who gave him every assistance in his power to enable him to fulfil the object of his mission. Mr. Lloyd is at liberty to use the observatory grounds for any experiments in connection with his large refractor, which it is intended to construct. M. Leverrier concurred with him in not attempting to construct a lens of more than one metre in diameter. The money at the disposal of Mr. Lloyd is 200,000*l*. The law-suit is at an end, and the donation of a similar sum for the museum is cancelled, but the astronomical donation has been confirmed.

PROF. H. G. SEELEY has been appointed Professor of Geography at the Queen's College for Ladies, Harley Street.

THE Geologists' Association are to make an excursion to the North Wales Border on Monday, July 17, and five following days.

THE forty-second annual meeting of the Statistical Society was held on June 27, at the Society's Rooms, the President, Mr. James Heywood, F.R.S., in the chair. The report read showed that the Society continues to advance steadily in numbers and in public estimation.

WE have before us the commencing number of "The Proceedings of the Linnean Society of New South Wales," which contains papers by Mr. Brazier, C.M.Z.S., on a new species of Australian and Solomon Island shells; by Mr. Ramsay on a new species of *Ptilotis* from the Endeavour River, with some remarks on the natural history of the East Coast Range near Rockingham Bay, and by Mr. Maclean, the President of the Society, on a new species of *Dandrophis* from Cleveland Bay. We are convinced that a work so well commenced has the good wishes of all interested in the diffusion of science.

MR. ALEXANDER AGASSIZ, in his recent trip to Peru, found occasion to conclude that the Pacific, within a comparatively recent time, extended through gaps in the Coast Range, and made an internal sea which stood at a height of not less than 2,900 feet, and probably much above this. This is proved by the fact of the occurrence of coral limestone 2,900 or 3,000 feet above the sea level, about twenty miles in a straight line from the Pacific. The corals are of modern aspect, although the species are undescribed. The fact that there are extensive saline basins at a height of even 7,000 feet on the coast of Peru would seem to indicate that the submergence was at one time still greater than that suggested. Indeed, eight species of *Allorchestes*, a salt-water genus of amphipod crustaceans found in Lake Titicaca, would seem to indicate that this lake, 12,500 feet above the sea, must have been at one time at the sea-level.

WE have received Part II. of vol. ii. of the *Transactions* of the Norfolk and Norwich Naturalists' Society. The Society, which has just completed its seventh year, has gradually been increasing in numbers, and there are now 150 members, many of whom are well known to the scientific world. The Society's efforts to carry out the objects for which it was established have been, on the whole, successful. Of the papers printed *in extenso*, a series of twenty letters forming a most interesting correspondence between Gilbert White and Robert Marsham, is by far the most important. This is rendered still more interesting by the valuable notes contributed by Mr. Harting and Prof. Newton. Of the other original papers, we may mention the Meteorological Report and the Ornithological Report, by Henry Stephenson, F.L.S. (author of the "Birds of Norfolk"); also the concluding portion of Mr. Geldart's list of the plants known to occur in Norfolk. The latter forms a portion (the sixth) of the Fauna and Flora of the County, which the Society is printing. Among the occasional notes and observations some interesting facts are recorded.

LIEUT. MINTZER, of the U.S. Navy, we learn from *L'Explorateur*, is organising a scientific expedition to the Arctic Seas, at Norwich, Connecticut.

A VERY destructive earthquake was felt at Corinth (Greece) on June 26, and another of the same date in Austria.

AT the Loan Collection during the present week, twelve demonstrations of apparatus were given on Monday, the same number on Tuesday, and six on Wednesday; four will be given to-day, four to-morrow, and ten on Saturday.

TWO handsome works have just been published by Masson of Paris—"Le Microscope, son Emploi et ses Applications," by Dr. J. Pelletan, with 278 figures and four plates, and "Traité d'Électricité Statique," by Prof. E. Mascart, two vols., with 298 figures.

PETERMANN'S *Mittheilungen* for June contains a considerably detailed account of the results of the discovery of Franz-Josef Land by the Payer-Weyprecht Expedition, founded on the work recently published at Vienna by Lieut. Payer. Accompanying the paper is the first satisfactory map yet published of the newly-discovered land, in which all the details of the sea and land are shown, as well as all the names imposed by the leaders of the expedition. Dr. Couto de Magalhães' "Travels in Araguaya" are concluded, and a brief synoptical summary is given of Walker's new statistical atlas of the United States.

THE Lindley Library, to which we referred last week (p. 200), does not belong to the Horticultural Society, nor was it bought by it. It was purchased with part of the surplus of the proceeds of the International Horticultural Exhibition and Botanical Congress held in London in 1866, and is vested in the hands of sundry trustees, who will be grateful for any donation. By permission of the Horticultural Society the library is deposited in its rooms.

THE twenty-eighth annual meeting of the Somersetshire Archæological and Natural History Society will be held at Bath on July 18, 19, and 20, under the presidency of Mr. Jerom Murch. Several excursions have been arranged.

THE first aquarium erected in Scotland was opened at Rothesay, in the island of Bute, last Thursday. The situation of the aquarium is in every respect favourable, and there is a large amount of tank accommodation, which has been arranged so as to contain both salt and fresh-water fish. The fresh-water tanks are perhaps the largest of the kind in the country, one of them containing over 20,000 gallons of water. A seal-pond is being constructed, and an eight-horse power engine sends the fresh and salt water from the reservoirs below to the tanks above. The reservoir for the former is capable of containing 90,000 gallons, while that for the latter has a capacity of 150,000 gallons. It is hoped that the aquarium will do good service as a school for practical natural history.

VARIOUS sanitary measures (according to Dr. Tholozan) have recently been adopted by the Turkish and Persian Governments with reference to the outbreak of plague, which commenced in Mesopotamia in the early part of the year. Since the beginning of March a sanitary *cordon* has been established on the north of the invaded territory, on the most frequented route of Kurdistan and Syria, between Tecrit and Kifri. On the south a quarantine of fifteen days is obligatory since April 1 on all vessels sailing on the Tigris and the Euphrates. It is at Kourna, at the confluence of these rivers. The ports of the Persian Gulf are protected by a quarantine which vessels from infected localities have to undergo at the island of Kezzer, formed by junction of the Chotel Aral and the Karoun. Since April 10 all communications by land between Persia and Mesopotamia are subject to a quarantine of fifteen days. For three years, it may be added, all pilgrimages into the infected country, by Persian subjects, have been interdicted. To fully comprehend this system of protection it should be remembered that on the west and north-west, for an extent of three degrees of latitude, no artificial barrier has been or can be established against the plague; but there are, happily, natural obstacles, which prove much more efficacious, the infected region being there bounded by the deserts of Syria and Mesopotamia. The greater rarity of communications there renders restrictive measures, on the arriving caravans, easier. Judging from past outbreaks of plague, it was anticipated that the present would decline in June (after reaching its *acmé* in the end of May), and disappear from Mesopotamia in July. But it may send offshoots to Bussora, Bouchére, and Arabistan, and a still greater danger is the introduction of germs of the plague into the high plateaux of Anatolia, Kurdistan, and Persia.

