THURSDAY, NOVEMBER 14, 1872

## EXPLORATION OF THE SOUTH POLAR REGIONS

IN the various explorations which the last few years have seen, it must be admitted that the South Pole has been neglected, and its rival, the North Pole, has had it all its own way. It is not to be wondered at, therefore, that Dr. Neumayer, with whom the Exploration of the South Polar regions has been a cherished project from his youth, and who for many years has lived in the hope of some day having the privilege granted him of taking part in an expedition on board a German ship that might have the honour of penetrating the South-Polar circle, and clearing up the mystery that lies beyond, will allow this state of things to continue without protest. Since this hope has been time after time frustrated, and because he fears that now it may never be realised, he is determined to do what he can to rouse an active interest in the subject among scientific men. By lectures in various parts of Germany, and otherwise, he endeavoured some little time ago to set afoot an exploring party, whose observations might have been of great use in connection with the now not very distant Transit of Venus, but in this, too, he failed; so that now there remains only the hope that, in connection with the scientific expeditions to the south for the observation of that momentous astronomical event, something may be done towards the realisation of the "darling scheme of his youth." Hence, to awaken a general interest in antarctic explorations, as well as to show what remains to be done, Dr. Neumayer has reprinted, in the form of a pamphlet, a long article of his from the "Zeitschrift der Gesellschaft für Erdkünde," on the subject, referring to his numerous lectures and writings on the subject, and has given a brief sketch of the progress of discovery in the South Polar regions, and an admirable summary of the points to which any expedition should direct its attention—to which, anxious to second his efforts, we gladly draw attention.

Of maritime expeditions, those to the Polar regions have had a lasting interest for geographers, both as leading to the solution of important scientific problems, and as being of value from a more material point of view. The importance of scientific observation inside the Polar circle is evident, Dr. Neumayer declares, to all who have any knowledge of the phenomena on the surface of the globe. Without such observations there exists a void and a lamentable one-sidedness in our knowledge, offering a fertile field for numberless, and mostly worthless, hypotheses. What have been the results of efficient observation in the far north for the confirmation and correction of our knowledge in the departments of magnetism, climatology, the geographical distribution of plants and animals, the laws of ocean currents, is shown by a superficial glance at the history of the development of these departments of science. But Dr. Neumayer maintains that for the purpose of discovering those general laws which are necessary as guides and standards in the interpretation of phenomena in climatology and physical geography generally, the South Polar regions are much better adapted than those of the North. A glance at the globe, he maintains, shows that such results can be obtained only by the expenditure of vast means and laborious research in the north, on account of the nature of the division of the land and water, which also throws difficulties in the way of a satisfactory study of the phenomena; whereas no such difficulties and disturbances are presented by the prevailing sea of the South Polar regions. These statements could be proved by many examples from physical geography, but it is only necessary to refer to the valuable additions which have been made by researches in high south latitudes to our knowledge of the laws of the relation between the distribution of the pressure of the air and of heat, and of the laws of winds. Moreover, Dr. Neumayer maintains that very valuable light would be thrown on the laws of the distribution of living organisms by explorations in this quarter, where there is scarcely any land but a few scattered islands.

Dr. Neumayer then proceeds to give a sketch of the history of discovery in the South Polar regions, dividing it into three periods. The first of these periods begins with the sixteenth century, and ends with the determination of the south point of America by Schoelten and Lemaine in 1616. The second period extends to the beginning of the present century, and the third from that time onwards.

The voyages embraced in the first period were not Polar voyages in the strict sense, for no one stepped over the Polar circle, and their main object was to fix the route to India and the Spanish colonies on the west coast of South America. The expeditions which went south during the second period had for their purpose to discover and fix the limits of the great southern continent which theoretical geographers supposed must exist in those regions in order that the balance of land might be maintained. The expeditions which have gone out to this quarter during the present century have had for their purpose mainly the observation of phenomena for scientific purposes.

Of the great voyagers belonging to the first period, it can hardly be said that any made discoveries in what is generally considered the Antarctic region. Sebald de West, in January 1600, saw a group of islands in 50° 40′ S. and 59° W., which were called Sebald's Islands, and which were possibly the same as the Falkland Islands, whose proper discovery falls to a later time. One of the minor voyagers of this period, Dick Gerritz, discovered an island group in 61° S. lat. and seems to have reached 64°. This ice-bound group was probably the same as that now called South Shetland, although it is possible Gerritz had seen Palmer's Land. During this period discoveries only reached the higher latitudes south of Cape Horn; in other circumpolar parts the 40th parallel had only been reached at the Cape of Good Hope; and in the Indian Ocean, on the way to Batavia, the islands of St. Paul and New Amsterdam were already known in the beginning of the 17th century.

The earliest of the discoveries of the second period were those of the famous Abel Tasman. The maps of Mercator in 1628 attach the north coast of New Holland to the great continent of Australasia, that spreads itself all over the South Polar region, and annexes the discoveries of Dick Gerritz to South America. The unrestrained fancy of the geographers of the time even leads them to set down a continuation of the Cordilleras as running through the "great south continent." This delusion Tasman destroyed, when, in the year 1642, he sailed round the south of New Holland, and discovered Van Diemen's Land; he also discovered the west coast of New Zealand. La Roche, in 1675, discovered South Georgia; while the Malouins (1700-1712) place the Falkland Islands accurately on the maps. The voyages of Hay and Lozier Bonnet circumscribed considerably the extent of the south continent in the Atlantic and Indian Oceans; but through the discovery of Cape Circumcision in about 52° S. lat. and 10° E. long., it was believed a new proof of its existence had been gained.

Dr. Neumayer pays a very high tribute to Cook for the restless energy with which he pursued his work, and the vast and valuable additions he made to the then scanty knowledge of these southern regions. The maps of 1762 have still the south continent prodigally displayed, reaching as far as 20° S. into the Pacific itself; the maps of 1775 show not a trace of it, although, even so late as 1773, Kerguelen believed he had seen it in lat. 49° S. and long. 70° E.; what he saw was Kerguelen Island. It was Cook who had the honour of proving that the "Great South Continent" was a mere chimera.

In March 1770, after the observation of the transit of Venus, he found New Zealand to be an island. On his second voyage he passed to the south of Kerguelen Island in February 1773, though he appears not to have seen it showing there was no hope for theoretical geographers in, this direction. In the previous month, January 17, he passed the South Polar circle in E. long. 39° 30′—the first time the feat had been performed by any explorer—sailing as far south as 67° 15′. In the (southern) summer of 1773-4 Cook explored the ocean from 175° to 98° W. long., and between 50° and 71° 10′ S. lat., thus clearly proving the non-existence of a great continent to the South Pacific. In December 1774 he sailed from New Zealand to Magellan's Straits, to convince himself that there was no sign of the supposed continent between 55° and 56° S. lat. There he re-discovered the island of St. Pierre, seen by Duclos Guyot in 1756, and a century earlier by La Roche, and named it South Georgia. On his return he discovered the Sandwich group, and narrowly missed the South Orkney and South Shetland Islands. Cook set out on his third great voyage of discovery in January 1777, intending to lay down the exact position of Prince Edward's and Kerguelen Islands, and make observations on the physical geography of the latter; but ere he could accomplish his aim "this greatest of all discoverers of the 18th century" met his sad death in February 1779.

A comparison of the maps of 1762 and 1785 will suffice to show how much was accomplished by Cook. The chief conclusion come to by the great navigator as the result of his extensive explorations was, that outside of the South Polar circle no stretch of land of any extent could be found, and that if any such existed inside the Antarctic zone, for all productive purposes, indeed even for the sustenance and development of organic life, it was useless. The labours of Cook gave thus a negative result; it remained to future voyagers to prove whether any continent existed *within* the Polar circle.

In the third period, that from the beginning of the present century, we have to do with expeditions, which, inside or in the close neighbourhood of the South Polar circle, have sailed through and explored great stretches of ocean, and examined the coasts and islands of the Polar zone. It is the explorers of this period who have contributed so largely to our knowledge of the physical geography of the Antarctic regions.

In October 1808 Captain Lindsay saw the Bonnet Group, and in February 1819 Smith re-discovered Gerritz or Gerrard's Islands, now known as the South Shetlands. We are indebted for much of our knowledge of the regions south of Cape Horn to the zeal of the American whale and seal fishers, Powell, Palmer, Pendelton, Fanning, and others. To these we owe the discovery of Palmer's Land and the South Orkneys. All agree in describing these lands as wholly bound in ice, almost always enveloped in dense fogs, and showing scarcely a sprig of vegetation. Here and there from out the mass of ice projects a black peak, which, even at a distance, by its showing no trace of the otherwise universal ice, proclaims itself of a volcanic nature. Numberless birds nestle on these islands, on which no quadrupeds have yet been found; and on the warm sides of the volcanic cones nothing is to be found but multitudes of living penguins, who use them as resting-places. In the surrounding sea is a rich vegetable life, on which the seals and fishes appear to thrive.

The re-discovery of the South Shetland Islands gave a new impulse to Antarctic exploration, in behalf of which an active interest now began to show itself in Europe. The Russian Empire took the lead, and in July 1819 sent out two ships, the *Wostok* and the *Merny*, under the command of Captains Bellinghausen and Lazaren, who distinguished themselves by their pluck and circumspection. They sailed round and defined South Georgia, and Bellinghausen endeavoured, under the meridian of Greenwich, to get as near the Pole as possible. However, after working his way with great difficulty as far south as 69° 25′ (1° 11′ W.), the impossibility of penetrating farther through the immense masses of ice compelled him to turn northwards. Another attempt under 18° E. long. was also in vain, and the advanced season compelled the ships to return to Port Jackson. The expedition set out again in November; and on January 22, 1821, in 92° 19′ W. long., reached 69° 33′ S. lat., not far from the *ne plus ultra* of Cook. On the same day, in 68° 27′ S. lat., 90° 45′ W. long., Bellinghausen saw an island 4,200 ft. high, which he named "Peter the Great Island;" and on the 29th, in 68° 43′ 20″ S. lat., 73° 9′ 36″ W. long., he saw land of great height, which appeared to him to be a cape belonging to a large continent. This he named "Alexander Land." The land was completely locked in ice, and in the sea itself all life appeared to be extinct. At the South Shetlands Bellinghausen fell in with Captain Palmer, who told him of his discovery of Palmer's Land.

The voyages of these Russian explorers, who returned home in the middle of the year 1821, were undoubtedly, as South Polar explorations, the most important which had hitherto been undertaken. They almost circumnavigated the Pole at an average distance of 30°, explored a larger tract inside the Polar circle than ever had been done before, and discovered the first Polar land. Moreover, they completed a series of valuable hydrographical researches, and it is to be lamented that these are still inaccessible to all who are unacquainted with the Russian language.

The next important expedition after the Russian one was that of Captain Weddell, during the years 1822-24, whose observations Dr. Neumayer considers perfectly trustworthy and very valuable, notwithstanding the aspersions of a subsequent explorer, Dumont d'Urville, whose own expedition was resultless. Weddell's labours embrace valuable materials on currents, the variation of the compasses, and nautical and meteorological matters. What is of great interest, is his voyage to a high south latitude in January and February 1823. With his two little vessels, the *Jane*, of 160 tons, and the *Beaufoy*, of 65 tons, he made his way from the South Orkneys between great masses of ice, and reached, on the 20th February, in 33° 20′ W. long., to 74° 15′ S. lat., the highest which had hitherto been attained. He found the sea here so free from ice, that he named it "George IV. Sea," and expressed his belief that it would be an easy matter to approach much nearer to the South Pole. Having convinced himself that no land of any importance existed in this direction, he turned northwards.

In 1829 Captain Henry Foster was sent out by the British Government for the purpose of making observations on the physical geography of these regions. He fixed his quarters at Pendulum Bay, on the island of Deception, whose east end was fixed by Weddell at 63° 2′ S. lat., and 60° 45′ W. long. Foster stayed here from Jan. 10 to March 6, and carried on a series of valuable hydrographical observations. Among other things he determined the length of the simple seconds pendulum. Before his departure he fixed in an exposed position a self-registering maximum and minimum thermometer, which in the year 1842 was found by Captain Smiles, who found the minimum temperature during 13 years to have been −20·5° Cent. Unfortunately the index of the maximum thermometer had got out of order and could not be read.

Captain Biscoe, with two small ships, the *Tula* and the *Lively*, went out in the year 1830. The highest latitude reached by him was 68° 51′ S., under 12° 22′ E. long. On the 16th of March, 1831, he found Enderby's Land, and on February 15, 1832, he discovered Adelaide Island, one of a series which runs in a westerly direction, each of which bears the name of its discoverer. Behind these towers to a considerable height the stretch of land now known as Graham's Land. From the observations of Biscoe and others, we learn that beyond the 60th parallel of latitude east winds prevail. The results of this expedition were of high importance; but notwithstanding that some maintain Graham's Land and Alexander Land to have no connection, Dr. Neumayer believes this still remains an open question.

The discoveries of Biscoe to the south of the Indian Ocean were to some extent confirmed by Kemp, who, in the end of 1833, in 60° E. long. and just inside the Polar circle, discovered the land known by his name. The insular condition of this as well as of Enderby's Land might be held as established, if any dependence could be placed upon the statements of Morrell, an American voyager of 1823; in him, however, Dr. Neumayer puts little faith.

The Messrs. Enderby of London, in the year 1838, fitted out two little ships, the *Eliza Scott* and the cutter *Sabrina*, the command of which they gave to Captain Balleny. The scene of Balleny's discoveries was the waters south of New Zealand, a quarter hitherto but little explored. On February 9, 1839, he discovered three islands, the centre one being in 66° 44′ S. lat., and 163° 11′ E. long. He did not manage to make his way farther south than 69° in 172° 11′ E. long. During the month of February, he sailed westwards on the 65th parallel, and on the 3rd March, in 118° 30′ E. long. and 65° 25′ S. lat., he found what is now known as Sabrina Land. More than once previous to this he believed he had seen signs of land, but the dense fogs prevented him from verifying his conjectures. In pursuing these discoveries in lower latitudes, the two little ships suffered much from violent storms, in one of which the *Sabrina* was lost with all hands.

(*To be continued.*)

## *BELGIAN CONTRIBUTIONS TO ASTRONOMY*

*Tableau de l'Astronomie dans l'hémisphère austral et dans l'Inde.—De l'Astronomie dans l'Académie Royale de Belgique, Rapport séculaire* (1772—1872). Par Éd. Mailly. (Bruxelles, F. Hayez, 1872.)

TWO publications by the same author lie before us, each meriting a separate notice. Of the first—an extract from the *Mémoires de l'Académie Royale de Belgique*,—it is difficult to speak more highly in many respects than it deserves. Learned and full as to its matter, clear and perspicuous in style, it tells in a very pleasant as well as instructive manner the story of southern astronomy. A good deal of misapprehension, we believe, exists as to the beauty of that part of the heavens which is for ever hid from European eyes. The Southern Cross seems to be more remarkable for its associations than its grandeur; and Canopus, the only gem of extraordinary brilliancy which never rises here, is yet outshone by our familiar Dog-star. Some parts indeed of the southern Galaxy are extremely luminous; and this may well be admitted without subscribing to the assertion of a somewhat flighty Hellenic observer, that around the bow of Sagittarius it gives light enough to read the smallest print! and the marvellous variable $\eta$ Argus, ranging from rivalry with Sirius down to the edge of invisibility without a telescope, is an object of interest for which, in its own way, we might seek a parallel in vain. But on the whole we may well feel that there is nothing in the hidden region to compensate a voyage to gaze upon it. Nor indeed is that region as extensive as, without reflection, might be supposed. The part of the sky which never rises being equal to that which never sets, its radius is the distance of the pole from the N. horizon; and mere inspection will show that this is no preponderating portion of the whole, if to the visible hemisphere we add all that part, which, though beneath the horizon at any one time, will successively come into view at other hours of day and night. All this is of course perfectly obvious to any student of astronomy; but we mention it because the idea is perhaps not often realised, how little, comparatively, of the sky we lose in our latitudes, and that little not of the most interesting character.

If, however, we exchange the naked eye for the telescope, we shall to some extent reverse our opinion. For our visible heavens contain no equivalent to α Centauri, the finest as well as the nearest of connected pairs; or to such superb agglomerations of stars as 47 Toucani with its ruddy heart and white border, or ω Centauri, staring like a comet even to the naked eye; or all the richness of manifold combinations in the Nubecula Major. Such are the regions whose investigation by successive explorers has been so well delineated in the pages before us. We have sketches by a master's hand of many an earnest labourer whose best years were devoted to the undertaking. Among the rest we recognise the youthful Halley, who commenced at the early age of twenty the first regular telescopic survey of these unfamiliar regions, experiencing, in consequence probably of his youth, the vexatious tyranny of some petty despot at St. Helena, whose name, withheld by him, is not worth digging up out of merited obscurity;—Lacaille, the diligent, the accurate, the honourable, who on his return to France, out of 10,000 livres granted for his expenses, notwithstanding his having exceeded his stipulated task, insisted upon restoring the overplus of 855 to the Treasury;—Sir T. Brisbane, who had served under the Iron Duke, in the Peninsula, and whose appointment to the governorship of New South Wales led to a characteristic anecdote: Lord Bathurst having stated at head quarters "qu'il avait besoin d'un homme pour gouverner la terre et non les cieux," and Brisbane having appealed to his old commander as to whether his love of science had ever interfered with his professional duties, the reply was, "Non, certainement, et je dirai que dans aucune circonstance vous ne fûtes absent ni en retard, le matin, à midi, ou pendant la nuit; et qu'en sus, vous fournissiez le temps à l'armée."—Then we have the vicissitudes of honour and contempt encountered by Dunlop, whose unintelligible "Angosiades" (to borrow de Zach's expression) at Paramatta were more injurious to the progress of astronomy than the blunders of the unlucky old chevalier at Tarbes;—the unmerited troubles and vexations and mortal sickness of poor Fallows, condemned to work with a bad instrument, and abandoned without help till he found his best assistant in his devoted wife;—the brilliant career of Henderson, the detector of the parallax of Sirius;—the laborious attempts of Maclear to deduce the solar distance from observations of Mars, whose fault it certainly was not that the result was but partially satisfactory; and his more successful verification and correction of the meridian arc, not quite so accurately measured by Lacaille a century before—all these are given in most interesting recital, together with equally detailed notices of many less generally known observers. We have also a full record of a scientific expedition which has, perhaps, attracted too little attention in England—that sent by the United States to Chili; how Lieut. Gilliss erected his observatory on the columnar rock of Santa Lucia, in the middle of the town of Santiago, 176 feet above the street, where the stones could not be blasted for fear of doing mischief below, and had to be split up by water after being roasted with flame; how the inhabitants came up at night by hundreds to see and gaze through the astonishing *Maquina*, and had their curiosity gratified by the good-natured Americans, even to the sentry's turn last of all; how the weather was almost too fine, drawing so much upon their energies by the unremitting work of a hundred nights, of which seventy-two out of seventy-six had been continuously clear, that they found the periodical rains setting in none too soon, and Gilliss's vitality was so dried up to the native standard of apathy, that he required a month of horse exercise to set him right; and how, with a staff so inadequate that they were obliged to confine their work to a portion only of the southern sky, 20,000 new stars were registered—a noble addition, of which we have reason to hope for the publication at no distant time.

Such are a few only of the narratives with which this admirable memoir abounds; and we only regret that our cordial appreciation of its general excellence is subject to some few, though not material, drawbacks in the way of omission. The graphic way in which minor circumstances and incidents are interwoven in the relation of less important undertakings makes us conscious that the story of Sir J. Herschel's memorable expedition to the Cape has been told in a too compressed form, and that details are comparatively absent which would have furnished matter not only of interest but of instruction. The candour of the writer has led him to state that much of his recital is based on an article in the *Edinburgh Review*: it would, perhaps, be an unfair, but it may not be an unnatural, inference that he had not had an opportunity of fully mastering the magnificent record of the Cape observations which astronomy owes to the liberality of the Duke of Northumberland. We miss, too, the first outspoken challenge of the pseudo-planet Vulcan uttered from a southern latitude, and justified by the event—the retort, not over courteous, of Liais, "L'observation du Dr. Lescarbault est fausse." And we should have preferred fuller information respecting the design of the great Melbourne reflector, and the conflicting opinions regarding its success. But we should be sorry to appear even to detract from the merits of a memoir which deserves, and will obtain, so high a rank among the materials for a general history of modern astronomy.

The second pamphlet is also extracted from the "Livre commemoratif" of the same scientific body, and is a history of astronomy as connected with the Académie Royale of Brussels, which has just reached the end of its first century. Its range is accordingly more limited, but the talent of its author has imparted a more than local value and interest to its contents. The Academy, founded under the auspices of the Empress Maria Theresa in 1772, experienced a total interruption through political troubles from 1794 to 1816. During its earlier existence it failed to awaken a scientific spirit in the Belgian provinces, and depended almost entirely upon the contributions of foreign talent, in which the conspicuous share claimed by England is testified by the names of Needham, Pigott, and Mann. A geodesical survey of Belgium being greatly needed, and the terms of some foreign astronomer being found exorbitant, application was made to Pigott, who was passing through Brussels in 1772 on his way to Spa. He immediately gave up his intended journey, and applied himself to the undertaking with a generous and disinterested earnestness which ought never to fall into oblivion. For five months, accompanied by his son, Mr. Needham, and his servants, he carried on the survey at his own cost, and with his own instruments, sent for from his observatory at Frampton House, near

Cowbridge, Glamorganshire. His enterprise met with all the reward he desired in the rectification of maps, in which some towns had been misplaced to an extent of five, ten, or fifteen leagues, or even more ! At this period there was actually no observatory in Belgium.

The varied labours and scientific insight of the Abbé Mann, a native of Yorkshire, who had turned Roman Catholic, served in the Spanish army, and become Carthusian, require more than a passing notice. Though Halley had previously traced an analogy between the tails of comets, the aurora, and electrical emanations, Mann might be considered in advance of his time in referring these phenomena, with light, heat, and magnetism (as a modification of electricity) to the same general principle, elementary fire ; and his view, expressed in one striking sentence, "Tout est analogue et harmonique dans la nature universelle," would still be considered as the annunciation of an eternal truth. The imperfection of their instruments misled these sagacious reasoners as to the identity of the Galaxy, stellar clusters, and nebulæ properly so called ; but restricting their too general hypothesis to this latter class, the anticipation is sufficiently striking which refers them to assemblages of primordial light or electric fluid, the luminous material of which the sun and stars are formed. And the words with which Mann commences his speculations are an embodiment of wise and sound thought : "On peut bien penser qu'une bonne partie de ce que je vais dire ne sera que des conjectures ; mais quand les conjectures sont fondées sur des observations et des expériences, et qu'elles donnent des explications naturelles des phénomènes, elles ne doivent pas être exclues de la physique, si on ne veut fermer la porte aux découvertes, qui ne viennent pour la plupart qu'à la suite de quelque conjecture heureuse, confirmées peu à peu par de nouvelles preuves, jusqu'à ce qu'elles parviennent au point d'une certitude entière."

The doubts with which the first discovery of the planet Uranus was received are recorded among these early memoirs ; they are well known—more so, probably, than an anecdote which was communicated to the present writer by a friend of the illustrious discoverer. When Sir Joseph Banks, and other fellows of the Royal Society, had failed to find the new object, Herschel had a portable tube constructed of silk, packed it up with his mirrors, and gave the doubters the meeting on the roof of Somerset House, where, the planet having been exhibited, Sir Joseph took off his hat and made him a bow, the rest of the company following his example.

After the reconstruction of the Academy, a considerable time (1816-1834) elapsed before it gave signs of activity ; and the state of science in Belgium may be conjectured from the fact that in 1823 the question was seriously proposed by that learned body whether the law of nutation was accurately understood, and, as well as the planetary perturbations, could be shown to be in accordance with the Newtonian theory. Two years afterwards, indeed, they decreed a prize to the Double Star Observations of Herschel and South. But even this was not done without such a singular deformation of the latter's name as must have much moved his choleric temperament, when he recognised himself (not, perhaps, immediately) as "un Anglais nommé Sawt !" However, during this period a master spirit was introduced among the members. To the energy and perseverance of Quetelet, among obstacles of no uncommon kind, was due the foundation of an Observatory at Brussels, which received its instruments in 1834 ; and with the election of this astronomer at that period to the office of perpetual secretary commenced the era of scientific and intellectual progress in Belgium. We have not space to enter at length upon the subsequent history of the Academy ; but will only indicate a few points of interest with which some of our readers may, perhaps, not be familiar. Such are the following :—

The extension, by Baron Behr, of the very curious relation between the periodic times of the four innermost satellites of Saturn to the other members of the system, the revolution of Hyperion being quintuple that of Titan. The continuance of the alternate recurrence (1, 3 ; 2, 4 ; 5, 7 ; 6, 8), with a break in the order and value of the relation, will be noted, as well as the probability that either the apparent vacancy between Rhea and Titan is a real one, or must contain *two* undiscovered satellites. The periods of the satellites of Jupiter are known to be only approximately commensurable ; but the Baron has found that the revolution of the fourth equals twice that of the third plus $\frac{1}{4}$ of the difference between those of the second and first. Then we have Capocci's idea, in 1850, of a parabolic mirror formed by the rotation of a vessel of mercury, and utilised for a telescope by a large "flat," with Krecke's suggestion that a mass of melted metal might thus be cooled into a permanent paraboloid ; a notice of M. Neyt's (of Ghent) great success in lunar photography with a silvered mirror of $9\frac{1}{4}$ inches ; of delineations of Mars executed in 1864, 1867, and 1871, by Dr. F. Terby (from whom, by the way, we are expecting a valuable monograph of this planet) ; and of a catalogue, now in progress, of 10,000 stars. Besides these, there is much valuable information relative to meteors, zodiacal light, tides, geodesy, and similar subjects ; and the impression of activity and progress conveyed by Dr. Mailly's excellent memoir is full at once of promise and pleasure. We sincerely thank him for his labours, and wish him and the Society of which he is so able an historian all possible success.

T. W. W.

## *OUR BOOK SHELF*

*First Principles of Human Physiology, &c.* By W. T. Pilter, certificated Teacher of the Science and Art Department. (London : Kempster, 1872.)

AMONG the least questionable services of the South Kensington establishment are the classes which have been held, under the superintendence of Prof. Huxley, and the personal guidance of three of our best physiologists, for instructing school-teachers in the elements of anatomy and physiology. The present hand-book may be taken as one result of these classes, and is interesting as an exhibition of what physiology looks like from what may be called the lay point of view.

The arrangement followed is that of Prof. Huxley in his admirable "Elementary Lessons," of which in fact this little book is a kind of diluted abridgement. Few readers will be sorry to miss the comparison of the three Cæsars, with the quotation from Hamlet, and the famous story of Mrs. A. ; but even in his weakest moments the master quotes Shakespeare, while the pupil introduces embellishments without alleviation.

It is only fair to say that the author writes clearly, and apparently has an intelligent understanding of the facts of physiology himself as far as he goes. Occasionally he gives a useful illustration or a detailed explanation which is not to be found in the Elementary Lessons, and there are not many bad blunders. The account of a cell at p. 14 is obsolete, though too often found in the minds of compilers of manuals and of examiners. Arteries are not lined with mucous membrane. The account of long and short sight is inexact. The *corpora quadrigemina* can be seen without removing the cerebellum, and do not consist of the olfactory and optic lobes. On the other hand the "*hold* of nervous system on the arteries" is a very happy expression, and the plasma of the blood exuding through the capillaries is well compared to "a stream lost in the sand." The experimental illustrations at the end of the chapters are good, and it would have been well if this part of the plan had been more fully carried out, together with some practical hints as to dissection and microscopic observation. Unless these practical studies are undertaken, the study of physiology is a mere cramming of statements, and is quite unworthy of a place in any scheme of education. If it is to be generally taught, the most important thing is to show teachers how they must set about it, and for this purpose directions can scarcely be too minute.

The questions in the appendix are excellent, though it was a pity to give only one specimen of an examination paper. They of course presuppose dissection of a sheep's head and viscera, and acquaintance with some simple physiological experiments. The woodcuts are very rough, but most of them answer their purpose.

On the whole it is not likely that any shorter or simpler manual than Huxley's "Lessons" can be written, that will be of use for the serious study of the elements of physiology by those who do not intend to go further. It would cost much more time and trouble to go through it than through the "popular" substitutes of which this is an example, but, for that very reason among others, the result would be far more valuable. P. S.

## *LETTERS TO THE EDITOR*

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

### Our National Herbarium

It is with as much pain as surprise that I notice in your impression of last Thursday a most unfair as well as ungenerous attack upon the botanical establishment at Kew under Dr. Hooker. It is not within my province to discuss the inaccuracies upon which the insinuations of bad cultivation are founded, nor yet the extraordinary statement that the herbarium which the constant experience of a long life has proved to me to be an indispensable adjunct for the efficient working of a national botanical garden—that this "collection of dead plants," as your correspondent contemptuously terms it—has interfered with the proper care of the garden. There is, however, one of the facts mentioned which my long and intimate acquaintance with the herbarium of the British Museum and its successive keepers, Mr. Brown and Mr. Bennett, calls upon me to deny.

Foremost amongst the "examples of scientific work at the London Herbarium" is given the "Prodromus Floræ Nova Hollandiæ." That great work, which at once placed Robert Brown at the head of the botanists of the age, was published in 1810, many years before the so-called "London Herbarium" was in existence.

I would add that the second of the works named as an example of scientific work at the London Herbarium was published in 1818, two years before the death of Sir Joseph Banks, the subsequent transference of whose herbarium formed the nucleus of the "London" or "Metropolitan Herbarium."

Nov. 11 George Bentham

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Permit me to correct some errors of detail into which Dr. Hooker has fallen in his reply to Prof. Owen, printed in a recent number of Nature.

1. Prof. Owen has no official relation to the Botanical Department, and, consequently, is not acquainted with the particular arrangements between the Trustees and the officers of that department.

2. This department is open in summer from 9 to 6, and in winter from 9 to 4.

3. The officers are required to be in attendance for six hours daily, but as this does not include an hour for dinner, the official hours are the same as at Kew.

Wm. Carruthers,
*Keeper of the Botanical Department*

British Museum, Nov. 4

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### The Beginnings of Life

On reading a review of my recently-published work, "The Beginnings of Life," in the last number of the *Academy*, written by Mr. H. N. Moseley, I could not help feeling considerable surprise at many of the statements which it contained. That such apparent ignorance of the facts should have been shown, and that such an inadequate statement of the case should have been made by a distinguished pupil of Prof. Rolleston, I was not prepared to expect. My first resolution was to pay as little attention to the statements of the reviewer as they seemed to deserve. It has, however, been strongly represented to me by friends whose opinion I value that some of the statements ought not to be allowed to pass without comment or contradiction.

Referring for a moment to the reviewer's opinion that known facts seem to warrant the notion that organic matter can only be formed "by a series of gradations brought about by a succession of complex conditions" (the process referred to in my work at vol. i. p. 94), I may remark that many facts bearing against this being the only possible mode of formation of organic matter are stated in vol. ii. pp. 27-33, and 36. Protoplasm (existing as *Bacteria*) is capable of growing indefinitely in a solution of ammonic tartrate; and, to say the least, we at present know nothing concerning the existence of any long series of intermediate conditions between the ingredients of the saline solution and the protoplasm which rapidly grows therein. As I have said (vol. ii. p. 28), "The most simple not-living or mineral constituents coming into relation with one another in the presence of pre-existing protoplasm, appear, for aught we know to the contrary, to fall at once into those subtle combinations which constitute the basis of living protoplasm. The rapidity of the process mocks and defies all theoretical explanation. Here at all events there seems to be no laborious process of synthesis—no long chain of substitution compounds before the final product is evolved." It has been commonly assumed that the process of "origination" is intrinsically different from the process of "growth," so far as living matter is concerned. One of the principal objects of my investigation, however, was to endeavour to ascertain whether this assumption was warranted by the facts. If experimental evidence seemed to show that an independent elemental origin of living matter was possible, we should have a very fair right to assume that the process of "origination" was not much more gradual or protracted than the process of "growth."

Turning now to the question of the nature of the evidence concerning the origin of living matter, it appears that the reviewer is content to admit what I have so frequently stated, (Nature, No. 35, p. 171, and No. 47, p. 412; "Modes of Origin of Lowest Organisms," p. 32), viz. that Bacteria develop in solutions, or parts of solutions, in which no particles can be observed with the microscope. It is true that the reviewer even says nothing about my having ascertained such a fact; he assents to it (notwithstanding the objections previously urged by Prof. Huxley), apparently because my friend and colleague, Dr. Burdon Sanderson, has since been compelled to come to a similar conclusion (*Thirteenth Report of the Med. Off. of Privy Council*). *Bacteria* appearing in such a manner in a solution, must either be the developed representatives of invisible germs thrown off from some pre-existing form of life, or they must be developed representatives of invisible germs on nuclei which had been engendered *de novo* (vol. i. p. 297). Experimental evidence alone can enable us to decide whether the latter of these equally legitimate though rival hypotheses is at all tenable. Fortunately, however, the experiments to which we are compelled to resort may be of the simplest description (vol. i. pp. 311, 337, and 350). Suitable fluids require to be boiled for a time in a glass vessel, the neck of which, if not many times bent or plugged with cotton wool, must be hermetically sealed in the flame of the blowpipe before the process of ebullition has entirely ceased.