AN interesting addition to the literature of insectivorous plants is furnished by a reprint, by Casimir De Candolle, from the *Archives des Sciences Physiques et Naturelles*, "Sur la Structure et les Mouvements de Feuilles de *Dionæa muscipula*." With regard to the power of digestion, M. De Candolle comes to a conclusion opposed to that of Darwin, that the absorption of animal substances is not directly utilised by the leaves, and is not necessary to the development of the plant. He considers their anatomical structure favourable to the hypothesis that the movement of the two valves of the leaf results from variations of turgidity of the parenchyma of their upper surface.

A SINGULAR and useful society is in the way of formation at Paris. Seventy-two institutions of France have met in the Hotel of the rue de Grenelle to organize a general topographical association. Each institution becoming a member engages to prepare a topographical map of its commune, with roads, streams, mountains, &c. As the number of institutions in France exceeds 40,000, the number of registered adherents is very small indeed; but more are expected to join, especially if the Government takes interest in the association. The scientific value of such maps may not be great, but the result in the diffusion of geographical methods and promotion of knowledge is unquestionable.

CAPT. ROUDAIRE has delivered before the Geographical Society of Paris a lecture on the results of the survey of the Tunisian

Chotts. The measures taken last year on the Algerian side have been verified. The same level has been found for the connecting station with an immaterial difference of 2·80 metres in favour of the operation. The altitude at Gabes is only 46 metres, which is no obstacle to the channel being opened. Every objection raised by an Italian Commission has been set aside. MM. d'Abbadée and de Lesseps promised their help and testified their satisfaction.

THE half-yearly general meeting of the Scottish Meteorological Society will be held to-morrow. The business before the meeting will be—1. Report from the Council of the Society. 2. Notice as to observations of the velocity of the wind at different heights, by Thomas Stevenson, F.R.S.E., F.G.S. 3. Meteorological Register kept by James Hoy, at Gordon Castle from 1781 to 1827, communicated to the Society by His Grace the Duke of Richmond and Gordon, with remarks thereon by Mr. Buchan, secretary. This, we believe, is a very valuable register.

MR. E. F. FLOWER has published "A Sequel" to his much-needed pamphlet on "Bits and Bearing Reins." We are glad to see that his efforts to abolish the useless and cruel bearing-rein, and to introduce a rational and humane, and therefore scientific, way of managing horses has been largely successful. We cannot see how any man who wishes to be "merciful to his beast" can, after reading Mr. Flower's pamphlet, persist in the use of the bearing-rein, which after all is quite unnecessary, and no doubt tends to make a horse contract vices.

NOS. 4 and 5 of the *Iowa Weather Review* give a very good summary of the weather of the State of Iowa during December, January, and February last, dividing the season into nine decades. The winter was unusually mild, being 10°·5 above the average of Iowa winters, while during the third decade of December the excess rose to 19°·7. Less than an inch of rain fell in the north-west of the State, but in the central countries the fall was large, amounting to 9·60 inches at Davenport. Several interesting practical tables are added showing the days of thaw when the maximum exceeded 32°, days of frost when the minimum fell below 32°, and days of cold when the temperature fell to zero or lower. Sudden colds following in the wake of storms are also detailed, together with the barometric rise, and the velocity and direction of the wind, accompanying these great falls of temperature, which form so marked a feature in the climate of America. The alleged change of climate from the cultivation of the soil and the destruction of forests by which the summers, as stated, are becoming warmer and the winters colder, is a question which deserves to be carefully examined.

WE have received "Results of Meteorological Observations made at the Bath Royal Literary and Scientific Institution during the Ten Years ending February, 1875," by the Rev. Leonard Blomefield. The pamphlet, which is an extract from the "Proceedings of the Bath Natural History and Antiquarian Field Club," is a conscientious piece of work, evidently got up with the greatest care. The instruments appear to be fairly placed, except the rain-gauge, which is fixed in a faulty position, viz., at the top of a building. The monthly and yearly mean temperatures have been deduced from the 9 A.M. observations corrected for diurnal range, though it may well be doubted whether "*means*" can be calculated from observations made at only one hour of the day and whether any diurnal range corrections yet exist applicable to Bath. Some very interesting comparisons are drawn between the climate of Bath and other parts of England, with on the whole a just apprehension on the part of the author of the misleading nature of data when based on the observations of different years. Some of the differences, however, pointed out by Mr. Blomefield, such as the higher temperature of Bath as compared with Exeter during January and February disappear when a comparison is made from observations taken during the same years at each place, or from results obtained by the method of differentiation. Among the interesting results arrived at is the higher temperature of the river as compared with that of the air at Bath amounting to 2°·5 on a mean of the year, rising in June to 4°·6, and falling in February to 0°·5. In many respects the pamphlet is a valuable contribution to the meteorology of the south-west of England.

DR. H. HAMBERG, Assistant Professor of Meteorology at the University of Upsal, has written in the "Proceedings of the Royal Academy of Sciences," Stockholm, a very interesting paper on the development of the barometric minimum accompanying the thunderstorms which occurred in Sweden and Norway from July 14 to 20, 1872. From the data before him, Dr. Hamberg concludes that the barometer fell most where the sky was cloudless, and that the fall of heavy rain was generally attended with a rise rather than a fall of the barometer, much in the same way as Dr. Hann has shown to take place within the tropics at Batavia. The question is as difficult as it is important in meteorology, and the investigation of the behaviour of the barometer during our summer thunderstorms is likely to lead to most valuable results.

THE additions made to the Royal Aquarium, Westminster, during the past week are as follows:—A large collection of fresh-water fish, including Carp, Bream, Chub, Perch, Roach, and Trout, presented by the Earl of Aylesford; Sand-eels (*Ammodytes lancea*), Gemmeous Dragonettes (*Callionymus lyra*), Lump-fish (*Cyclopterus lumpus*), Five-bearded Rocklings (*Motella mustela*), Sea Bream (*Cantharus lineatus*), a shoal of young Lobsters (*Homarus vulgaris*), hatched in the tanks.

THE additions to the Zoological Society's Gardens during last week include eleven Lineated Pheasants (*Euplocamus lineatus*), nine Amherst Pheasants (*Thaumalea amherstiæ*), nine Gold Pheasants (*T. picta*) and two Peacock Pheasants (*Polyplectron chinquis*), bred in the Gardens; a Cape Buffalo (*Bubalus caffer*).