"It is admitted now on all hands," the reviewer says, "that prolonged exposure to the action of boiling water destroys all life in solutions; hence, if undoubtedly living things be found in solutions treated as above, from which germs have certainly been excluded, the only possible explanation of the phenomena is that the living things have been evolved *de novo*." The reviewer then states that Pasteur, Lister and others had tried such experiments with a number of solutions capable of supporting life, and had found "that no living things whatever developed themselves." Subsequently he states that Dr. Sanderson had also repeated such experiments with similarly negative results. Strangely enough however, the reviewer says nothing concerning certain other experiments made by M. Pasteur, (see vol. i. pp. 340, 374—399), in which, using different and more suitable fluids, living organisms were almost invariably found in his experimental flasks; and as he is similarly silent concerning the multitudes of such experiments, with similar results which have been made by Needham, Spallanzani, and Schwann, by MM. Pouchet, Joly, and Mussett, by Professors Mantegazza, Jeffries Wyman, Cantoni, Hughes Bennett, and many other experimenters, one is forced to conclude either that the reviewer is ignorant of the whole history of the subject and has not even read the book which he affects to criticise, or else that he has acted in a manner which, without explanation, is not quite easy to understand.

Without, however, exhibiting any consciousness of having made material omissions in the statement of his case, the reviewer then proceeds to demolish and explain away the results of my own experiments, as though they alone stood in the breach. The process is summary, if not very original. Taking up the view previously expressed by a distinguished biologist, he admits that "the only possible answer" to the results which I obtained (short of coming to a conclusion similar to my own) is to suppose "that the bodies seen in the solutions were not living, but dead, and had been there all the time." Seeing, however, what an abundance of evidence in disproof of such a supposition has been given in my work (See Series *a*, Exps. 2, 4, and 5; Series *b*, Exps. 2, 4; Exp. *b* (p. 443), Exps. *e, j, m, n, s, x*, together with very many of the experiments recorded in *Appendix* C), I can only conclude that these portions also have unfortunately escaped the notice of my reviewer, more especially as he ventures to state that "The only attempt made to determine whether the organisms observed in the solutions were living or not, was in the case of Exp. 4, vol. i. p. 368." With regard to the reviewer's further statement that "the turbidity or scum in the solutions was not caused by a development of organisms, but by some coagulation or similar alteration in the fluid," the suggestion is really almost too puerile to be worthy of serious notice. If freshly-filtered infusions of hay or turnip are prepared in the manner above described; if they remain clear for a time after they have been boiled; if, in a few days, they gradually become turbid, and if, on subsequent microscopical examination, it is found that the turbidity is in all cases due almost solely to the presence of myriads of *Bacteria*, *Vibriones*, and perhaps *Leptothrix* filaments (such as are figured in vol. i., Fig. 24), one can only renew a query previously put:—"Can dead organisms multiply in a closed flask to such an extent as to make an originally clear fluid become quite turbid in the course of two or three days?" ("Modes of Origin of Lowest Organisms," p. x.)

It may be well to remark here, also, that the truth of the general doctrine as to the possibility of the independent origin of living matter, is in no way essentially bound up with the results of my experiments with saline solutions. For reasons fully detailed in my work, I am strongly inclined to believe that the bodies figured by me as found in these more or less pure saline solutions had been formed therein. Fortunately, however, even if I were quite wrong in the interpretation of this portion of the evidence, there would still remain a superabundance of it in favour of the truth of the general position which I and many others support concerning the origin of life.

Like others who have written on the same side of the question, the reviewer in the *Academy* shows a strong tendency to accept in an unconditional manner the experimental results and conclusions of some favoured worker. Formerly Pasteur's experiments were much lauded, and the existence of atmospheric germs was believed (as he himself put it) to have been "mathematically demonstrated." Now, however, M. Pasteur is thrown overboard; for, as the reviewer tells us, "Dr. Burdon Sanderson has recently shown that in the case of Bacteria this view can no longer be maintained." It is a source of much satisfaction to me that Dr. Sanderson's very conclusive experiments should have forced him to come to this conclusion, because they were confirmatory of others made independently by myself ("Modes of Origin of Lowest Organisms," pp. 30 and 91), and published somewhat earlier. But if the causes of fermentation and putrefaction are not derived from the air, it becomes obvious that they must be contained in the fluids employed. These causes are, however, by no means necessarily germs of Bacteria, as Dr. Sanderson's language would seem to imply.

It now happens that Dr. Sanderson's experiments are constantly quoted as though they were irreconcilable with my own. This, however, is quite a misconception. In many respects, as I have in part already shown, our conclusions have been similar. Dr. Sanderson has, however, employed only a limited number of different solutions, and these mostly of a kind not adapted for demonstrating the independent origin of living matter. He expressly states that he was interested only in the behaviour of certain fluids, and having found, as others had done, that there was no reason to believe that living matter could arise in them *de novo*, he was quite content: though with reference to an independent origin of living matter he says, "It will be quite unnecessary either to deny or to assert its possibility under other and different conditions." It certainly is somewhat unfortunate that Dr. Sanderson should not have been induced to carry his experiments a little further, and ascertain what would have been the result of similar methods of experimentation with other fluids (*See* vol. ii. p. cl.)—with infusions of hay or turnip, for instance. But unless he also is prepared to reject, as untrustworthy, all the experiments with positive results obtained by Pasteur, Pouchet, Wyman, Cantoni, myself and others, Dr. Sanderson should, from his present standpoint, be a believer in the possibility of the independent origin of living matter.

The reviewer deals with the third part of my work in a very extraordinary and summary manner. He looks upon it as a tissue of "absurd statements concerning heterogenesis," and does not think it worth his while even to mention the fact that more or less similar phenomena have been seen by many excellent observers—by Turpin, Kützing, Reissig, Harte, Gros, Pringsheim, Pineau, Carter, Nicolet, Pouchet, Schaaffhausen, Braxton Hicks, and Trécul—and that the author whom he criticises, merely comes in as one capable of supplying that confirmation which is commonly demanded when we have to do with an order of facts not generally admitted. The actual observations of all these independent investigators are passed over and ignored, apparently because Mr. Moseley is not able to undertand that phenomena which widen the range of our experience are not necessarily "opposed to all the accepted facts and theories of biological science." He does, however, criticise in a very characteristic manner one particular set of observations of my own of a startling nature, in which the development of Free Nematoids, belonging to the genus *Diplogaster*, was seen taking place from a number of the altered spores of a fresh-water alga named *Vaucheria*. After the reviewer has done a little work at the subject himself, he will doubtless become thoroughly convinced that the "crucial observations" to which he refers do unfortunately "lie outside the province of heterogeny" (see vol. ii. p. 37, note 1; and 519, note 1). He seeks to set aside my conclusions by suggesting a series of possibilities which are so little recondite that they might, even by an ordinary use of the imagination, fairly be considered to have been duly weighed by the observer himself. Whilst the reviewer is also not ingenuous enough to confess that I should in all probability be thoroughly familiar with the appearance of Free Nematoids and their eggs, he, without the least hesitation, again suggests an explanation whose only warrant seems to exist in the supposed necessity for upsetting my statements. I can assure Mr. Moseley, however, that after having worked for more than three years at the subject of the distribution and anatomy of Nematoids (Trans. of Linn. Soc. vol. xxv., 1865, p. 73; Philosoph. Trans. 1866, p. 545). I have never seen anything in support of his altogether gratuitous supposition that "considerable variation in size may exist in the ova produced under various conditions by individuals of the same species."

H. CHARLTON BASTIAN

University College, Nov. 9

## Physics for Medical Students

YOUR correspondents on this subject in the last number of NATURE entirely agree with me that "a medical man should have some knowledge of natural philosophy and its applications to the conditions with which he has to deal;" but there are one or two points on which they seem to have misunderstood me. As one of the examiners who set the question challenged by Mr. Heath, I defended it, and pointed out that it bore a very close relation to medical science, besides showing, by the simplicity of the solution, that it was one of the mildest questions which could be set.

If my friend Dr. Beale will refer to my former letter, he will see that I nowhere regard the production and waste of heat in the body as one of the mildest of questions.

I ask whether a medical student should not know something of such important matters, and wish to imply that, in order to know, he must acquire some knowledge of the simplest principles of heat. He is not likely to acquire these unless they form a part of the preliminary training of medical students. I presume Dr. Beale will admit that just so far as man can be regarded as a molecular body, capable of absorbing or radiating heat, to the same extent must the laws of molecules apply to him; for his position is untenable that medical men need a knowledge of Physics, if the laws of Physics do not apply. His remarks on materialism are not warranted by anything in my letter, and do not apply to me. I will not attempt to answer in these pages the general questions proposed by Dr. Beale, on the heat-giving properties of food, or on the waste of heat from the body, nor to describe the methods by which researches on them have been or may be carried out. It is well known, and a medical man who wishes to be stamped with a medical degree ought to know, how much heat a given quantity of food is capable of producing, and also that this amount of heat is exactly equivalent to a certain definite amount of energy: the form in which this energy will show itself in the human body in all the different stages of growth and decay, both in health and disease, is essentially a question for medical men to study.

Physical Laboratory, King's College W. G. ADAMS

### Diathermacy of Flame

WILL you be so good as to allow me to draw the attention of your correspondent, Mr. W. Mattieu Williams, to what appears to be an oversight in his letter on "The Diathermacy of Flame," published in your number of Oct. 17 last. Near the bottom of col. 1, page 506, he says, "My flames were thus maintained at a *constant mean distance* from the thermometer;" and, farther on, "Here, then, is a serious discrepancy. I get an increase of 4° by the first addition of two flames, and by eight such additional pairs obtain an increase of 34° instead of the 32° due to theoretical diathermacy," &c. The explanation of the discrepancy seems to be that the radiant heat from a flame, like that from any other body, varies as the inverse square of the distance, and therefore the total effect is proportional to $\frac{1}{d^2} + \frac{1}{d'^2} + \frac{1}{d''^2} +$ &c., not $\frac{1}{d} + \frac{1}{d'} + \frac{1}{d''} +$ &c., where $d$, $d''$, &c., are the distances of the flames from the thermometer; in which latter case the order of lighting the jets would answer the desired object.

Without going further into the subject, I would also draw attention to the desirability of keeping the gas at constant pressure, in order that the flames may be always of the same size and shape. It does not appear to be sufficient merely to record the quantity of gas consumed.

The Castle, Parsonstown, Nov. 5 ROSSE

### The Corona Line

IT is rather absurd, as Capt. Herschel says, for an American to carry on a discussion with a resident of India through a London periodical; but there are one or two points in his letter of July 29th which I should like to notice.

In the first place, let me acknowledge my mistake as to the original proposer of a chart of the spectrum based upon a scale of inverse wave-lengths; the error arose in the manner Capt. H. supposes. Let me add also my profound satisfaction—shared, I am sure, by all who work with the microscope—on learning, a few months ago, that such a chart is in preparation, and that under the charge of a committee of the British Association.

Next, as to the question, "What guarantee was there that No. 31 of the Preliminary Catalogue was the 'coronal line,' anterior to the Dodabetta measurements?"

In 1869 the case stood thus, so far at least as my own observations are concerned:—In July I had found (not *discovered*, for Mr. Lockyer had anticipated me, although I did not know it until October) that the 1474 dark line was generally reversed in the spectrum of the chromosphere. I had been led to examine this part of the spectrum with especial care by the report of green lines seen by Pogson and Rayet during the eclipse of 1868.

On the forenoon of the day of the eclipse of 1869 (August 7) this line was distinctly reversed at several points on the sun's limb, and with my instrument no other bright line could be seen near it. When, therefore, in the afternoon during the eclipse, I saw in that part of the spectrum a strong, solitary bright line, I considered myself warranted in identifying it with my old acquaintance, 1474, particularly as the measurements of Prof. Harkness, with a one-prism instrument, accorded as well as could be expected.

In 1870 the matter was examined more critically. A few minutes before totality, the 1474 line being already distinctly, and even conspicuously, reversed, the cross wires of the spectroscope micrometer were carefully adjusted upon it, and as soon as totality began the corona all around the sun was thoroughly explored without disturbing the micrometer setting. The bright line remained entirely unchanged in position under the whole dispersive power of thirteen prisms, very bright near the moon's limb, but fading to imperceptibility at a distance of from 10′ to 20′.

It seems to me, therefore, that the Dodabetta measurements must be regarded as merely confirming what was before fully ascertained. Of course it was highly desirable that the fact should not be allowed to rest upon the testimony of any one observer.

Then as to another point—the puzzling coincidence between the coronal line and a line in the spectrum of iron.

The absence of hundreds of other and more important iron lines from the coronal spectrum, and the difficulty of supposing the vapour density of this metal less than that of hydrogen, or of otherwise accounting for its presence in such quantities in the upper portions of the solar atmosphere, made it from the first highly improbable that this line could be due to iron. Now I think I can add another fact pointing in the same direction. During the past summer, observing at an altitude of more than 8,000 ft., I have repeatedly witnessed solar disturbances by which the b's, the E lines, and the double iron line 1463 K (all in the same field with 1474) were considerably displaced and distorted, while 1474, and some other lines of unknown origin near it, were not in the least affected. I think therefore I may say that 1474 does not usually sympathise with the lines of the iron spectrum, and this adds to the probability that it is of different origin.

But, on the other hand, so close is the coincidence, that the more I examine the matter, the harder it is to suppose that we have to do with a mere accidental juxtaposition. For one I am very anxious to hear whether the new and unequalled instruments of Dr. Huggins throw any further light upon the subject, and I should be very glad to hear that they show the non-coincidence of the bright and dark 1474's, because it would greatly simplify the problems, but I cannot say that I expect such news.

Now if the coincidence is absolute, there must be some reason for it; either the coronal matter exists in terrestrial iron as an impurity, or the two substances have in their molecular constitution some similar dimension, some common parameter, which accounts for this identical vibration-period; for I take it even an *absolute* coincidence between the lines of two spectra entirely independent in their origin is infinitely impossible—I mean of course coincidence determined to be such by a spectroscope of infinite dispersive power.

As to the numerous coincidences observable upon the charts of Kirchhoff and Angström, between the lines of iron, titanium, and calcium, it seems most likely that they originate in the slight impurity of the metals used by the experimenters. Certainly the matter merits most careful investigation, for if this is not the case a road would seem to be opened by which we may hope ultimately to penetrate many of the secrets of metallic molecules. C. A. YOUNG

Dartmouth College, U.S.A. Oct. 10

### Brilliant Meteors

ON Sunday evening, (Nov. 3), at 5.30, a magnificent "bolide" was observed at Glasgow, shooting athwart the sky. It made its first appearance in the Constellation Auriga (about

10° to the left of Capella); from thence it glided slowly across the sky, shining with a brilliant *green* light, and exhibiting a pear-shaped disc of *one-third* of the apparent diameter of the full moon. When it had arrived at the middle of its path (being almost due north), its velocity abated, and its colour changed to a *whitish-blue*. The meteor, accompanied by a diminutive *red* tail, and followed by a train of sparks, then regained its original velocity, and gradually approaching the horizon, eventually disappeared behind a cloud lying parallel, and close to the horizon in the N.N.W. The whole time occupied during its flight being 2·5″. In my letter reporting the auroral display of Nov. 10 last year, I suggested the application of Photography to the solution of auroral problems; might I venture to ask if any of your photographic correspondents have been able, during the displays of this year, to prove the possibility of taking auroral photos? I think the results would be interesting to most of your readers. ROBERT MCCLURE

Glasgow, Nov. 4

ON Wednesday night the 6th November, whilst looking from this place over the sea, directly west, a few minutes before ten o'clock, I saw a meteor of large size subtending I should think one-sixth the angular magnitude of the moon. It was accompanied by a short scintillating train, and moved slowly quite parallel with the horizon directly north. Its elevation was about 15°, and its rate of motion I should think $1\frac{1}{2}°$ per second. The night was dark and somewhat cloudy, and the line described by the meteor seemingly quite straight. D. WINSTANLEY

Blackpool, Nov. 8

### Day Aurora

WITH respect to the "Day Aurora" alleged to have been seen by Secchi (see vol. vi. p. 492) his description is not that of an aurora, especially as regards its position, which was far from being at right angles to the magnetic meridian; and as regards the "fantastic rays (*jets filamenteux*)" whose "forms perfectly resembled those of the solar protuberances," they would therefore be very unlike the rays of an aurora. T. W. BACKHOUSE

Sunderland, Oct. 30

## *THE KATIPO OR VENOMOUS SPIDER OF NEW ZEALAND*

FROM the interesting "Field Notes of a Naturalist in New Zealand," which have been appearing in the *Field* for some weeks, we extract the following description of this hitherto little-known animal.

Among the invertebrata there is a venomous spider known as the "katipo;" and, as this is almost the only noxious inhabitant of the land, it may be interesting to give some account of it, especially as there are some very curious points in its natural history. The first scientific notice of the existence of a poisonous spider in New Zealand was furnished by Dr. Ralph, in a communication to the Linnean Society in 1856 (see Journal Proc. Lin. Soc., vol. i., 1856, pp. 1, 2). Dr. Ralph's paper contained a short description of the full-grown spider, observations on its nesting habits, and an account of experiments which he had made in order to test the potency of its venom. The native name, katipo, signifies "night stinger" (being derived from two words, *kakati*, to sting, and *po*, the night), and, although more strictly applicable to the venomous spider, it is often used to denote a wasp or other stinging insect. The species has been described and figured in the Transactions of the New Zealand Institute (1870, vol. iii. pp. 56-59), under the name of *Latrodectus katipo*, and is closely allied to, if not identical with, one inhabiting Australia. The exact range of this spider in New Zealand has not been accurately ascertained; but it appears to be rather local in its distribution, while its habitat is strictly confined to the sand hills skirting the sea-shore. Along the coast from Wainui to Waikanae (on the north side of Cook's Strait) it is excessively abundant. From Waikanae to Horowhenua it is comparatively scarce; but at the latter place, and for a few miles farther north, it is said to be abundant. At Manawatu, and thence along the coast for twenty or thirty miles, it is very rare. At the mouth of the Wanganui river, again, it is very abundant; and a story is still current among the natives of the district about a fishing party, all of whom were bitten by this dreaded spider, and in two cases with fatal results.

The writer then adduces several instances to prove that the bite of the spider is occasionally fatal, and certainly very painful and distressing. But, he says, "I have satisfied myself that, in common with many other venomous creatures, it only exerts its dreaded power as a means of defence, or when greatly irritated; for I have observed that on being touched with the finger it instantly folds its legs, rolls over on its back, and simulates death, remaining perfectly motionless till further molested, when it attempts to escape, only using its fangs as the *dernier ressort!*"

The cocoon or nest of the katipo is perfectly spherical in shape, opaque, yellowish white, and composed of a silky web of very fine texture. The eggs are of the size of mustard seed, perfectly round, and of a transparent purplish red. They are agglutinated together in the form of a ball, and are placed in the centre of the cocoon, the exterior surface of which is sometimes encrusted with sand. The spider itself undergoes the following changes in its progress towards maturity:—In the very young state it has its body white, with two linear series of connected black spots, and an intermediate line of pale red; under parts brown; legs light brown, with black joints. In the next stage, the fore part of the body is yellow, with two black "eye spots;" sides black, with transverse marks of yellowish white; dorsal stripe bright red, commencing higher up than in the adult, and with the edges serrated. At a more advanced age the stripe on the back is brighter, with a narrow border of yellow, and the thorax and legs are nearly black. In the fully adult condition, the female of this spider is very handsome both in form and colour. Examples differ considerably in size, the body, which is almost spherical, varying in development from the size of a pigeon-shot to that of a small green pea; and in the largest specimens the outspread legs, measuring across, cover a space of only three-quarters of an inch; thorax and body shining, satiny black; a stripe of bright orange-red passes down the centre of the body, the edges being tinged with yellow. At the anterior extremity this stripe is broad and angular, and is surmounted by an open narrow mark of white in the form of a nail head; below this, and immediately above the junction of the thorax, there are two divergent spots of orpiment yellow, with white edges; legs black, with the extremities inclining to brown. The male is considerably smaller, and has the body shining blackish-brown, with an obscure narrow line of yellow down the centre of the back, broader towards the posterior extremity, and a similar interrupted line on each side of the body.

The spider here described belongs to a genus which contains several species in other parts of the world, also reputed venomous. Walckenaër, writing of the *Latrodectus malmignatus*, an allied species, common in Sardinia, Corsica, and parts of Italy, remarks:—"This spider is certainly poisonous; its bite causes, they say, in man pain, lethargy, and sometimes fever;" and Mr. Abbot, in his account of *Latrodectus* in his "Georgian Spiders," states that its bite is "undoubtedly venomous." It is curious, also, as already noticed by Dr. Powell, that the species of this genus, so widely distributed over the world as to be found in Europe, America, Australia, and New Zealand, should all agree in being black with red markings, for colour is of all characteristics the most variable, and especially so in the case of spiders.

## INSECT METAMORPHOSIS*

EVERYBODY, whether learned or unlearned, is aware that insects undergo changes in their shapes and habits. Great numbers of popular works on natural history have made the description of these changes or metamorphoses familiar to the public; and Newport, Dugés, Heroldt, Fabre, and those British entomologists and naturalists whose names are household words amongst us, have informed the scientific world upon the anatomical and minute changes of structure which accompany the wonderful varieties in form and in method of life. The array of facts is enormous, and yet, with all this vast amount of sterling knowledge to build upon, very little progress has been made towards recognising the cause and meaning of metamorphosis in biology—in the science of life. The facts and details of the subject have been accumulating, but the nature of its philosophy has been studied by very few naturalists, and it is only of late years that Lubbock and Fritz Müller, and a few others, have been stimulated by the light of the theory of evolution to examine into it. Believing that the subject is increasing in interest, and that its consideration bears upon some of the most important theories respecting life, it is proposed to devote this lecture to a description of the different kinds of metamorphoses in insects, and to a consideration of the biological meaning of the phenomena.

Let me recall to your recollection two instances of what may be called perfect and complete metamorphoses. When the tenderest cabbages are growing in the early summer, a number of very small caterpillars or larvæ may be seen upon the plants, devouring them in a regular and systematic manner. Avoiding the leaf-veins as indigestible, they nibble the juicy leaf, and consume daily more than their own weight. These pests of the gardener have small heads and ends, and the body is greenish and striped with yellow bands, being at the same time hairy. At first very small in size, the caterpillars do not attract much attention, and especially, as after living for a few days, they hide up out of the light, and look shrivelled and ill. After a short time, the caterpillar in retreat bends its back violently, and

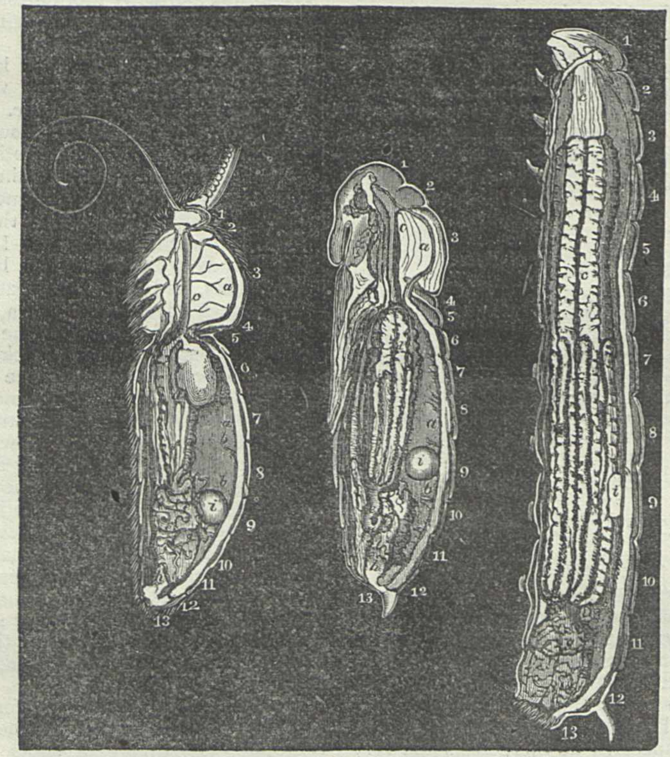

FIG. 1.—Metamorphosis of Tortoise-shell Butterfly.

splits the skin of one of the rings or segments of the part nearest the head, then a vigorous struggle enables the legs and the head to be withdrawn through the crack, and the larva is noticed to have attained a new skin within the old one. It crawls on to its favourite plant and makes up for lost time, grows rapidly, and really may be said to live to eat. It cares not for its fellows, nor for any other leaves; it is content with its own cabbage, and has no ambition and no desire to quarrel or to move away. During growth the powers of mastication and of digestion increase, but they are checked several times by the larva having to pass a period of quietude whilst a new skin is finished under the old, and whilst this is cast off. These skin sheddings have a definite relation to the increasing size of the insect, but they are not simple changes of skin because the old one has become too tight for its rapidly growing possessor. They accompany certain important changes within the insect, and not only is the outside skin shed, but the mucous membrane of the digestive organs and of the air tubes which enable the creature to breathe, suffer also. They are really important elements in the metamorphosis, which term includes the sum of the changes of shape, habit, and instinct.

When full growth has been attained, the caterpillar crawls from its cabbage and wanders restlessly about, even to considerable distances, in search of a dry sheltered spot. After having discovered such a locality, it fills up the space between its hind legs with silk, and attaches this part of the body to the wood or stone, as the case may be. The larva then hangs head downwards, and forthwith begins to bend its head backwards, upwards, and then from side to side, until, after a little practice, it is enabled to touch the solid substance to which it is hanging on either side of its body. Then some silk is secreted, and by applying the mouth to the spots touched one after the other, a fine sling of silk thread binds the insect down and prevents it from being swayed to and fro by the wind. This is the last act of the larva which shows any evidence of will. Then it begins to look shrivelled, shorter than before, and broader behind the

* A Lecture delivered before the British Association, 1872, by Prof. Duncan, F.R.S.

head, and after a time the skin splits, and is shed with greater or less wriggling. A sticky, varnish-looking moisture covers the very different-looking thing which now presents itself, and dries rapidly, and forms a case over the skin of the "pupa" beneath. The alterations within and without the insect at this time, that is to say, during three or four days after leaving the cabbage, are carried out with great rapidity, and the future butterfly is well foreshadowed at this period in the structure of the chrysalis or pupa. Hanging as a chrysalis or pupa in a perfectly immobile condition, neither seeing, hearing, nor tasting, and losing very little weight from the exhalation of its moisture, the insect lives on for many months, and until spring has nearly ended. Then the dark case splits, and a tender white butterfly crawls forth, and, under the influence of warmth and the sun, becomes dry,

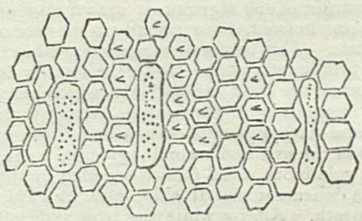

FIG. 2.—Œsophageal Epithelium.

stretches, and unfolds its crumpled-up wings, walks feebly upon long legs, trails a short body, moves a curious flexible trunk in front of its head, the result of the modification of its former jaws, and takes to flight. The common white butterfly, whose solitary flight is so zigzag and wandering, and whose flight in company is so tumultuous, ascending and vibrating, lives for love. It has a soul above cabbages, and rarely condescends even to sip or suck the daintiest nectar from flowers. After a longer or shorter existence, it begins to lay eggs, and places them in the immediate

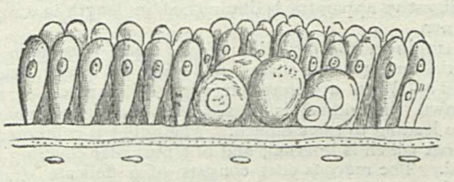

FIG 3.—Stomach Structure.

neighbourhood of the favourite food of the larvæ, which are to come from them.

Another familiar example of perfect metamorphosis may be studied in the instance of one of the false wasps, *Odynerus parietum*. This small wasp-like insect may be seen on the other side of the Channel in great companies on lucern and clover when in full flower. It is a solitary kind, and the male and female care nothing for their companions, who rush and tumble over, in, and about the flowers, sucking their sweetness, and squabbling

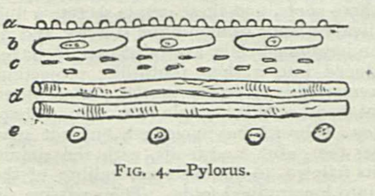


FIG. 4.—Pylorus.

and flying for the freshest corollas. Day after day this buzzing busy crowd may be seen leading a life of happy enjoyment, feeding, playing, and flirting; but after a while an unusual excitement is noticed amongst a large number of the insects. These extend their flight beyond the favourite field, and seek the neighbourhood of sandy clayey banks close by. They may be observed digging their heads into the sand with great assiduity, and pulling out sand grains, and gradually forming a hole. Each wasp works independently of its neighbour. As soon as the hole is large enough to admit the wasp's body, the legs remove, by a process of brushing, the particles loosened by the jaws. After a short time the wasp will be found to have made a tunnel, and the constant out-pour of sand and clay indicates that excavation is still proceeding out of sight.

Soon the *Odynerus* perfects two or three chambers deep in the bank and opening into the tunnel. She (for it is the female who does the work) carefully pounds the insides of the cavities and removes all roughness from them, and leaves them as commodious hollows, water-tight, and not likely to fall in. This is not all. On coming back into the light, the wasp seizes cylindrical pieces of earth, and moulds them more or less into shape with her jaws, and places them in front of each other, and side by side, so as to form a hollow tube, which sticks out from the bank and opens into the tunnel. The free end of this ante-chamber is left open, and the pieces of which the whole is formed are gummed together and pressed. The tube is ex-

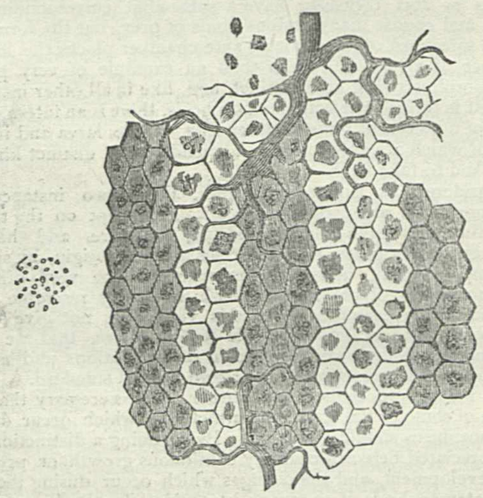

FIG. 5.—Stomach Structure of Pupa.

tremely fragile, and the pieces of it are not in contact everywhere. Nevertheless, the *Odynerus* passes along it readily enough, but no other insect of its size can do so. All this work is carried on whilst the wasp appears to be in an intense state of excitement, and when it is completed the insect flies off to the flowers again. But not to return to its former habits. On the contrary, the purposeless tumbling about of flowers, and the occasional sip of nectar, are forgotten, and the flighty little vegetarian becomes a ferocious and ardent huntress of prey. She seeks the small larvæ of a species of weevil which abounds about the plants, and seizing one, digs her sting into it, so that a weak venom is introduced close to the nervous system of the victim. The larva is paralysed

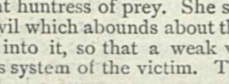

FIG. 6.—Stomach Structure of Imago.

at once, but not killed; on the contrary, it remains motionless, but lives. She then flies off with her prey to the bank, enters the tubular ante-chamber, traverses the tunnel, and reaches one of the chambers. Here she deposits her insensible victim, and lays one egg close to it. Returning again to the field, she seizes another larva, stings it, and carries it off to deposit it close to the first. This procedure is repeated as many as thirty times, and the chamber becomes full of insensible weevil larvæ and one *Odynerus* egg. The other chambers are filled in the same manner, and an egg is laid in each. Then the wasp comes out of the tunnel for the last time, breaks down the tubular ante-chamber, so as to hide the entrance to the tunnel and chambers, flies off, and dies. She never sees her offspring, for which she, a vegetarian, has provided animal food in abundance.