## *SCIENTIFIC SERIALS*

THE January number of Reichert and Du Bois-Reymond's *Archiv* opens with the conclusion of L. Dittmer's lengthy communication on double monsters.—Carl Sachs describes and figures the terminations of nerve fibres in certain tendons.—In a long controversial article, Prof. Hitzig defends his own and Fritsch's conclusions with respect to the functions of the cerebrum against Hermann, Braun, Carville, and Duret.—F. Boll's article on the Savian vesicles found in the torpedo about the nasal orifices and between the external edges of the electrical organs and the limb-cartilages, is very interesting, because he demonstrates the existence in their epithelium of spindle-shaped cells corresponding in character to those so commonly found in special sense organs.—Dr. Colasanti, of Rome, gives an account of the results of section of the olfactory nerve in the frog. He finds that there is no consequent alteration in the nutrition or appearance of the olfactory cells or of the peripheral ramifications of the pale nerve-fibres.—Dr. Colasanti, in another short memoir shows that the fertilised hen's egg may be reduced in temperature to from − 7° to − 10° C. without its vitality being destroyed or in any way interfered with.—Rabl-Rückhard contributes an elaborate account of the brain and cerebral nerves of the black ant (*Camponotus ligniperdus*).

The March number of the *Archiv* contains a very interesting account by P. Guttmann of his new experiments on respiration. Investigating the respiratory pause following on inspiration, he found that in vagotomised rabbits this pause does not occur. The possible reasons for this are discussed. In rabbits, in whom apnœa has been produced, it is always found that when the apnœa terminates, an inspiration, not an expiration, is the first phenomenon.—Bernstein and Steiner contribute an important paper on the transmission of contraction and the negative variation in the muscles of mammalia; but the intricacy of the subject does not admit of a brief abstract.—Another valuable paper on this subject, by Du Bois-Reymond himself, is commenced in this part. It constitutes the second part of his researches on negative variation of the muscular current during contraction, and must be consulted by all workers in this difficult branch of research.—Dr. Wenzel Grüber has five papers, some of considerable length, on various anomalous muscular dispositions. Such papers should be condensed as much as possible.

THE two last numbers of the *Nuovo Giornale Botanico Italiano* are chiefly occupied with Italian botany.—Among papers of more general interest we have a description by A. Mori, of the structure of the wood of *Periploca græca;* and two by Prof. Caruel :—On the flowers of *Ceratophyllum*, in which he describes the peculiar contrivance for the fertilisation of the female flowers, the rigid leaves apparently serving as the channel of transport for the pollen; and observations on *Cynomorium*, in which several points in the structure of the flower are detailed, and the author gives his adhesion to Dr. Hooker's suggestion of a possible genetic connection between Balanophoreæ and Halorageæ.

*Zeitschrift der Oesterreichischen Gesellschaft für Meteorologie*, March 15.—The first article is by Prof. Tomaschek, of Brünn, on mean temperatures as thermal constants for vegetation. The law, formerly pointed out by him, of the dependence of the commencement of blooming, on the height of daily mean temperatures, appears not only not to be shaken, but to be supported by an investigation of the results for the exceptional year 1862.—The next article is by Dr. Hann, on the results of observations on Mount Washington and Pike's Peak. During very cold weather, the change of temperature with height is less than usual, amounting only to about 0·3° C. for each 100 metres, so that the equilibrium of the air vertically must be at such times very stable. The mean decrease with height in the dry climate of Pike's Peak is somewhat greater than in the Alps and at Mount Washington. The daily and monthly ranges are excessive on the elevated plains. Dr. Hann greatly regrets the impracticable form in which the reports have been published, considering the desirability of having the actual observations for Pike's Peak and Colorado Springs, two stations better situated for meteorological purposes than any others in the world, accompanied by the proper data and corrections, which are here wanting.—In the Kleinere Mittheilungen we find a description of Redier's self-registering barometer.

*Journal de Physique*, February.—This number commences with the first part of a paper by M. Jamin, describing his recent researches on magnetism. He gives an account of his methods of observation, offers some theoretical ideas on the nature of magnetism, and discusses magnetic conductivity and distribution in a thin plate.—In a note on meteorology applied to agriculture, M. Marié Davy gives some interesting tables with reference to changes observed in wheat at different dates (the relation of transpired water to the temperature and actinometric degree, the weight of constituent substances, proportion of nitrogen in stalk, &c.). He considers that by the end of May or beginning of June, according to locality, one may generally deduce from meteorological data the probable value of the coming harvest, save in the case of exceptional perturbations, whose injurious action is circumscribed.—M. Duter investigates the distribution of magnetism in circular and elliptical steel plates.

*Gazzetta Chimica Italiana*, 1876, fascicolo ii.—This part commences with a paper by G. Pisati in continuation of former researches entitled :—On the elasticity of metals at different temperatures. In this paper the author treats of the elasticity of torsion at various temperatures of wires of silver, iron, steel, copper, brass, gold, platinum, and aluminium. The apparatus employed is figured, and the results shown in many cases graphically by means of curves.—On the production of ozone during the evaporation of water, by G. Bellucci.—The modifications of starch in plants, by M. Mercadante.—Synthesis of propyl-isopropyl-benzene, preliminary note by E. Paterno and P. Spica. This hydrocarbon, of which the formula would be $C_6H_4 \left\{ \begin{array}{l} C_3H_7 \\ CH_2.C_2H_5 \end{array} \right.$ has been prepared by the action of zinc ethyl on cumene chloride. It is a liquid a little lighter than water boiling at about 205°—208°. Other hydrocarbons boiling at a high temperature are also produced during the reaction. The authors propose to continue their researches.—The absence of leucine in the product of the germination of graminaceæ, by M. Mercadante.—The remainder of the part is devoted to abstracts of papers from foreign sources.

## SOCIETIES AND ACADEMIES

### LONDON

Royal Society, June 15.—"Researches illustrative of the Physico-Chemical Theory of Fermentation, and of the conditions favouring Archebiosis in previously Boiled Fluids." By H. Charlton Bastian, M.A., M.D., F.R.S., Professor of Pathological Anatomy in University College, London, and Physician to University College Hospital.

The author first calls attention to the fact that no previous investigator has professed to have seen well-marked fermentation set up in urine that had been boiled for a few minutes, if it has thereafter been guarded from contamination. The previous invariable barrenness of this fluid after boiling has been ascribed by germ-theorists to the fact that any organisms or germs of organisms which it may have contained were killed by raising it to the temperature of 212° F. (100° C.).