The egg is soon hatched in each chamber, and a small, legless, and extremely delicate larva crawls forth, and seizes upon the victim close to it. So tender is the larva that the least roughness of the sides of the chamber would destroy it, and the least struggle on the part of the poisoned weevil grubs would kill it; but all this has been made safe, and the little thing eats into its living prey, and when one is finished it attacks another, until all are eaten up. This is the life of the larva. It is incapable of walking any distance, and simply leads a life of gormandising on the flesh and juices of weevil grubs. It never emerges from the chamber, and when it has no more to eat, spins a cocoon of silk around itself, and sleeps therein during the late autumn, the winter, and until the spring. Then a change in form ensues, and a pupa, which greatly resembles the perfect insect, appears under the skin which is shed. In the course of a few weeks the perfect false wasp escapes from the pupa skin, digs its way into the world, and emerges to enjoy the destiny already described.

Many other false wasps which belong to the same group of insects as this *Odynerus* have a somewhat corresponding life cycle, and choose many curious kinds of prey, but the formation of the safeguard of the tubular ante-chamber places this kind in advance of all others. It is then an example of very perfect metamorphosis with high instinct, and, like in all other instances of what is termed perfect metamorphosis, there is an intermediate stage of a quiescent pupa between that of the larva and imago, both of which are able to lead independent and distinct kinds of lives, and to take food.

Considered as isolated examples, these two instances of metamorphosis are perfectly inexplicable, except on the theory that the successive changes—shape, structure, and habit—were especially given to the species at their origin, by special creation. When, however, the nature of the very different metamorphoses of other insects, which closely resemble these in structure, is examined into, this view does not give entire satisfaction, and an uncomfortable feeling arises, that we with finite understandings are tying down the operations and mysterious ways of Omnipotence to our own limited standard.

But before proceeding any further, it is necessary that the nature of some of the structural alterations which occur during metamorphosis should be stated. By so doing a distinction can be appreciated between ordinary continuous growth or progressive development, and the changes which occur during the perfect metamorphosis of an insect. Consider shortly the nature of the change of outside form. A young larva of a butterfly or moth has a head which is not separated by a neck from the long body, and the whole is divided more or less distinctly into rings or segments. The three segments next to the head form the chest and support the true legs, and are succeeded by nine others belonging to the body or abdomen. There are then thirteen in all. The body segments are nearly equal, but the last is the smallest, and it, together with some of the other rings, supports what are termed false legs or claspers. They are continuations of the skin, and do not exist in all larvæ of butterflies and moths; and, although they are extremely useful in enabling the insect to hold on and to crawl, they disappear in the pupa state with the last skin-shedding. Thus there is the head segment, and three chest segments, and nine body segments, and on the side of each of these, excepting the head, is a point, which usually marks an opening where air tubes or tracheæ enter the body to ramify over the whole of the internal structures. When within the egg, and before it was perfectly formed, the head of the larva consisted of at least four separate pieces, but these united and coalesced in one before birth. None were destroyed, but the edges of the separate portions fused together. A corresponding fusion and blending of certain of the chest and body segments occurs during metamorphosis, and there is neither a destruction nor new creation of parts to produce the extraordinary difference between the long body of a caterpillar, the short swathed figure of the pupa, and the great chest and small abdomen of the butterfly. The same anatomical elements are present, but they are more or less modified.

The first skin sheddings of the caterpillar do not add to or alter its segments, but the last skin shedding which occurs during a period of immense internal change exposes the pupa or chrysalis to view, and all the characteristics of the skin of the larva are lost. On commencing this last skin shedding, the chest segments, 2, 3, and 4 (Fig. 1) of the caterpillar, increase in size, and the insect really soon begins to shorten. The small Tortoise-shell butterfly larva is thus suspended, with its skin on, for some ten or twenty hours before the chrysalis is revealed. During this time, the 2, 3, 4, and 5 segments become much enlarged and curved downwards by the action of the muscles of their under surface, which are repeatedly contracted and expanded slowly. The skin bursts, and the insect then exerts itself to the utmost to extend the fissure along the segments of the body, and gradually draws out its antennæ, or feelers, and its weak but long legs, and immature wings, all of which have been maturing beneath the old skin, and are covered with an extremely delicate tissue. The false legs drop off with the old skin, and the pupa hangs in this moist and curious condition for a few minutes. Then it makes a few powerful efforts, and contracts and expands itself to the utmost by taking in air through its air tubes and forcing it out again by bringing the segments closer together. The result is to contract the body segments along their under surface, and to diminish their length generally. The front margin of one segment is drawn up within the hinder edge of the one in front, and especially in the case of the fifth and sixth segments. This contraction persists, and in the neighbourhood of the fifth is sufficient to initiate the small waist-like circular division between the chest and the body, which becomes more distinct in the imago than in the pupa. Atrophy and shortening of the fifth and sixth segments occur; and there are corresponding changes in the first and second segments, so as to commence a neck. A gelatinous viscid fluid is secreted by the pupa, and it covers all its delicate external skin, and by hardening agglutinates all beneath. After a while the true skin of the pupa, is found separated by air from the dark pupa case outside.

After the escape of the imago from the pupa case, if its wings be removed, and its head, chest, and body be examined, the distinction between the number of its segments and those of the full-grown larva will be readily appreciated. The nine body-rings of the caterpillar exist, but are much modified. The two terminal are drawn up inside the body, and the first segment has joined itself to the last chest-piece. The shortening is very great, whilst the enlargement of the rings which support the wings—namely, the third and fourth—with much consolidation and fusion of them, does not compensate for it. As may be supposed, the shortening of the internal organs must be extraordinary, and as a matter of fact the nervous cord is shortened, its ganglia are concentrated, and the digestive apparatus is diminished in length in a remarkable manner.

The changes in the digestive organs keep pace with those of the skin and general shape, and may be briefly described as follows:—When a caterpillar nips off a piece of a leaf with its jaws, the morsel is passed into the gullet, which is a short tube leading to the stomach. The gullet is composed of a mucous coat which is internal, and of a muscular covering which is external. The mucous coat consists of a delicate structureless membrane, which is continuous with a corresponding tissue in the mouth in front and in the stomach behind. It is called the basement membrane, and that of the gullet is folded longways, when it is empty. When the gullet is crammed with food, the folds are obliterated and the membrane is stretched. All the inside of this membrane is covered with a layer of delicate hexagonal cells, which are very small and thin, and consist of a plain cell wall and transparent fluid contents (Fig. 2). They cover the basement tissue like a pavement, and the morsel of food comes in contact with them, and they absorb and transmit any vegetable liquids which may escape from the cells of the leaf. Between the hexagonal pavement cells here and there are oval depressions filled with granular mucus. The basement tissue is slightly depressed in these spots, and these crypts secrete a fluid which acts like the salivary glands of man upon starchy and sugary fluids. Amongst the hexagonal cells are others which have their upper surface produced into a short tooth-like projection, that foreshadows a remarkable structure in the perfect insect. Outside the basement membrane is a single row of hoop-shaped muscular fibres. They are broad and nucleated, but not striated. Each fibre encircles the gullet, and tends, with the simultaneous contraction of its fellows, to diminish the calibre of the tube, and to throw it into longitudinal folds. Their passive dilatation, on the contrary, permits the gullet to become distended. They have, however, the peculiarity so common in the circular muscular fibres of all animals, of contracting one after the other in series, and of dilating or expanding in the same rhythmical manner. The result of this progressive contraction is to force the contents of the gullet in the direction of the stomach. The alterations of contraction and the expansion permit the layer of muscular fibres, which is outside the circular set, and whose direction is longitudinal, to pull up and shorten the canal. The long fibres are attached to a ring behind the mouth, and around the commencement of the gullet, and they are continued down the tube to the stomach. They are closely packed, and are very distinct. When the gullet is shortened by their contraction, any food in it is brought nearer the opening into the stomach, and then it is forced into that organ by the progressive contractions of the circular fibres. The piece of leaf is lubricated by the granular mucus of the crypts, and is squeezed by the contraction of the circular fibres. Much of the contents of the cells of the leaf is thus set free, and is absorbed by the mucous cells, and transmitted through the basement tissue to the blood, which permeates all the tissues more or less.

The stomach is large in comparison with the size of the larva, is cylindrical in shape, and does not taper gradually into the gullet in front and the intestine behind. The calibre is many times greater than that of the rest of the digestive canal. Like the gullet, a mucous layer, a basement membrane, and two sets of muscular fibres, enter into its composition. But the mucous membrane differs in every particular, except in the structureless basement membrane. The basement membrane is densely covered internally by an aggregation of large cells of two kinds, and the more active the larva may be in its eating, the more numerous and larger are these cells. One kind is elongate, and narrow at the base, where there is an attachment to the membrane, and rounded at the free end (Fig 3). They are thus more or less club-shaped, and they are formed by a very delicate cell wall, a nucleus and more or less granular, coloured, and liquid cell contents. They are crowded together, and belong to what is called columnar epithelium. They become less bulky, thinner, and crooked, if the caterpillar is starved, and just before the skin-sheddings also. Another kind is represented by large globular cells, which are fewer in number compared to the others. They are composed of a very delicate cell wall, of nuclei, and liquid contents, and they burst in the ordinary process of digestion, and appear to supply a gastric juice. The columnar cells, on the contrary, absorb nutritious matters, and transmit them through the basement tissue. These huge cells are very remarkable, and all degenerate, and greater part are cast off during skin-sheddings. A layer of circular or hoop-shaped muscular fibres is found outside the basement membrane, and whilst those of the fore part of the stomach are so closely applied to each other, side by side, as to form a continuous circular muscular coat, those of the nether parts of the organ are wider apart, but at the termination of the canal in the intestine they are again concentrated, and not simply in one row, but in many, so as to form a dense circular muscle or sphincter. The longitudinal fibres are outside these, and are continuous in front with those of the gullet, and they end in the tissue, which connects the dense circular fibres of the sphincter together. The large cells of the inner coat of the stomach are not found on the basement membrane which covers the thick sphincter, and they cease suddenly a short distance in front of it.

This part of the stomach is evidently in very constant and somewhat violent movement, for the use of the dense mass of circular fibres is to compress and crush the food in its passage to the intestine; consequently, a cellular layer exists on the basement, which is suited to bear pressure. The cells of this part resemble to a great extent those of the gullet; they are flat, hexagonal, and pavement-like, but a great number of them have very decided tooth-like projections on their free surface (*a*, Fig. 4). These projections occur in numerous circular series, and they are sufficiently prominent to wound a delicate vegetable cell passing over them, and submitting to the pressure induced by the contraction of the circular fibres. It is evident that if the muscular contraction be great, and the cells of the leaf rather hard, these hexagonal tooth-bearers will suffer from much and perhaps destructive compression.

But a very interesting structure is superadded to this part of the digestive system in order to prevent such an accident to the delicate mucous membrane. There is a layer of very large flattish cells beneath the basement membrane and between it and the circular fibres. Each of these cells (*b*) contains much fluid within a very visible cell-bag, and there are the usual nuclei. They are not quite in opposition laterally, and they rest upon an expansion of the muscular fibres, some granular fluid and nuclei intervening (*c*). Their office is to act as cushions beneath the immediate seat of pressure, and where the circular fibres are the strongest, there they are best developed. This arrangement of fibres, cushion cells, basement membrane, and delicate tooth-like projections, is continued to the extreme end of the stomach. There the circular sphincter muscle exists, and the basement is folded more or less longitudinally, so as to admit of the calibre of the canal being extended and contracted to the utmost. The cell teeth are found here in angular series, and there is one circular row of large ones. Microscopic examination of the dense mass of circular fibres reveals that the fibres are separate, stout, and that some of them possess a structureless investing membrane (*d*). The longitudinal muscles of the stomach, which are extremely long and close together, end by forming one or even three processes, which are united to the circular fibres, and the corresponding fibres of the intestines take their origin in this sphincter. Many nerves and air-tubes supply this part, which ends in an intestine of moderate length, and which time will not permit me to consider.

These structures are all developed in exact relation with the gormandising habits and the nature of the food of the cabbage-eating larvæ. The pieces of raw vegetable consist of cells with tolerably stout walls, and these have to be broken into before any nutritious matter can be let out to be digested, and the growth of the insect is so rapid that the quantity of food swallowed and passed along the stomach is very great.

This active stomach has periods of rest during the skin-shedding, when the cells of its mucous coat are cast off and replaced by new ones. The day comes at last when the caterpillar loses its love for cabbage and is to get no more, and then, ere it hangs pendent before the alterations in the size of the segments commence, changes may be noticed to have begun in the anatomy just described, changes which might take place from disuse. The stomach is, comparatively speaking, empty of food, the club-shaped cells are smaller and less round, and the globular cells are broken up. The muscular fibres appear thinner, wider apart, and more transparent. Immediately after the agglutination of the outside of the pupa occurs, sensible changes proceed in the digestive canal, and very rapidly. By the fifth day the whole canal has become shorter, the gullet has become thread-like and longer than in the caterpillar. The stomach is not half the length or one-third of the breadth of its former condition, and the intestine is longer than before. A general atrophy of all the layers of muscular fibre exists, and the dense muscular sphincter of the stomach with its peculiar fibres has been absorbed and replaced by simple, separate, and delicate circular muscles. The longitudinal fibres are wide apart, and very transparent. The longitudinal folds of the gullet have disappeared with the mucous crypts, and the basement membrane is covered with a granular fluid, in which the remains of the old hexagonal cells float. A mass of broken-down, club-shaped globular cells occupies the small stomach, and a totally different arrangement covers the basement. Cells packed closely together here and there, and separated by lines of granules, indicate that a new kind of mucous coat is being developed. These cells assume the hexagonal shape, are moderately tall, and contain a few granules, and they extend over the place of the toothed cells at the sphincter, and join the cells of the intestine (Fig 5). The toothed cells have disappeared, and the cushion cells of the region of the sphincter also. All these structures are remarkably delicate and difficult to manipulate, and it may be remembered that they are not performing any function whatever.

When the imago escapes from its hard pupa case, and when it has completed its metamorphoses, the digestive canal presents further modifications, which are brought about, however, during the imprisonment. The gullet is longer, and has a sac-like crop projecting from it; the stomach is narrower, and the intestine is longer. All the muscular fibres are extremely delicate, and there are no new arrangements of them. The basement membrane of the gullet is developed on one side into a bag-shaped tissue, and the whole of it is covered by extremely delicate cells, most of which have a long hair-like process sticking up from them, which was foreshadowed by the tooth-like projection of the larva state. The stomach cells have increased in height, and contain granules, but they resemble those of the pupa until the food is taken; then the cells increase in size, and many are set free in a globular form, and there is not a want of likeness between some of them and those of the larva (Fig. 6). This long gullet, crop, and tubular stomach, so flaccid from want of strong muscles, is admirably adapted for the peculiar food of the perfect insect. The sugary fluids of flowers require no crushing and rasping, and not much digestion—so the hairs of the gullet-cells assist in the passage of the syrup down the canal, and the gentle pressure of the delicate muscles of the stomach suffices for its purpose.

To say the least, these are wonderful changes in the same anatomical elements, and they indicate that metamorphosis includes modifications the result of disuse and alterations which bear a prospective relation to the future wants of the altered insect form.

It appears at first sight that this separation into different stages of life is necessary for the insect, and that it must have a time devoted to eating, digesting, and assimilating, a quiet condition devoted to internal changes, and a stage where reproduction can be carried on. But this generalisation fails when it is remembered that some larvæ eat and reproduce, and some imagos reproduce and lead bloodthirsty lives also. It is important to recognise the distinction already hinted at. The growth of the young embryo larva within the egg, and that of the escaped and skin-shedding larva, is progressive, but the descriptions given of the changes in the shape and in the anatomy of the digestive organs of the pupa and imago, prove that they do not depend upon simple progression from elementary condition to complexity. The changes of structure belong to a different order of things to the simple growth of the larva's tissues; they appear to be superadded.

(*To be continued.*)

## NOTES

THE Medals in the gift of the Royal Society have this year been awarded as follows:—The Copley Medal has been awarded to Professor Friedrich Wöhler, of Göttingen, For. Memb. R.S., for his numerous contributions to the Science of Chemistry, and more especially for his researches on the products of the decomposition of Cyanogen by Ammonia; on the Derivatives of Uric Acid; on the Benzoyl Series; on Boron, Silicon, and their compounds; on Titanium, and on Meteoric Stones. A Royal Medal has been awarded to Professor Thomas Anderson, M.D., for his investigations on the Organic Bases of Dippell's Animal Oil; on Codeine; on the Crystallised Constituents of Opium; on Piperin and on Papaverin; and for his researches in Physiological and Agricultural Chemistry. A Royal Medal has been awarded to Mr. Henry John Carter, F.R.S., for his long-continued and valuable researches in Zoology, and more especially for his inquiries into the Natural History of the Spongiadæ. The Rumford Medal, awarded every two years, has been awarded to Anders Jonas Angström, For. Memb. R.S., for his Researches on Spectral Analysis.