In executing some of the experiments with urine described in this communication, two chemical agents have been brought into operation under novel conditions, and an ordinary physical influence has been employed to an entirely new extent. In several respects, therefore, these new experiments differ much, as regards the conditions made use of, from those hitherto devised for throwing light upon the much-vexed questions as to the possible origin of Fermentations independently of living organisms or germs, and as to the present occurrence or non-occurrence of Archebiosis.

The chemical agents employed under new conditions in these experiments were *liquor potassæ* and *oxygen*—both of them being well known as stimulants, if not as promoters, of many fermentative processes.

It has been recognised by several investigators of late years that neutral or slightly alkaline organic fluids are rather more prone to undergo fermentation than slightly acid fluids. This fact may be easily demonstrated. As the author pointed out in 1870, if two portions of an acid infusion are exposed side by side at a temperature of 77° F. (25° C.) fermentation may be made to appear earlier and to make more rapid progress in either of them by the simple addition of a few drops of liquor potassæ; on the other hand, if a neutral infusion be taken and similarly divided into two portions placed under the same conditions, fermentation may be retarded, or rendered slower in either of them at will, by the simple addition to it of a few drops of acetic or some other acid.

A neutral or faintly alkaline organic solution can in this way be demonstrated to possess a higher degree of fermentability than an otherwise similar acid organic solution. It seems, therefore, obvious that the changes capable of taking place in *boiled* acid and neutral solutions respectively should also vary considerably. Numerous experiments by different observers have demonstrated the correctness of this inference. Boiled acid infusions guarded from contamination mostly remain pure and barren if kept at temperatures below 77° F. (25° C.), though other infusions similarly treated and similar in themselves, except that they have been rendered neutral by an alkali, will oftentimes become corrupt and swarm with organisms. The latter result follows still more frequently with neutral infusions when they are exposed to a higher generating temperature in the warm-air chamber; and under this stronger stimulus a small number of boiled acid fluids will also ferment.

On the other hand, the influence of oxygen in promoting fermentation has been fully appreciated since the early part of the present century. Formerly an influence was assigned to it as an initiater of fermentation as all-important as some chemists assign to living germs at the present day. But this was a very exaggerated view. In some fluids, as the author has shown, fermentation may be initiated just as freely, or even rather more so, in closed vessels from which the air has been expelled by boiling, as in others in which atmospheric air, and consequently oxygen, is present. The explanation of this fact is probably to be found in the supposition that, in starting the fermentation of these fluids, diminution of pressure may be of as much, or even of more importance than contact with free oxygen. In respect to other organic fluids, however, the influence of oxygen seems decidedly more potent as a co-initiater of fermentation than that diminution of pressure which is brought about by hermetically sealing the vessel before the fluid within has ceased to boil. Urine will be found to be an example of this latter class of fluids.

The physical influence which has been employed in unusual intensity in the present researches is *heat*.

Previous experimenters have never designedly had recourse to a generating or developing temperature above 100° F. (38° C.). The heat employed has frequently been below 77° F. (25° C.), though a temperature between this and 95° F. (35° C.) has been regarded both by chemists and biologists as most favourable to the occurrence and progress of fermentative changes generally.

Early in the month of August, 1875, the author ascertained the fact that some boiled fluids which remained barren when kept at a temperature of 77°–86° F. (25°–30° C.) would rapidly become turbid and swarm with organisms if maintained at a temperature of 115° F. (46° C.). More recently he has discovered the surprising fact that a generating temperature as high as 122° F. (50° C.) may be had recourse to with advantage in dealing with some fermentable solutions. Fluids which would otherwise have remained barren and free from all signs of fermentation have, under the influence of this high temperature, rapidly become turbid and corrupt. This discovery is regarded as of great importance in reference to the questions now under discussion, and it is one which was quite unexpected. The author had previously shared in the generally received opinion that temperatures above 100° F. (38° C.) were likely to impede rather than promote fermentation.

In maintaining the experimental fluids at the high temperature above-named, the vessels containing them were placed in the hot-air chamber of an incubator, such as physiologists employ, to which one of the very ingenious gas-regulators of Mr. F. S. Page had been fitted (see *Journal of the Chemical Society*, January, 1876). In this way the fluids may be kept at a known and practically constant temperature for an indefinite time.

*Liquor Potassæ as a Promoter of Fermentation in Boiled Urine.*

In the autumn of 1875 the author instituted some experiments to ascertain whether the fermentability of boiled urine, like that of many other fluids, could be increased by previously mixing with it a quantity of liquor potassæ sufficient for its neutralization.

The experiments answered this question in the affirmative. It was found that urine to which the above-named amount of liquor potassæ had been added, would constantly ferment and swarm with organisms within a few days after it had been boiled; though some of the same stock of urine in the acid state (that is, without the addition of any alkali) would when similarly treated in other respects, remain barren. The fact of the production of an increased fermentability in boiled urine by previous neutralisation was thus established.

Further experiments were then instituted to throw light upon the cause of such increased fermentability. It was desirable to ascertain whether (1) it was due to survival of germs in the boiled neutralised fluid, or (2) to the chemical influence of potash in initiating or helping to initiate the molecular changes leading to fermentation in a fluid devoid of germs or other living matter.

The mode of testing the relative validity of these rival interpretations seemed easy. It was only necessary to ascertain what the effect would be of adding boiled liquor potassæ, in proper quantity, after the acid urine had been rendered barren by boiling it instead of adding it previous to the process of ebullition. If fermentation occurred in the fluid thus neutralised without extraneous contamination, the first interpretation would obviously be negatived.

This crucial experiment was at first tried with flasks plugged with cotton-wool, the plug in each of them being penetrated by a closed glass tube containing the measured amount of liquor potassæ. The tubes having been drawn out to a capillary portion at the lower end, and bent at an obtuse angle, they could be easily broken by slight downward pressure against the bottom of the flask whenever it was desired to mix the liquor potassæ with the boiled urine. This apparatus was very similar to that first made use of by Dr. William Roberts in some experiments with hay-infusion (Phil. Trans. vol. clxiv. p. 474), in which he obtained opposite results from those now about to be recorded with urine. The latter fluid is, however, for several reasons more suitable than hay-infusion for trying such experiments.

Several trials made with urine in this apparatus showed that its fermentability was just as much increased by adding boiled liquor potassæ after the urine had been boiled in the acid state, as by adding the alkali previous to the process of ebullition. Such a result was therefore quite opposed to the first interpretation as to the cause of the increased fermentability of neutralised urine.

The definite overthrow or establishment of this interpretation was so important that it seemed desirable to try such experiments again by some more rigid and certain method. The author, therefore, devised a new mode of experimentation in which sealed retorts replaced the flasks plugged with cotton-wool, and in which the contents of the enclosed liquor-potassæ tubes could be more effectually heated.

It was first of all ascertained that accurately-neutralised urine boiled in a retort and sealed whilst boiling, would ferment in a day or two if kept at a temperature of 122° F.[1]

This fact having been established, other retorts were charged with a measured amount of urine, and also with a small glass tube containing liquor potassæ in quantity almost sufficient to neutralise the urine employed.[2] The glass tubes containing the liquor potassæ had been drawn out at one end, sealed, and then immersed in boiling water for different periods before introducing them into the retorts. After each retort had been charged with urine and a liquor potassæ tube, its neck was drawn out to a capillary point, the urine was boiled, and the retort was hermetically sealed before ebullition had ceased. Thus closed, the vessel was at once immersed with its neck downwards in a can of boiling water for from four to fifteen minutes, so as to expose it and its contents for an additional period to a temperature of 212° F. (100° C.).

The urine was thus boiled in its unaltered acid state and sterilised. After the retorts had cooled the liquor potassæ was liberated from its tube in all but one of the batch, which was kept as a control experiment. The liberation was easily effected. It was only necessary to give the retort a sudden shake so as to drive the capillary neck of the enclosed tube against its side. The tube was thus broken and immediately (owing to the comparative vacuum within the retort) the liquor potassæ was sucked out and mixed with the fluid which it was destined to neutralise.

The result of these experiments was similar to those executed with the plugged flasks and liquor-potassæ tubes. The boiled caustic potash added afterwards within the sealed retorts, caused the previously barren fluids to ferment and swarm with *Bacteria*. The fluid in the control experiment remained pure, though after several days, or longer, it also could be made to ferment by breaking the liquor-potassæ tube, and replacing the retort in the warm chamber.

*Effects of liberating Oxygen by Electrolysis within the Closed Retorts.*—A few other experiments were made with retorts to which platinum electrodes had been fitted. These contained, as before, measured amounts of urine, together with liquor potassæ tubes. All the preliminary stages were similar to those of the experiments above recorded; but just before breaking the liquor-potassæ tubes in these further experiments, oxygen and hydrogen were liberated from the boiled urine by electrolysis.

The result in the few experiments made was very remarkable. Under the combined influence of liquor potassæ, oxygen, and the high temperature of 122° F. (50° C.), the sterilised urine fermented and swarmed with *Bacteria* within the closed retorts in from 7–12 hours—that is, in a much shorter time than would suffice for the occurrence of similar changes in unboiled urine freely exposed to the air.

*Behaviour of some specimens of unaltered Acid Urine under the influence of the High Generating Temperature of* 122° F. (50° C.).

In the course of the previous experiments it was found that occasionally a specimen of boiled urine would ferment at a temperature of 122° F. without the addition of liquor potassæ. This was afterwards ascertained to occur invariably (with the urine experimented upon) when the acidity of the fluid was not higher than would be represented by six minims of liquor potassæ to the ounce (or about $1\frac{1}{4}$ per cent.). Urines slightly more acid than this sometimes did and sometimes did not ferment without liquor potassæ; but when the acidity exceeded what would be equivalent to two per cent. of liquor potassæ, the fluid did not ferment under the influence of the high generating temperature alone. Urines of all degrees of acidity, however, were found to ferment under the combined influence of heat and liquor potassæ added afterwards, in the manner already detailed.[3]

[1] Though the boiled urine will ferment in retorts from which the air has been expelled by boiling, it will undergo this change more quickly if it is in the presence of purified or sterilised air. In the experiments now about to be described, however, it was much more convenient to use airless retorts.

[2] As a slight excess in the amount of liquor potassæ has been proved to have a most restrictive influence when dealing with urine, it was found safer in these experiments not to provide liquor potassæ sufficient for full neutralization. Many details on this subject are given in the memoir itself.

[3] In the urine of highest acidity with which experiment has been made, twenty minims of liquor potassæ to the fluid ounce (about 4 per cent.) was required for neutralisation.

It was further ascertained that the acidity of some specimens of urine was lessened during the process of ebullition (owing to the deposition of acid phosphates); and such urines boiled for six minutes were found to ferment in a much shorter time than when they were only boiled for three minutes. The prolongation to this extent of the germ-destroying temperature actually hastened the subsequent process of fermentation.

*Interpretation of Results.*

The generally received belief that all *Bacteria* and their germs are killed by exposing them even for a minute or two to the temperature of 212° F. (100° C.) has of late been strongly reinforced by Prof. Tyndall. The fact, therefore, of the fermentation of some specimens of boiled acid urine, with the appearance of swarms of *Bacteria*, under the influence of the high generating temperature of 122° F. (50° C), is inexplicable except upon the supposition that fermentation has in these instances been initiated without the aid of living germs, and that the organisms first appearing in such fluids have been evolved therein.

If the author's further position (Proceedings of Royal Society, Nos. 143 and 145, 1873), that *Bacteria* and their germs are killed in fluids whether acid or alkaline at a temperature of 158° F. (70° C.), is correct, then the occurrence of fermentation in the previously neutralised boiled urine would similarly disprove the exclusive germ-theory of fermentation and establish the occurrence of Archebiosis.

Any difficulty which might have been felt by others in accepting the above interpretation of the results of these latter experiments—in face of the view held by M. Pasteur that some *Bacteria* germs are able in neutral fluids to survive an exposure to a heat of 212° F. (100° C.)—has been fairly met and nullified by the experiments (devised for the purpose), in which the urine was boiled in the acid state and subsequently fertilised by the addition of boiled liquor potassæ.

If we look at these latter experiments from an independent point of view, it will be found that this fertilisation of a previously barren fluid by boiled liquor potassæ must be explained by one or other of three hypotheses:—

1*st Hypothesis. The boiled liquor potassæ may act as a fertilising agent because it contains living germs.*—However improbable this hypothesis may seem on the face of it, it has been actually disproved by many of the experiments recorded in this memoir. These experiments show that boiled liquor potassæ will only act as a fertilising agent when it is added in certain proportions. If it acted as a mere germ-containing medium, a single drop of it would suffice to infect many ounces, a gallon, or more of the sterilised fluid. This, however, is never the case; it only fertilises the barren urine when it is added in a proportion dependent upon the precise acidity and quantity of the fluid with which experiment is being made.

2*nd Hypothesis. The fertilising agent may act by reviving germs hitherto presumed to have been killed in the boiled acid urine.*—The acceptance of this hypothesis would involve a general recantation of the previously received conclusion that *Bacteria* and their germs are killed by boiling them in acid fluids. But such a recantation would be scarcely justifiable or acceptable unless based upon good independent evidence.

The possibility, however, of accepting this second hypothesis is still further closed by the results of experiments in which a slight excess of liquor potassæ was added to the boiled urine. Such fluids invariably remained barren. Yet it can be easily shown that the mere development and growth of *Bacteria*-germs may take place both quickly and freely in boiled urine containing a very large excess of liquor potassæ.[1] It would seem that this agent mixed with boiled urine in quantity slightly more than is needed for neutralisation, prevents the *origination* of living matter therein, although even when in considerable excess the same agent affords no obstacle to the development, growth, and multiplication of germs purposely added thereto.