THE annual meeting of the Fellows of the Royal Society, for the election of officers and Council for the ensuing year, will be held, as usual, on the 30th inst. As we have before announced, Dr. Sharpey, after a long period of service as secretary, resigns his functions, which have been of such great advantage to the Society, and by the performance of which he has earned the thanks and respect of all men of science, Prof. Huxley being nominated by the council as his successor.

IN the *Boston Daily Advertiser* for Saturday, Oct. 26, 1872, the conclusion of Prof. Tyndall's last lecture is thus reported:—"There are three great theories which enable the human mind to open the secrets of nature—the theory of gravitation, the mechanical theory of heat, and the undulatory theory of light. These three pillars, as far as the human intellect is concerned, support the universe. To whom are we indebted for these discoveries? To men who had no practical ends in view, and who cared only for the truth. To-day, when there are so many temptations to young men to leave pure science for practical aims, it behoves us to look with sympathetic eyes upon the investigator who makes all this knowledge possible. I met on the steamship *Russia* a respected friend who ascribed the electric telegraph to a source to which I certainly should not have thought of referring it. It is the direct outcome of men who never made a shilling by it. Volta, Faraday, never made a shilling by it. All honour to the men who make these discoveries. Gauss and Weber, at the University of Göttingen, actually constructed a telegraph line from the physical cabinet to the observatory. Give all honour to the men who apply discoveries, but do not forget the men who make them. Many of you in this country have made fortunes, and have shown that you know how to apply them. Look with sympathetic eye upon the investigators. Give them opportunities. Do not overload them with other work. 'Cast your bread upon the waters,' and believe me 'it will return to you after many days.' My course among you is nearly over. I began it with some anxiety and end it with regret. It has been harder for me at times than I had expected, and I owe much to my assistants. I shall long and gratefully remember my reception on the occasion of my first lecture here. If I am treated in the same manner elsewhere, I shall return to the old country full of content. During my stay here I have heard 'the old country' mentioned again and again. You cannot abolish your antecedents. Out of England's loins you have come. Your ancestry is stamped upon your faces, your laws, your politics, and your characters. De Tocqueville, sympathising with democratic institutions, says, regarding England and America: "I refuse to regard these people as two; one is the outgrowth of the other." Atrocious ignorance of each other is at the bottom of all our differences. I trust that hereafter each nation will respect the individuality of the other; while thoroughly maintaining its own.' The lecture was listened to with great attention, and loudly applauded at the close. Every point made in behalf of the investigators, and upon our relations to the mother country, received loud approbation. Our report cannot do justice to Dr. Tyndall's earnestness in the latter portions of his lecture. It is to be hoped that some of our so-called 'practical men' may take to heart the lessons he has tried to teach them."

THE late Prof. De Morgan, in a note to his article on Tables in the "English Cyclopædia," strongly expresses his regret that the British Museum did not purchase Dr. Hutton's valuable mathematical library, and, consequently, the first set of mathematical tables ever collected in England was dispersed. With a view to avert a similar break-up, we may inform our readers that at a very early date the mathematical collections of the late Mr. Babbage must be disposed of. It is with reference to these that De Morgan, in the above-cited article, acknowledges his indebtedness ("large and rare collection of Tables"). Its excellence, however, is not confined to this special department only. We learn that catalogues will be issued in the course of a few days.

IN reference to the Swiney Lectureship, which we announced recently as having become vacant, we venture to hope the post will not be thrown away on some one who is already well off, and has taken his place in life, but that it will be given to some young man who has shown himself well qualified for scientific research, and who may thus be enabled to devote his time to investigations which may lead to results of enduring value. Several eminent men have already held this lectureship, including, we believe, Dr. Carpenter.

PROF. WEISS, of the Vienna Observatory, has recently passed through London, on his return from a tour of inspection through the United States, where he has visited all the principal observatories, in order to collect materials for a report on the instruments demanded by modern science in a first-class observatory like that of Vienna, which is about to be removed and extended. It appears that the 26-inch object-glass ordered by the American Government, as soon as the completion of Mr. Newall's magnificent instrument has established the feasibility of such an enormous aperture, is already finished, and the mounting is in a forward state.

*Silliman's Journal* for November mentions the death of the Rev. John B. Perry, Professor of Primordial Geology in Harvard College, and of Dr. John F. Frazer, Professor of Natural Philosophy and Chemistry in the University of Pennsylvania.

THE death is announced, in the Isle of Wight, on Friday last, of Dr. H. B. Leeson, F.R.S., for many years lecturer on chemistry at St. Thomas's Hospital.

THE University of Aberdeen certainly is not disposed to neglect science in looking out for a Lord Rector; among those spoken of to be put up for the next election, are Mr. Darwin, Prof. Huxley, and Dr. Lyon Playfair.

WE are glad to call attention to the fund now being raised for the education and maintenance of the family of Mr. John Cargill Brough, subscriptions to which may be paid at Messrs. Robarts and Lubbock's bank. We understand that a considerable amount has already been received.

THE winter course of lectures at South Kensington Museum for the instruction of women in science and art was opened on Monday by Prof. Duncan. The course is to consist of three series—the first by Prof. Duncan, on "Cosmogony and the World as a Planet;" the second by Prof. Carey Foster, on "Physics;" and the third by Prof. Rutherford, on "Physiology." There was a large attendance of ladies.

THE Committee of Directors of the Crystal Palace have resolved to extend the uses of that Institution by establishing practical engineering classes, in connection with their School of Art, Science, and Literature, under the Principalship of Mr. J. M. Wilson, Assoc. Inst. C.E. Such a preparatory course will render pupils on entering an engineer's office at once useful to their employers, and will enable them to take advantage of the opportunities offered to them during the time they are articled. These classes have been established for the purpose of affording to students of civil and mechanical engineering the advantage of thorough practical instruction in the rudiments of either profession, and in the manipulation of materials. The classes are also available for gentlemen anxious to become engineering draughtsmen, or to compete for the Whitworth Scholarships, or to enter the Steam Mercantile Marine. The course of instruction will consist of three terms extending over twelve months. One term will be spent in the drawing office, one in the pattern shop and foundry, and one in the smith's fitting and erecting shops. The students will be engaged in mechanical drawing, estimating and calculating, pattern-making, and constructing machinery for the market. Lectures will be delivered from time to time by the Principal, or by some eminent professor, on subjects connected with theoretical and practical engineering, and the students will be required to pass an examination upon such lectures at the expiration of each term. Convenient and extensive shops and offices, supplied with the best engineering machinery, have been fitted up for the purposes of the institution. The shops will be finished and the teaching commenced on January 1, or within a few days of that date. The premium for the year's instruction will be fifty guineas. The Crystal Palace is in many respects most suitable for such a purpose; for, irrespective of its being central and easy of access, it contains so many engineering models, works of science and art, hydraulic, pumping, and other machinery, that illustrations of important works in great variety are always accessible.

LORD F. CAVENDISH, M.P., presided on Monday at a meeting of the committee appointed to consider the proposed plans for establishing a College of Science at Leeds. The cost originally estimated was 61,000*l.*; but the funds are not forthcoming, and a committee was appointed to reconsider the subject.

SIR H. C. RAWLINSON, in his inaugural address on Monday night to the Geographical Society, referred to two contemplated African expeditions—one, got up by Livingstone's friends, and called the "Livingstone Congo Expedition," is to ascend the Congo from above the rapids, and endeavour to penetrate to the equatorial lake where Livingstone's rivers are lost, and in the vicinity of which it is expected the great traveller will be found at the close of next year. Livingstone's close friend, Mr. J. Young, of Kelly, has taken upon himself the expenses of the expedition to the amount of 1,500*l.* or 2,000*l.* A rival German expedition has been officially announced as in preparation for the same reason.

THE following numbers are stated to have been sold of Mr. Murray's scientific books at his annual "sale" last week:—6,200 of Mr. Darwin's new work on the "Expression of the Emotions in Man and Animals;" 1,100 of Darwin's "Origin of Species" and other works; 350 of Lyell's "Principles of Geology," 2 vols.; 900 of Lyell's "Students' Elements of Geology;" 1,500 of Kirk's "Handbook of Physiology;" 300 of Sir Roderick Murchison's "Siluria;" 1,200 of Prof. Newth's "Natural Philosophy;" 380 of Whymper's "Scrambles on the Alps."

A TELEGRAM from Copenhagen states that Mr. Edward Whymper has arrived there from his second journey of exploration in North Greenland. He brings with him rich collections of curiosities, among which are some very singular specimens of fossil wood.

THE Conversazione of the Photographic Society was held on Tuesday evening last, and the Annual Exhibition of Photographs will be open at the rooms of the Society, No. 9, Conduit Street, till the 30th inst., from nine till dusk, and on Monday and Saturday evenings.

THE members of the Hunterian Society were received by their President, Dr. Herbert Davies, on Monday evening last, at 23, Finsbury Square. In the course of the evening some original experiments were performed by Prof. Norris, of Birmingham, showing some hitherto unnoticed manifestations of the attraction of cohesion, with a view to explain the possibility of the passage of blood corpuscles through the capillaries in certain morbid states of the body, without the capillaries themselves being destroyed.

ON the evening of November 5 two new planets were discovered at the Paris Observatory. The first, discovered by M. Paul Henry, about 9 o'clock, is of the 11th magnitude; the second, discovered by M. Prosper Henry, is in magnitude 11·5.

PROF. WINLOCK communicates to 1,909 of *Astronomische Nachrichten* carefully tabulated "Results in Right Ascension of Observations of 156 Fundamental Stars observed with the Meridian-Circle of Harvard College University" (in English).

IT may not be generally known, says the *Astronomical Register*, that amongst other works translated of late years into the Chinese language are the following:—Herschel's "Outlines of Astronomy," by Wylie, 3 vols., sm. folio, China, 1859; De Morgan's "Algebra," by the same, 8vo., 1859; Mac Gowan's "Law of Storms," China, 1853; Milner's "History of England," abridged, by Muirhead, Shanghai, 1856. There is also a Treatise on Arithmetic, in Chinese, by Wylie, 1853.

THE committee of the Palestine Exploration Fund have just received a first instalment of the work of surveying the Holy Land. It consists of the first three sheets of an Ordnance map of the country, on the scale of one inch to a mile, based on an accurate trigonometrical survey, and including the district between Jaffa and Jerusalem, and the country north of Jerusalem towards Nablous, and embracing an area of 560 square miles. The survey has been already completed over an area of about 1,000 square miles, and further sheets may be expected about the beginning of the new year.

THE Ninth Report, just issued, of the Belfast Naturalists Field Club, speaks of continued activity and enterprise on the part of the Society. A considerable portion of the report is occupied by accounts of the various excursions, and short abstracts are also given of a number of papers read at its meetings, many of them having a chiefly local interest.

## *THE BIRTH OF CHEMISTRY*

### IV.

*Iron, lead, quicksilver.—Colours used for painting and dyeing.—Glass.—Certain minerals known to the ancients.—Miscellaneous processes.—Association of the seven metals with the seven greater heavenly bodies.—Consequent introduction of symbols into the history of matter.*

IRON was not in common use till long after the introduction of copper. It is far more difficult to procure, because it is not met with in the native state, and the fusing point is very high. The metallurgy of iron is more complex than that of copper, and when obtained it is a more difficult metal to work. According to Xenophon the melting of iron ore was first practised by the Chalubes, a nation dwelling near the Black Sea, hence the name Chalups (χάλυψ) used for steel, and hence our word *Chalybeate* applied to a mineral water containing iron. Steel was known to the ancients, but we do not know by what means it was prepared; it was tempered by heating to redness, and plunging in cold water. According to some, kuanos (κύανος) mentioned by Homer was steel; but Mr. Gladstone prefers to conclude that it was bronze. Iron was known at least 1537 B.C. It was coined into money by the Lacedæmonians, and in the time of Lukourgos was in common use. It was used in the time of Homer for certain cutting-instruments, such as woodmen's axes, and for ploughshares. Its value is shown by the fact that Achilles proposed a ball of iron as a prize for the games in honour of Patroklos. Neither iron money nor iron implements of great antiquity have been found, because, unlike the other metals of which we have spoken above, iron rusts rapidly, and comparatively soon disappears. No remains of it have been found in Egypt, yet Herodotus tells us that iron instruments were used in building

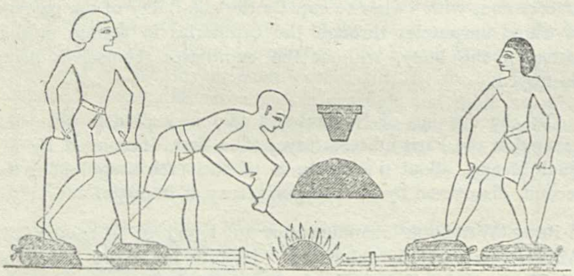

FIG. 3.—Egyptian Bellows. Fifteenth Century B.C.

the pyramids; moreover, steel must have been employed to engrave the granite and other hard rocks, massive pillars of which are often found engraved most delicately from top to bottom with hieroglyphics. Again, the beautifully engraved Babylonian cylinders and Egyptian gems, frequently of cornelian and onyx, must have required steel tools of the finest temper. We have no record of the furnaces in which iron ore was smelted, but we know that bellows were in use in the 15th century B.C. in Egypt, and some crucibles of the same period are preserved in the Berlin Museum. They closely resemble the crucibles in use in the present day. The accompanying woodcut (Fig. 3) represents a double pair of bellows, a furnace, fuel, and above perhaps a crucible.

The native Indians prepare iron from hæmatite at the present time by equally primitive bellows, which indeed resemble the above very closely, and which, without doubt, have been unaltered for centuries. A small furnace, A (see the accompanying section, Fig. 4),* is rapidly constructed of clay, and into the bottom of this two nozzles, B, are introduced; these are connected with the bellows by bamboo tubes. The bellows, C, consist of cup-shaped bowls of wood covered with goatskin above, and connected with the bamboo below. In the centre of the goat-skin cover a round hole is cut; the blower places his heel upon this, which is thus closed, while at the same time the skin is depressed and a blast is driven from the tube, then he steps upon the second skin, and thus a continual blast is kept up. The bent bamboo and string, D, is for the purpose of raising the goatskin cover of the bellows after depression, which, it will be noticed, is accomplished in the Egyptian bellows by a string raised by the hand. A piece of hæmatite is introduced with some charcoal, and after the lapse of some time, it is reduced by the carbonic oxide to a spongy mass of iron. Undoubtedly a crude furnace and appliance of this nature was used by the first smelters of iron.

* We are indebted to Dr. Percy for permission to copy this figure from his "Metallurgy," and to Mr. Murray for the other woodcuts.

Although we hear less of lead than of the preceding metals, it was known to the Egyptians at an early date, and it is mentioned by Homer. In the time of Pliny leaden pipes were used to convey water; and sheet lead was employed for roofing purposes. The chief supply of the metal came from Spain and Britain. Pliny believed that lead was reproduced in the mine, so that if an exhausted mine were closed it would be fit to work again in a few years' time. This idea of the growth of the metals was very generally accepted by the alchemists. Tin and lead were sometimes alloyed together by the ancients, and tin was used as a solder for lead. Litharge, or protoxide of lead, and *cerussa usta* (burnt ceruss), or red lead, were used by painters. *Cerussa*, which we now call "white lead," or more strictly, carbonate of lead, was prepared by exposing sheets of lead to the fumes of vinegar in a warm place, a heap of decomposing manure for instance. A basic acetate of lead is formed by this means, which is partially converted into carbonate by the carbonic acid given off by the decomposing organic matter. Cerussa was used by Athenian ladies as a cosmetic. Cerussa usta was first formed accidentally from cerussa during the burning of a house near the Piræus. Litharge is easily formed by heating lead above its melting point in air, when it absorbs oxygen gas, and the resulting oxide may be skimmed off.

Mercury was common in the time of Pliny, but it is not mentioned by earlier writers. It was found native in Spain, but was more generally obtained by heating cinnabar (sulphide of mercury)

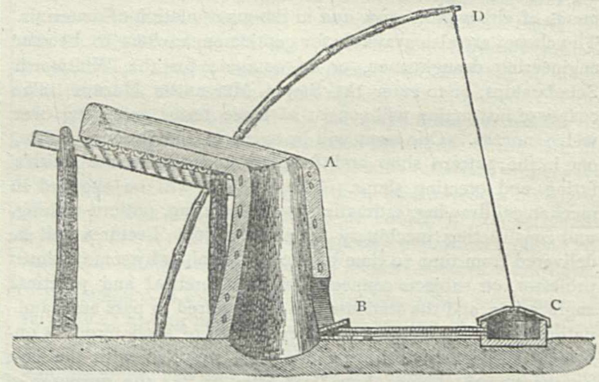


FIG. 4.—Smelting Furnace and Bellows used by native Indians in the present day.

with iron filings in an earthen vessel, to the top of which a cover was luted. The iron decomposed the sulphide, and the liberated mercury was volatilised and condensed on the cover of the vessel, whence it was collected. This method, described by Dioscorides, is the first crude example of *distillation*, which afterwards became a principal operation among the alchemists and chemists for separating the volatile from the fixed. In the time of Dioscorides cinnabar was called *minium*, but it became so largely adulterated with red lead that the term minium was ultimately applied to the latter. Minium is still one of the names for red lead. Pliny was acquainted with the high specific gravity of mercury, and with its power of dissolving gold. Substances were sometimes gilded by a gold amalgam. Mercury was also used, as now, for extracting gold from its earthy matrix; the gold-bearing rock was powdered and shaken up with mercury, which dissolved out the gold; the amalgam of gold and mercury was then squeezed through leather, which separated most of the mercury; the solid amalgam was heated to expel the mercury, and pure gold remained. Vitruvius states that gold was recovered from gold embroidery by burning the cloth in an earthen pot, and throwing the ashes into water to which quicksilver was added. The latter attracted the gold and dissolved it; the amalgam was put into a piece of cloth and squeezed between the hands, and the mercury, on account of its fluidity, was forced through the pores of the cloth, while the gold remained.

Native mercury was called *argentum vivum* (quicksilver), while mercury distilled from cinnabar was called *hydrargyrum* (ὑδωράργυρον, liquid silver), from which we take our present symbol for the metal, *Hg*. The alchemists, among whom, as we shall hereafter see, mercury was a very principal metal, call it by the various names of *mercurius*, *argentum vivum*, *hydrargyrum*, with others of a more fanciful nature.

The ancients were not acquainted with any other metals in an uncombined state, except the seven mentioned above. *Stibium* or sulphide of antimony, was used in the East at an early period for painting the eyelashes. It is still used for that purpose, and is called *kohl*. Native carbonate of zinc was known, and black oxide of manganese. The two sulphides of arsenic were known, and were used as pigments. The yellow sulphide was called *auripigmentum* and *arsenicum*; the red sulphide went by the name of *sandaracha*. Auripigmentum became contracted into *orpiment*, a word which we find both in alchemical treatises and in our most modern treatises on chemistry.

The colours used by the ancients for painting were examined by Sir Humphry Davy at the beginning of this century, and he came to the conclusion that "the Greek and Roman painters had almost all the same colours as those employed by the great Italian masters at the period of the revival of arts in Italy." Various colours have been examined from the frescoes in the Baths of Titus, from Pompeii, and from Egyptian tombs. The colours of the Egyptians were red, yellow, blue, green, black, and white. The red was bole, that is a clay deriving its colour from oxide of iron; the yellow an ochre, also clay, coloured by a paler form of oxide of iron; the green a mixture of this ochre with a blue powdered glass, produced by fusing together sand, carbonate of soda, and oxide of copper. The black was ivory black, prepared by heating bones out of contact with air until completely carbonised; the white was powdered chalk. These various colours were mixed with gum and water before use. The Greeks and Romans used red lead and cinnabar, as well as red ochre, and yellow protoxide of lead. The blue powdered glass mentioned above was called κύανος by the Greeks, *Cæruleum* by the Romans. Vitruvius describes the method of preparing it; and Davy prepared a substance which perfectly resembled the ancient colour, by fusing together fifteen parts of carbonate of soda, twenty parts of powdered flints, and three parts of copper filings. The green of the Romans was carbonate of copper, and for browns they sometimes used dark oxide of iron, sometimes oxide of manganese. The *purpurissum* of the Romans was Tyrian purple, a very valuable colour obtained from a shell fish, and much used for dyeing. In order to obtain the colour for the purposes of painting, clay was placed in the chaldrons of dye, so as to absorb the colour, and was afterwards removed and dried. *Indicum purpurissum* was probably indigo; Pliny mentions that the vapour possesses a fine purple colour. Ivory black was called *Elephantinum*; lamp black, that is soot, was called *Atramentum*. The latter mixed with water constituted the ink of the ancients.

According to Pliny, glass was first discovered by some Phœnician merchants who were returning from Egypt with a cargo of *natron* (carbonate of soda), and who landed on the sandy banks of the river Belus. In order to support the vessels they used for cooking their food over the fire, they used some large lumps of natron, and the fire was sufficiently strong to fuse it, with the fine sand of the river. Hence resulted the first glass. Whatever may be the value of this story, we find representations of glass-blowing on the monuments of Thebes and Beni Hassan; and the Egyptians were well acquainted with it 2450 B.C. The most celebrated manufactory of glass was in Egypt; and, according to Strabo, a peculiar kind of earth found near Alexandria was essential for the finer kinds of glass. The Egyptian glass had nearly the same composition as our "crown glass," which contains 63 per cent. of silica, 22 of potash, 12 of lime, and 3 of alumina. The Phœnicians and Egyptians exported large quantities of glass to Greece and Rome. The Egyptians engraved and cut glass with the diamond; they also possessed extraordinary skill in colouring glass with various metallic oxides, and combining several colours in the same vase, and they imitated precious stones with great success. We read of whole statues made of emerald, but these were undoubtedly of emerald glass, viz., glass coloured by oxide of copper. The Egyptians understood the art of enamelling on metals. Aristophanes is the first Greek author who mentions glass (τὴν ὕαλον); he alludes to the use of a lens of glass, as a burning-glass in the Νεφέλαι, which play was acted in Athens. B.C. 423. Colourless glass was the most valuable, and a small quantity of oxide of manganese was added then as now for the purpose of decolourising it. A very ancient opaque green glass, analysed by Klaproth, was found to contain 65 per cent. of silica, 10 of oxide of copper, 7·5 of oxide of lead, 3·5 of oxide of iron, and about 6 per cent. of both lime and alumina. A red glass was found to be coloured by red oxide of copper.

Dyeing was well understood by the ancients; the Egyptians understood the effect of acid on some colours, and were acquainted with mordants, that is, substances which "fix" the colouring matter in the fabric, and prevent it from being washed out. The most celebrated dye of antiquity was the purple of Tyre, discovered about 1500 B.C., perhaps earlier. It was produced by certain shell fish which inhabit the Mediterranean; these are spoken of as *buccinum* and *purpura* by Pliny. A few drops only of the dye were obtained from each fish, and the colour hence became very valuable, and was monopolised by the emperors of the world. The Egyptians dyed linen with indigo, which they procured from India, for they had considerable intercourse with that country at an early period.

Lime was used for removing the hair from skins about to be tanned. Leather made in the time of Sheshonk, the contemporary of Solomon, has been found in a good state of preservation. For the process of tanning, they used the pods of the Acacia Nilotica, a plant which, according to Sir G. Wilkinson, was also prized for its timber, charcoal, and gum.

*Nitrum* was a term applied to carbonate of soda, or natron, which, we have already seen, was used in the manufacture of glass. The substance which we now call *nitre* (nitrate of potash) was probably known in India and China before the Christian era. Dr. Thomas Thomson has suggested that when the real nitre was imported into Europe, it received the same name as carbonate of soda (nitrum) from the similarity of its appearance, and retained the name on account of its greater importance. Roger Bacon always speaks of nitrate of potash as nitre. The low Latin name for soda became *natrium*, hence our present symbol for sodium, *Na*.

Soap is first mentioned by Pliny; it was made by mixing wood ashes, which contain carbonate of soda, with animal fat. It was used solely as a kind of pomatum. The Greeks added wood ashes to water to increase its cleansing properties.

The only acid with which the ancients were acquainted was acetic acid, or vinegar. It has been suggested that the Egyptians discovered nitric acid and nitrate of silver, because a silver stain has been found upon some linen, but the evidence is insufficient. We remember the story about Cleopatra dissolving two pearls, valued at ten millions of sestertii, in vinegar; although only a story, it would seem to show that vinegar was the most powerful solvent known. This is further indicated by the story of Hannibal dissolving rocks by vinegar.

A number of minerals are mentioned by Pliny, but we can recognise but few of them. Iron pyrites (sulphide of iron) was used for striking fire with steel in order to kindle tinder, and was hence called pyrites (πῦρ, fire), or fire-stone. Sulphur was well known, and was used for matches; it was also apparently burnt in a current of air, and the sulphurous acid produced employed for bleaching purposes. Asphalt was used for embalming, and undoubtedly also for torches.

Thus far we have become acquainted with the various theories of the Ancients, in which changes in the composition of matter are discussed, and with various processes by which changes were actually effected. Before we leave the Ancients, and pass at one bound to the eighth century A.D., we must notice the commencement of a symbolical system in the history of matter, which in the hands of the Alchemists and early Chemists assumed vast proportions, and still appertains to the science of Chemistry. This system was commenced by the association of the seven metals with the seven greater heavenly bodies. We do not know at what period the metals were designated by the names and symbols of the planets: certainly at a very remote age.

At a very early date the Chaldæans represented the stars by symbols, and these gradually increased until astrology became one mass of symbols. On the occasion of certain religious ceremonies the Kings of Assyria wore a necklace in which the sun, moon, and stars were represented as emblems, for they were first worshipped as emblems of the Deity. Sculptural representations of necklaces with seven discs upon them have also been found. Symbols were carried before Egyptian priests, and their gods were represented with certain signs symbolical of their special attributes. The Assyrian goddess Astarte, carries in her left hand a symbol (*b*) (Fig 5.) not very different from the *crux ansata* of the Egyptians (*a*); and the symbol (*c*) by which the planet Venus was afterwards represented by the astrologers and is still represented by astronomers. In the celebrated "Book of the Dead" (B.C. 1350), the most perfectly preserved Egyptian ritual which the world possesses, this latter symbol (*c* in the figure) occurs frequently among the hieroglyphics. This is very noticeable in the "Judgment scene"

FIG. 5.—*a* Crux ansata of the Egyptians; *b* Assyrian symbol of Astarte; *c* Later symbol of the planet Venus.

of the Turin papyrus, a copy of which exists in the British Museum. The upper portion of the *crux ansata* was frequently made more rounded in form, and it is obvious that if in addition to this the cross was somewhat lowered, we should arrive at the third symbol (*c*) shown above. The *crux ansata* (*a*), if written quickly, could easily pass into this latter symbol (*c*), and this may account for the occurrence of both symbols in the judgment picture, to which we have alluded above.

Plato speaks of the sun, moon, and five planets, but does not distinguish them by the names of gods; Epinomis mentions them in conjunction with the names of gods. It is probable that the Chaldæans also associated the principal heavenly bodies with the names of deities—San with the sun, Hurki with the moon, Bel Merodach with Jupiter, Astarte or Ishtar with Venus, Nergal with Mars, &c. The relative position of the planets was generally as follows: the Earth was the centre of the system; next in order came the Moon, the Sun, Venus, Mercury, Mars, Jupiter, and Saturn; but these positions were sometimes varied. It was known that Saturn completed a revolution in about thirty years, while Jupiter required twelve years, Mars only two, and Mercury and Venus occupied about the same time as the Sun; hence the above order. As Saturn was farthest from the source of heat, and the slowest in his motion, he was supposed to be of an icy character, and to assert an evil influence.

While speaking of the seven greater heavenly bodies, and the seven metals, we may allude incidentally to the curious prominence of that number in many matters—"that mysterious number," as Mr. Layard calls it, "so prevalent in the Sabæan system." Thus (to select a few instances at random) we have seven days of the week, seven wise men of Greece, seven wonders of the world, seven cardinal sins, seven-stringed lyre, seven harmonic proportions, seven heavens, seven walls of Ecbatana, seven gates of Thebes. The list might be extended almost indefinitely. Among the Hebrews the number was specially prominent. Not to mention the frequent allusion to it in the Apocalypse, we may recall the incidents of the fall of Jericho: the town was surrounded for seven days; on the seventh day the walls fell at the blast of seven trumpets, which were carried round the walls seven times by seven priests.

We cannot tell why the seven metals were associated with the seven deified heavenly bodies, unless it was because all things which amounted to the same number were connected with them. This, at least, we know, that long before the time of Geber, the first writer on chemistry, the metals had received the same names and symbols as the planets. "There is abundant evidence," says Mr. Gladstone, "of a correspondence between the seven metals of Homer and the seven metals of the ancient planetary worship of the East." In the time of Homer only six simple metals were known, and the seventh was the compound *kuanos*; quicksilver afterwards became the seventh simple metal, and received the name and symbol of the seventh planet. The metals were apportioned as follows:—

| | | |
|---|---|---|
| Gold . . . | The Sun . . . . . | ☉ |
| Silver . . . | The Moon . . . . | ☽ |
| Quicksilver . . | Mercury . . . . . | ☿ |
| Copper . . . | Venus . . . . . | ♀ |
| Tin . . . . | Jupiter . . . . . | ♃ |
| Iron . . . | Mars . . . . . | ♂ |
| Lead . . . | Saturn . . . . . | ♄ |

Herodotus tells us that Ecbatana had seven walls, the outermost of which was the lowest, and the others gradually ascended like steps to the highest, which enclosed the king's palace. They were each painted of a particular colour; the outermost white, the second black, the third purple, the fourth blue, the fifth red, the sixth the colour of silver, the seventh the colour of gold. Undoubtedly these had reference to the seven greater heavenly bodies. It is impossible to account for the colours, but it is curious to notice the particular colour which would fall to any particular metal. Placing the planets in order as applied to the metals, we should have gold to gold, silver to silver, red to copper, blue to iron, purple to tin, black to lead, the most despised of the metals. It is probable that the Sabæans associated these colours with the seven heavenly bodies. The temple of Bel-Merodach, rebuilt by Nebuchadnezzar, and called by him the "Wonder of Borsippa," appears also to have consisted of seven terraces differently coloured. The following is a portion of the inscription from a clay cylinder found among the ruins of the temple:—"I (Nebuchadnezzar) have completed the magnificence of the tower with silver, gold, precious stones, enamelled bricks, fir, and pine. . . . . This most ancient monument of Borsippa is the house of the seven lights of the earth."

How the symbols conferred upon the planets and afterwards upon the metals arose it is difficult to say; they are undoubtedly of Chaldæan origin, but to what extent they have since been modified no one can tell. They exist in early MSS. on Alchemy. That the sun should be represented by a circle, the symbol of perfection, is no wonder. Again, that the moon should be symbolised by a crescent we can understand; but the others present greater difficulties. Among these, some say we have the looking-glass of Venus, the thunderbolts of Jupiter, the spear and shield of Mars, the scythe of Saturn, and the caduceus of Mercury. In the temple of Hermes at Pselcis he is represented with a staff having a serpent twining around it, from which it has been suggested the caduceus of Mercury may have been derived. Some see in ♃, not the thunderbolts, but the throne of Jupiter; others the *Zeta* of Zeus; others, again, the Arabic 4, indicating that Jupiter was the fourth planet in order. Some, too, have seen in ♄ the K of Kronos. It is less difficult to understand why a particular metal was assigned to a particular heavenly body. Thus gold would naturally be associated with the sun, on account of its colour, perfection, and beauty, and because it was ever regarded as the noblest metal. For the same reason silver would fall to the moon, with its pale, silvery colour and light. So, again, iron, the metal of war, would be associated with Mars; lead, the dull, despised metal, with Saturn, the slowest of the planets; quicksilver, the nimble volatile metal, with Mercury, the messenger of the gods.

These signs became in the hands of the Alchemists the commencement of a symbolic system in chemistry.

(*To be continued.*) G. F. RODWELL

## SOCIETIES AND ACADEMIES

### LONDON

**Royal Geographical Society**, Nov. 11.—Major-General Sir H. C. Rawlinson, president, in the chair. The President, in his inaugural address, recapitulated the leading incidents which have occurred in the exploration of Africa since June, at which time we were in receipt merely of a brief telegraphic announcement that Mr. Stanley had arrived at Zanzibar with despatches, having left Livingstone alone and well at Unyanyembe; and stated that, as the Society honestly consider Mr. Stanley's journey to Lake Tanganyika to be in its results the most important geographical achievement of the year, they feel that, in awarding him their medal, they are only discharging their strict duty, while at the same time they are doing honour to Livingstone and promoting the great end of African discovery. The President then passed on to the history of the Society's own Relief Expedition, touching which he said:—"Much disappointment was felt at the abrupt termination of this expedition. The committee of the Geographical Council charged with the management of the Search and Relief Fund, after a most patient investigation, delivered two reports to the subscribers, the purport of which was that they disapproved of the conduct of Lieutenant Dawson in breaking up the expedition, and that they attributed it to a lamentable error of judgment that he did not carry on to the Doctor, as supplementary to Stanley's relief, a supply of arms, instruments, medicines, and other articles of which he manifestly stood in need. The judgment delivered by the committee has since been greatly fortified by letters written by Dr.