In the face of these facts it would seem impossible to accept this second hypothesis, even if it had not been independently negatived by the great mass of evidence—lately reinforced by the experiments of Prof. Tyndall—to the effect that *Bacteria* and their germs are really killed in fluids raised for a few minutes to the boiling-point (212° F.).

3*rd Hypothesis. The fertilising agent acts by helping to initiate chemical changes of a fermentative character in a fluid devoid of living organisms or living germs.*—If the cause of the fermentation of the fluids in question does not exist in the form of living organisms or germs either in the fertilising agent itself or in the medium fertilised, then it must be found in some chemical reactions set up between the boiled liquor potassæ and the boiled urine.

The experiments in which liquor potassæ is added to urine in definite proportions before and after it has been boiled with the result of inducing fermentation in the otherwise barren fluids, as well as those in which unaltered urine ferments under the influence of the high generating temperature of 122° F. (50° C.), all alike, therefore, point to the same conclusion. They show, as other experiments have done, that an exclusive germ-theory of fermentation is untenable; and they further show that living matter may and does originate independently during the progress of fermentation in previously germless fluids.

As a result of the fermentative changes taking place in boiled urine or other complex organic solutions, many new chemical compounds are produced. Gases are given off, or these with other soluble products mix imperceptibly with the changing and quickening mother-liquid, in all parts of which certain insoluble products also make their appearance. Such insoluble products reveal themselves to us as specks of protoplasm, that is of "living" matter. They gradually emerge into the region of the visible, and speedily assume the well-known forms of one or other variety of *Bacteria*.

These insoluble particles would thus in their own persons serve to bridge the narrow gulf between certain kinds of "living" and of "dead" matter, and thereby afford a long-sought-for illustration of the transition from chemical to so-called "vital" combinations.

[1] A mixture of one part of liquor potassæ to seven of boiled urine poured into a bottle which has been washed with ordinary tap-water will, within forty-eight hours, swarm with *Bacteria* if it is kept at a temperature of 122 F.

**Zoological Society**, June 20.—Prof. Flower, F.R.S., vice-president, in the chair.—The Secretary exhibited a drawing of a fine species of Fruit-Pigeon of the genus *Carphopoga*, living in the Society's Gardens, which apparently belonged to *C. paulina*, Bp. of Celebes and the Sulu Islands.—Mr. Sclater read extracts from letters received from Signor L. M. D'Albertis and Dr. George Bennett, respecting M. D'Albertis' proposed new expedition up the Fly River, New Guinea, and exhibited a small collection of bird skins made at Yule Island and on the adjoining coast of New Guinea, by the last-named naturalist.—Dr. A. Günther, F.R.S., read a letter from Commander W. E. Cookson, R.N., respecting the large tortoises obtained in the Galapagos Islands which had been recently deposited in the Society's Gardens by Commander Cookson. The living specimens had been obtained in Albemarle Island, those obtained in Abingdon Island having died before reaching this country. Dr. Günther added some remarks on the specimens of tortoises and other animals collected by Commander Cookson, and promised a more detailed account on a future occasion.—Mr. G. E. Dobson read a paper on peculiar structures in the feet of certain species of mammals by which they are enabled to walk on smooth perpendicular surfaces, especially alluding to *Hyrax* and the bats of the genus *Thyroptera*.—A communication was read from Dr. J. S. Bowerbank, F.R.S., being the sixth part of his monograph of the silicio-fibrous sponges.—A communication was read from the Rev. O. P. Cambridge containing a catalogue of a collection of spiders made in Egypt, with descriptions of new species and characters of a new genus.—A communication was read from Mr. W. T. Blanford containing remarks on the views of A. von Pelzeln as to the connection of the faunas of India and Africa, and on the mammalian fauna of Tibet.—A second communication from Mr. W. T. Blanford contained remarks on some of the specific identifications in Dr. Günther's second report on collections of Indian reptiles obtained by the British Museum.—Mr. Howard Saunders read a paper on the *Sterninæ* or Terns, with descriptions of three new species, which he proposed to call *Sterna tibetana*, *Sterna eurygnatha*, and *Gygis microrhyncha*.—Dr. Cunningham, of the University of Edinburgh, described a young specimen of a dolphin, caught off Great Grimsby, in September, 1875. After pointing out the great difficulty experienced in referring it to its proper place amongst the dolphins—this difficulty arising chiefly from the unsatisfactory and even unreliable descriptions which have been given in this country by former observers—he came to the conclusion that he was justified in referring it to *Delphinus albirostris*, the differences being, in his opinion, merely those of age.—Mr. J. W. Clark read some notes on a dolphin lately taken off the coast of Norfolk, which he was likewise induced to refer to the same species.—A communication was read from Mr. R. B. Sharpe, containing the description of an apparently new species of owl from the Solomon Islands, which he proposed to call *Ninox solomonis*.—Mr. A. H. Garrod some notes on the anatomy of certain parrots.—Mr. H. E. Dresser read the description of a new species of broad-billed sandpiper, from North-Eastern Asia, to which he gave the name *Limicola sibirica*.—A second communication from Mr. Dresser contained the description of a new species of *Tetraogallus*, discovered by Mr. Danford in the Cilician Taurus, which he proposed to call *T. tauricus*.—Dr. A. Günther read some notes on a small collection of animals brought by Lieut. L. Cameron, C.B., from Angola.—A communication was read from Lieut. R. Wardlaw Ramsay, giving the description of a fine new species of Nuthatch from Karen-nee, which he proposed to call *Sitta magna*.

**Meteorological Society**, June 21.—Mr. H. S. Eaton, M.A., president, in the chair. The following papers were read:—On the climate of Scarborough, by F. Shaw. The thermometers used were placed in a louvre-boarded case fixed to the north side of a wooden structure, having an open grass plot in front of them. The garden is about midway between the north and south sides of the town, and 150 yards from the shore; and as both residents and visitors are continually passing along this line, the observations may be taken as fairly representing the temperature of Scarborough as a watering-place. The mean monthly temperatures based on the average of the past eight years are:—

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| Jan., 38°·8 | April, 46°·6 | July, 60°·4 | Oct., 48°·2 |
| Feb., 39·7 | May, 50·5 | Aug., 58·9 | Nov., 42·2 |
| Mar., 41·6 | June, 55·9 | Sept., 55·1 | Dec., 39·0 |

The mean for the year is 48°·1.