Livingstone on July 1st, in which, in answer to his son's letters from Zanzibar, he deplores the break-up of the expedition, showing how valuable would have been to him the arrival of the officers at Unyanyembe, and he proposed subsequently to have utilised their services. At the same time, it is only fair to Lieutenant Dawson to say that no imputation whatever rests upon his courage or his honour. Let it be understood, once for all, that there is not the remotest ground for questioning the accuracy of Mr. Stanley's statement. It is positively certain that Stanley and Livingstone met at Ujiji this time last year, that they travelled on an exploring journey round the northern end of Lake Tanganyika, and subsequently came down together to Unyamyembe, where the Doctor still was at the date of his last despatches." Referring to the sufferings undergone by Livingstone, the President said, "it is not therefore surprising that, while smarting under his losses and injuries, he should have reflected with some bitterness on Dr. Kirk, the Acting-Consul at Zanzibar, who was more or less concerned in sending off the supplies, and in selecting the agents to be employed." After alluding to the complete reconciliation which it is hoped has now been effected between Livingstone and Kirk, the president at some length entered into Livingstone's geographical researches, and arrived at these conclusions:—"There can be no reasonable doubt that this great water-system of Central Africa belongs to the Congo and not to the Nile. The proofs of the identity of the Lualaba and the Congo, derived from a comparison of height-measurements, of volume of water, of the periodical rains and rise of the rivers, &c. have been put together very clearly in a paper by Dr. Behm, which has just appeared in the current number of Petermann's 'Mittheilungen,' and many arguments arising from local information, as well as from coincidences of natural history and ethnology, might be added in corroboration. The only impediment, indeed, to a full and clear understanding on this point is the remarkable fact that, although Livingstone had followed down the gradual slope of the Lualaba from the high plateau where it rises, 5,000 or 6,000 feet above the sea-level, to a point where the barometer gave an elevation of only 2,000 feet—that is to a point depressed 1,000 feet below the parallel Nile basin to the eastward; and although the constant trending of the waters to the west haunted him with misgivings, still he clung tenaciously to his old belief that he must be on the track of the Nile, and even speculated on the possibility of the great river he was pursuing debouching by the Bahr-el-Ghazal. It must be borne in mind, however, that Livingstone in his African solitude had no knowledge of Schweinfurth's discoveries. He had no idea that one, or perhaps two, watersheds intervened between the Lualaba and the head-waters of the Bahr-el-Ghazal; nor does he seem to have been aware that his great river at Nyangwé contained 19 times the volume of water contributed by the western affluent of the White Nile. When this revelation breaks on him, it is not too much to suppose that he will abandon his Nile theory, and rest satisfied with the secondary honour—if indeed it be secondary—of having discovered and traced the upper course of the Congo, which is emphatically called by the natives 'the great river' of Africa." The president then spoke of the "Livingstone Congo Expedition," to which we refer in another column. "The deputation of Sir Bartle Frere on a mission to Zanzibar for the suppression of the slave trade, of which Livingstone may hear before he leaves the vicinity of Lake Tanganyika, will be to him an event of the intensest interest, and may thus have an important influence on his future movements. It is not impossible that Lieut. Cameron might fall in with Baker's flotilla on the Albert Nyanza, as reports have reached us, though not as yet officially confirmed, that Sir S. Baker had pushed on during last summer with a flying column from Gondokoro to the point where the Nile leaves the Nyanza, and had made arrangements for his steamer and boats to be brought up in carts."

Linnean Society, Nov. 7.—Mr. G. Bentham, president, in the chair. On the buds developed on leaves of *Malaxis*, by Dr. Dickie. These buds, developed chiefly on the margins of the leaves of *Malaxis paludosa*, are of interest from the very remarkable resemblance which they bear to the ovules of Orchids, representing an embryo enclosed in a loose enveloping testa.—On the "Piopio" of New Zealand (*Keropia crassirostris* Gmel), by T. H. Potts.

Chemical Society, Nov. 7—Prof. Williamson, F.R.S., in the chair. Papers were read by Mr. C. E. Stanford, on "the action of charcoal on organic nitrogen," being an account of his experiments to ascertain the value of a method of deodorising and utilising fish-offal and other offensive matters by mixing them with charcoal; and "on Iona pebbles."—A communication entitled "Mineralogical Notices," by Prof. Storey Maskelyne and Dr. Flight, was then read by the former, giving a short description of several minerals mostly new or from fresh localities.—Mr. J. R. A. Newlands gave a brief explanation of "a means of preventing explosions in coal-mines," which the author proposes to effect by erecting air-tight chambers over the upcast and downcast shafts, and forcing air through the workings by powerful air pumps or ventillating fans. —There were also papers "on the specific heat of occluded hydrogen," by W. C. Roberts, and Dr. C. R. A. Wright, and "on some probable reactions that yielded negative results" by Dr. C. R. A. Wright. A specimen of bromocamphor was exhibited by Mr. Williams, of the firm of Hopkin and Williams, who stated that it was used medicinally as a nerve sedative, in such diseases as *delirium tremens*.

Entomological Society, Nov. 4.—Prof. Westwood, president, in the chair. Mr. S. Stevens exhibited an example of *Pieris Daplidice*, and six of *Argynnis Lathonia*, captured by himself in the autumn, at Dover; also, from the same locality, varieties of *Pyrameis cardui*, and *Callimorpha dominula*; *Sesia asiliformis*, *Chærocampa celerio*, and *Deilephila livornica* from Brighton; and a dark variety of *Pieris rapæ* from Ireland. Mr. F. Smith exhibited a large collection of *Formicidæ* sent from Calcutta by Mr. Rothney. He also exhibited, and presented to the Society, the minute-book of the old Entomological Society, containing records of the meetings between 1806 and 1822; incorporating also the minutes of the pre-existing Aurelian Society—this had been given to him by Dr. J. E. Gray. Mr. Butler exhibited the impression of the wing of a butterfly in Stonesfield slate; it was remarkably perfect, and approached nearest to the existing South American genus *Caligo*. Mr. Davis exhibited a large collection of beautifully preserved larvæ of various insects. Mr. Davis exhibited a collection of drawings illustrating the transformations of Indian *Lepidoptera*. He also remarked concerning the habits of the common gnat; from July to the present time he had, every day, found swarms of this insect in his house, all being females, which sex only is capable of inflicting painful bites; the windows were constantly closed, yet each day a fresh swarm appeared to replace those destroyed, and he could not account for their appearance, unless they (as he thought probable) came down the chimneys. Mr. Müller read notes on the habits of a small beetle allied to *Anobium*, which he had bred from a large oak-gall from California. The Rev. R. P. Murray communicated notes on variations in the neuration of certain *Papilionidæ*. A further portion of the proposed general Catalogue of British Insects, comprising the *Ichneumonidæ*, *Braconidæ*, &c. compiled by the Rev. T. A. Marshall, was announced as published, and notes thereon by Mr. Marshall were read.

Anthropological Institute, Nov. 5.—Dr. R. S. Charnock, vice-president, in the chair. A paper was read on "Man and the Ape" by Mr. C. Staniland Wake. After referring to the agreement in physical structure of man and the ape, and to the fact that the latter possesses the power of reasoning, with all the faculties necessary for its due exercise, the author proceeded to show that it is incorrect to affirm that man has no special mental faculty. He has a spiritual insight or power of reflection which enables him to distinguish qualities and to separate them as objects of thought from the things to which they belong. All language is in some sense the result of such a process, and its exercise by even the most uncivilised peoples is shown in their having words denoting colours. The possession by man of the faculty of insight or reflection is accompanied by a relative physical superiority. The human brain is much longer than that of the ape, and he has also a much more refined nervous structure, with a naked skin. The author here showed that the only physical fact absolutely necessary to be accounted for is the great size of the human brain, and this could not be done on the hypothesis of natural selection. Mr. Wallace's reference, on the other hand, to a creative will really undermines Mr. Darwin's whole hypothesis. After referring to the theories of Mr. Murphy and Haeckel, the author stated that the only way to explain man's origin, consistently with his physical and mental connection with the ape, is to suppose that nature is an organic whole, and that man is the necessary result of its evolution. While man, therefore, is derived from the ape, as supposed by Mr. Darwin, it is under conditions very different from those which his hypothesis requires. According to this, the appearance of man on the earth must have been in a certain sense accidental; while, according to the author's view, organic nature could only have been evolved in the direction of man, who is the necessary result of such evolution, and a perfect epitome of nature itself.

PARIS

Academy of Sciences, Oct. 28.—M. Faye, President.—The first paper was a long reply to M. Pasteur's late paper on the production of wine, by M. Fremy; at its conclusion M. Pasteur rose and defended his former position, after which M. Fremy again returned to the attack, on the conclusion of which M. Pasteur contented himself with saying that he had already answered all objections. M. A. Trécul then read a note on the origin of Ferments, on the conclusion of which M. Pasteur made a few remarks, and the discussion dropped.—M. Yvon Villarceau next read a paper on a new general mechanical theory. M. Chevreul followed with the conclusion of his answer to M. A. Gruyer's report on the London International Exhibition of 1871. MM. P. A. Favre and C. A. Valson's researches on crystalline dissociation came next. They concluded this, the third paper, as follows:—"The result of solution is to give to the elements of the dissolved bodies a reciprocal independence, and the internal mechanical work necessary to produce this effect is measured by the changes of volume which accompany solution, and consequently by the quantity of heat brought into play when the same effects of force are applied directly to the dissolving liquid by means of equivalent actions."—M. Is. Pierre and E. Puchot followed with a paper entitled "New Studies on valeric acid, and on its preparation on the large scale." The authors assert that valeric acid rotates the planeof polarisation in the same direction as cane sugar, while amylic alcohol rotates it in the opposite direction. A paper on butyric acid, by the same authors followed. The acid, prepared from butyric alcohol, exerts no sensible action on polarised light; it boils regularly at 155·5, when the barometer stands at 760 M.M.—A paper on the extension of the *Phylloxera* in Europe, by M. J. E. Planchon, was then read. The author states that the insect is indigenous to America, and that it is a recent importation into Europe.—A memoir by M. Resal on the equation of movement of a funicular curve, &c., was referred to the section of mechanics, and was followed by an essay on the theory of running streams, by M. Boussinesq.—A paper by Mr. Grace Calvert on the power possessed by certain substances of stopping putrefaction and the development of protoplasmic life, was then read, after which came the second of M. Dareste's studies on the osteological type of osseous fish; it was referred to the zoological and anatomical section.—M. Dumas then read some communications from the *Phylloxera* Commission, which received at this meeting a communication from M. Loarer.—The Lightning Conductor Commission received five reports from M. W. de Fonvielle, who is charged with a mission to England by that commission. A memoir on fevers by M. P. Levers was sent to the commission for administering the Bréant legacy, and that on the preservation of articles of food received a paper from M. Lacc.—M. Yvon Villarceau then presented M. Stephan's Observations and Ephemerides of the planet 123.—Then came some new observations on Summit and Thalweg Lines, by M. C. Jordan,—A note by M. H. Delray on the purple of Cassius was then read. The author proposes the following definition of this body, the true constitution of which has not yet been satisfactorily determined. He says that purple of Cassius is a lake of stannic or melastannic acid coloured with finely divided gold, and that the latter has, by reason of its combination with the tin oxide, lost its solubility in mercury, just as many colouring matters become insoluble as soon as they encounter vegetable fibre. He adduces several experiments in support of this view.—A note from M. H. Violette on the Fusion of Platinum followed. The author has fused platinum in a wind furnace connected with the chimney-shaft of a large factory, and fed with gas-carbon in small fragments. 50 grammes were thus fused in an hour, but one of the secretaries of the Academy suggests that the platinum was contaminated with the carbon or silicon, and thus rendered abnormally fusible. M. de Quatrefages then presented a note by M. de la Blanchière on changes of colouration produced in fish by the conditions of their *habitat*, after which M. C. Sedillot presented some researches on the physiological and anti-fermentescible properties of sodic silicate, by MM. A. Rabuteau and F. Papillon; these further experiments confirm the author's previous results, with the exception that in some cases the action on ferments is only temporary. The author hopes to be able to explain this retarding action of the silicate in a future communication.—This paper was followed by one on some chemical researches on the leaves of *Eucalyptus globulus*, by M. Rabateau. These leaves are used as an antiperiodic, and the author endeavoured to find in them an alkaloid, but did not succeed.—M. Ch. Grad then read a paper on the quaternary formations of the Algerine Sahara, and was followed by M. A. Béchamp with a paper on some researches on the physiological theory of the alcoholic fermentation produced by beer yeast. The researches of the author tend to support the physiological and not the chemical theory.—M. Jacquez then demanded the opening of two notes deposited by him on the 23rd November, 1857, and 4th January, 1858. The notes related to the action of borates in preventing putrefaction and the growth of mould, and their use as an injection for subjects for dissection; the conclusion arrived at in the first note is, that these salts are extremely efficacious for the above purposes.—A note by M. Guynemer, deposited on the 3rd of January, 1870, and relating to the November meteorites, was next opened.—A note by M. Malessart on a new motive power obtained by a particular disposition of electro magnets, was submitted to M. E. Becquerel for examination.—M. Lamson presented some drawings of a machine, the motive power of which was produced by the action of gravity. They were submitted to M. Dupuy de Lôme.—M. F. Thomas sent a note on the production of fluorine by the action of cupric sulphate on an anhydrous fluoride, which was submitted to M. Balard.

## BOOKS RECEIVED.

English.—The Forms of Water in Clouds and Rivers, Ice and Glaciers: J. Tyndall (H. S. King and Co.).—Elementary Treatise on Natural Philosophy: A. Privat Deschanel, translated by Prof. J. D. Everett (Blackie and Son).—Notes on River Basins: E. R. Williams (Longmans).

## DIARY

*THURSDAY*, November 14.

London Mathematical Society, at 8.—Remarks on some Recent Generalisations of Algebra: the President.—Sur les Fonctions Circulaires: M. Hermite.—Investigation of the Disturbance produced by a Spherical Obstacle on the Waves of Sound: Hon. J. W. Strutt.—On the Mechanical Description of a Cubic Curve: Prof. Cayley.—A Series of Models of Cubic Surfaces to Illustrate their Different Forms: Prof. Henrici.—On a Theorem Relating to the Polyedra with Triangular Faces, with Illustrative Models: Prof. W. A. Clifford.

*SUNDAY*, November 17.

Sunday Lecture Society, at 4.—On the Dawn of the Sciences in Europe: Prof. W. K. Clifford.

*MONDAY*, November 18.

Entomological Society, at 7.

*TUESDAY*, November 19.

Zoological Society, at 8.30.

Anthropological Institute, at 8.—The Moabite Jars, with a Translation: Rev. Dunbar I. Heath, M.A.—Human Remains from Iceland: Capt. Burton and Dr. Blake.—The Atlantean Race of Western Europe: the late J. W. Jackson.

*WEDNESDAY*, November 20.

Geological Society at 8.—On the Geology of the Thunder-Bay and Shabendowan Mining Districts, on the North Shore of Lake Superior: Dr. Alleyne Nicholson, F.G.S.—On the Relations of the supposed Carboniferous Plants of Bear Island with the Palæozoic Flora of North America: Dr. J. W. Dawson, F.R.S.—Further Notes on Eocene Crustacea from Portsmouth: H. Woodward, F.G.S.—On a New Trilobite from the Cape of Good Hope: H. Woodward, F.G.S.

Meteorological Society, at 7.—On the Storms experienced by the Submarine Cable Expedition in the Persian Gulf, Nov. 1 and 2, 1869: Latimer Clark, M. Inst. C.E.—On the Meteorology of Southland, New Zealand, in 1871: C. Rous Marten.—On a Self-registering Tide-gauge and Electrical Barograph: H. C. Russell, Government Astronomer, Sydney.

*THURSDAY*, November 21.

Linnean Society, at 8.—On the *Compositæ* of Bengal: C. B. Clarke, F.L.S.—On Diversity of Evolution under one set of External Conditions: Rev. J. T. Gulick.

Chemical Society, at 8.

## CONTENTS