The maximum temperature on any day in July, the warmest month, does not exceed on the average, 78°·0; the highest in the eight years being 85°·5 in 1868. The mean of the extreme minimum temperature in the eight Januarys is 24°·2; the lowest being 13°·3, which occurred on January 1, 1875. The moderate and agreeable summer temperature is due to the close proximity of the town to the sea, which in the warmest month of the season is about 5° below that of the air. The autumn and winter temperatures are also much influenced by the sea on the one hand, and the shelter afforded by the surrounding hills on the other. The sea is about 5° warmer than the air in the autumn, and 3° in the winter, while the prevailing winds are south-westerly and not felt in their full force. The annual rainfall, on the average of the past ten years, is 28·29 inches, which falls on 167 days.—Notice of upward currents during the formation and passage of cumulus and cumulo-stratus clouds, by Rev. J. Crompton. On Nov. 1, 1866, the day after the visit of the Prince and Princess of Wales to Norwich, when the city was profusely decorated with flags, the author, when walking close to the cathedral, was struck with the unusual fluttering of the flags on the top of the spire, which is 300 feet high. They were streaming with a strained, quivering motion, perpendicularly upwards. A heavy cloud was passing overhead at the moment, and as it passed the flags followed the cloud and then gradually dropped into comparative quietness. The same phenomenon was noticed several times. As the cloud approached, the upper banners began to feel its influence, and streamed towards it against the direction of the wind, which still blew as before, steadily on all below; as the cloud came nearer the vehement quivering and straining motion of the flags increased, they began to take an upward perpendicular direction right into the cloud, and seemed almost tearing themselves from the staves to which they were fastened; again, as the cloud passed they followed it as they had previously streamed to meet its approach, and then dropped away as before, one or two actually folding over their staves. All the other flags at a lower elevation did not show the least symptom of disturbance.—Suggestions on certain variations, annual and diurnal, in the relation of the barometric gradient to the force of the wind, by Rev. W. Clement Ley. The author finds that the mean velocity of the wind corresponding to each gradient is much higher in summer than in winter. This is the case at all stations (though not equally) with all winds, with all lengths of values of radius of isobaric curvature, and with all values of actual barometric pressure. The general character of the mean diurnal variations of velocity, as these occur at the stations in the British Isles, may be fairly inferred from mean horary velocity curves, and may be thus described:—At the inland stations, in summer, a slight increment of velocity occurs about midnight. This is succeeded by the morning minimum, which takes place in most of the months examined a little after sunrise. The mean velocity then rises until 1 P.M., when the diurnal maximum is sometimes attained. A slight subsidence then commonly occurs, but the mean velocity rises again at 3 or 4 P.M., and this second increment frequently forms the diurnal maximum. A great fall then takes place, which is more rapid than the rise in the morning; and the evening minimum, which is in most months the diurnal minimum, is attained about 10 P.M. The mean velocity at 1 P.M. is, in fine and hot weather, more than double the 10 P.M. velocity in miles per hour, and exceeds the diurnal mean by about one-third. In winter the inflexions are very greatly modified. The midnight rise is not in all months traceable, and the subsequent diminution is not very great. The morning maximum occurs about sunrise. The diurnal maximum takes place about 1 P.M., is less than double the minimum in miles per hour, and exceeds the mean of the day by about one-fifth only.—Average weekly temperature of thirty years (1846–75) at Cardington, by John Maclaren.—De la vulgarisation par la presse des Observations météorologiques, by M. Harold Tarry.

**Physical Society**, June 10.—Prof. G. C. Foster, president, in the chair.—Mr. W. J. Wilson exhibited and explained a reflecting tangent galvanometer which he has recently designed for the purpose of exhibiting the indications of the instrument to an audience, and so arranged that the divisions on the scale show without calculation the relative strengths of different currents. It should be observed at the outset that this object cannot be attained by attaching a mirror to the needle as in the ordinary galvanometer, as the angle passed over by the reflected ray is double that through which the needle is deflected. In the arrangement exhibited, the beam of light after passing through a small orifice traversed by cross wires, is reflected vertically by a fixed mirror: the ray then passes through a lens, and is again reflected from a small plane mirror parallel to the first, which is rigidly fixed below a small magnetic needle. By this means the ray becomes again horizontal, and, since the light now falls on the second mirror always at the same angle, the extent of motion of the ray is identical with that of the needle, and, if the scale be one of equal parts placed in the magnetic meridian, the indications on it will be proportional to the tangents of the angles, and therefore to the strengths of the currents. The needle and mirror are suspended by a silk fibre, and a bent strip of aluminium, the ends of which dip into water in an annular trough, is attached to the needle in order to check its oscillations. A series of observations taken with varying resistances introduced into the current, showed that the indications are very reliable.—Mr. S. P. Thompson then exhibited an electromotor clock made by Mr. W. Hepworth, of York, and provided with a commutator of Mr. Thompson's design. This part of the instrument is very simple, and reverses the current at each single oscillation by means of two light springs resting on inclined planes. The motion of the pendulum drives the train of wheels by a modification of the gravity-escapement, and a very small battery-power is sufficient.—Prof. G. Fuller, C.E., exhibited and described his "electric multiplier," an instrument which may be looked upon as an automatic electrophorus. An insulated plate of vulcanite is supported in a vertical position, and on each side of it is an insulated metallic plate, and these can be moved together to and from the vulcanite by rotating a handle. When these plates are far apart, two metallic arms provided with points are made to pass one on each side of the vulcanite plates. One of these is insulated, and is provided with a rod terminating in a knob, which at a certain point in its path almost touches the metallic plate on the opposite side of the sheet of vulcanite. The other arm is in connection with the earth. The action of the instrument is as follows. A charge of, say, negative electricity, having been given to the insulated arm, it is passed over its face of the vulcanite, while positive is drawn up from the earth and thrown upon the opposite face by the uninsulated series of points. These arms are then removed, and the two metallic plates are brought into contact with the vulcanite. Call the side of the plate charged with negative electricity A, and the other B. The negative of A induces positive on the near face of its metallic plate and repels the negative. This passes, by a strip of tin-foil joining the two faces of the vulcanite, to the other metallic plate neutralising its free positive, and when the plates are moved away from the vulcanite, that from A is charged with positive, and that from B with negative. Before reaching its extreme position this latter communicates its charge to the insulated arm by the brass knob, and the electricity is then distributed over the face A. At the end of its path B is momentarily connected to earth. It will be evident that the effect of again bringing the plates in contact is to increase the charge of positive electricity on the metallic plate opposite the face A. With the small model exhibited, Prof. Fuller has frequently obtained sparks an inch in length.—Prof. Guthrie then exhibited and employed Prof. Mach's apparatus for sound reflexion, which is one of an interesting series of appliances designed by him for the demonstration of certain fundamental principles in physics. It consists of a mathematically exact elliptical tray, which is highly polished and provided with a close-fitting glass cover. The tray is covered with pulverised dry silicic acid, and a Leyden jar frequently discharged between two small knobs at one of the foci, when the silicic acid arranges itself in fine curves around the other focus.

Entomological Society, June 7.—Prof. Westwood, president, in the chair.—Messrs. A. A. Berens, A. H. Swinton, and C. M. Wakefield were elected ordinary members.—Mr. Douglas made some further remarks on the "Corozo Nuts," known as "Vegetable Ivory," exhibited by him at the last meeting, which were attacked by a beetle of the genus Caryoborus. Mr. McLachlan, in connection with the above, exhibited the nuts of a species of Caryoborus (*C. bactris*) forwarded to him by Prof. Dyer. In this case each nut served as food for a single larva only, which bored in it a cylindrical hole of considerable size and depth; whereas the former nuts were infested with several larvæ in each nut.—The President exhibited the larva of an Australian species of Hepialus, from Queensland, bearing a singular fungus, with four or five branches issuing from the back of the neck and the tail; also a fungus growing out of the back of a Noctua pupa.—Mr. McLachlan, on behalf of Dr. Atherstone of South Africa, exhibited a couple of very singular Orthopterous insects (belonging to the Acrydiidæ), which in colour and in the granulated texture so exactly mimicked the sand of the district as to render it almost impossible to detect them when at rest. The insect was supposed to approach the *Trachyptera scutellaris*, Walker.—The President read descriptions and exhibited drawings of two very singular forms of Coleoptera from Mr. A. R. Wallace's private collection. For the first, which belonged to the Telephoridæ, he proposed the generic name Astychina, remarkable for the form of the terminal joints of the antennæ in one sex, which were modified with what appeared to be a prehensile apparatus, differing from anything known in the insect world, but of which some analogous forms were found to occur among certain Entomostracous Crustacea. The other pertained to the Cleridæ, and was named Anisophyllus, differing from all known beetles by the extremely elongated branch of the ninth joint of the antennæ.—Mr. Smith read descriptions of new species of Hymenopterous insects from New Zealand, collected by Mr. C. M. Wakefield.—Mr. J. S. Baly communicated descriptions of new genera and species of Halticinæ.—Dr. Sharp communicated descriptions of a new genus and some new species of Staphylinidæ from Mexico and Central America, collected by Mr. Salvin, Mr. Flohr, and Mr. Belt.—Part I. of the Transactions for 1876 were on the table.

PARIS

Academy of Sciences, June 19.—Vice-Admiral Paris in the chair.—The following papers were read:—Theorems relative to curves of any order and class, in which are considered couples of rectilinear segments having a constant product, by M. Chasles. Experimental critique on glycémia (continued), by M. Cl. Bernard. He illustrates these three points:—1. Sugar is rapidly destroyed in the blood after its extraction from the vessels. 2. Within the vessels, after death, sugar disappears rapidly. 3. In the living animal, the saccharine richness of the blood oscillates constantly.—On the cause of the movements in Crookes's radiometer, by M. Govi. He rejects the idea of an impulsive force of light, and of thermal currents of gas in the receiver; the causes he assigns being the dilatation by heat, or condensation by cold, of gaseous layers which all bodies retain at their surface, even in an absolute vacuum. It should be possible to obtain insensible radiometers, by heating the vanes, during the action of the mercury pump. M. Fizeau said the constant motion, for as long as an hour, of a radiometer placed in the centre of a circle of candles, was against this hypothesis.—Examination of new methods proposed for finding the position of a ship at sea, by M. Ledieu.—On the existence of mercury in the Cevennes, by M. Leymerie. In 1843 he had evidence that liquid mercury had been met with near a village at the foot of the Jurassic plateau of Larzac, was injurious to vegetation, was used to cure sheep disease, &c.—The plague in 1876; prophylactic measures, by M. Tholozan.—M. Pasteur presented a work entitled "Studies on Beer: its Maladies, and their Causes; Process for rendering it Unalterable, with a New Theory of Fermentation."—Influence of temperature on magnetisation, by M. Gaugain. Allevard steel and Sheffield steel undergo nearly the same *permanent* modification when subjected to the same alternations of temperature, but the *temporary* modification is much greater for the Sheffield steel than for the other. The coercive force is diminished by variations of temperature. The inductive action on a bobbin diminishes when the temperature increases.—Extension of the principle of Carnot to electric phenomena; general differential equations of the equilibrium of the movement of any reversible electric system, by M. Lippmann.—Letter to M. Dumas on experiments on the use of sulphide of carbon and sulphocarbonates, by M. Delachanal.—A letter from MM. Weyprecht and Wilczek was read, explaining their project for scientific exploration of the arctic regions.—Differential electro-actinometer, by M. Egoroff. Two of Edmond Becquerel's actinometers are arranged one above another in a common box, so that the current of the one is neutralised by that of the other, and a mirror galvanometer is interposed in the circuit. Each actinometer is a parallelopipedal box of glass with two opposite sides of hardened caoutchouc, and slits with silver plates in them. The outer box has slits to correspond, the width of which can be varied. The absorbing body to be studied is placed between the light and the slit corresponding to one of the actinometers, and the galvanometer noted when one and when both of the actinometers are in action.—Researches on the commercial analysis of raw sugars, by MM. Riche and Bardy.—On a new class of colouring matters, by M. Lauth. The first source of these has been the aromatic diamines obtained in reducing the nitrated derivative of acetylic combination of organic bases.—On some derivatives of isoxylene, by M. Gundelach.—On the spirophore, an apparatus for recovery of the asphyxiated, especially for drowning persons and new-born infants, by M. Woillez. (We notice this elsewhere.)—Graphic study of movements of the brain, by M. Salatré. Into an orifice of the cranium is inserted a glass tube, with caoutchouc stopper above, traversed by a smaller glass tube, which is connected with a lever and drum arrangement (of the Marey type). Water is poured in till it reaches about the middle of the small tube; its oscillations (from the brain surface) affect the registering lever. Among other results, the respiratory oscillations, observed simultaneously in the brain and the vertebral column, are synchronous. Artificial respiration reverses the order of oscillations, the liquid rising in inspiration, falling in expiration. Attitudes have a great influence. In efforts of any kind the oscillations are much increased.—Contractile vacuoles in the vegetable kingdom, by M. Maupas. The contractile vacuole has been regarded as a characteristic of animality. But various recent facts are against this. M. Maupas describes contractile vacuoles he has found in macrospores of the algæ, *Microspora floccosa*, Thuret, and *Ulothrix variabilis*, Kützing (both in Algeria).—The mineral of nickel, in New Caledonia, or "Garnierite," by M. Garnier.—On nitrated alizarine, by M. Rosenstiehl.

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